Organization	Title	Date
Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services	Toxicological Profile for Polycyclic Aromatic Hydrocarbons	1995
Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services - Environmental Health and Medicine Education	What Are Routes of Exposure to Lead?	
Altech for USACE Detroit	Phase II Assessment: Fox River, Wisconsin	2001
Altech for USACE Detroit	Phase II Limited Soil Investigation, Kaukauna Power Canal, Parcel J	2006
Barr for USACE Detroit	Volume I: Fox River Environmental Baseline Assessment and Phase I Environmental Assessment Report	2000
Egyptian Journal of Petroleum (Abdel-Shafy & Mansour)	A review on polycyclic aromatic hydrocarbons: Sou	2016
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TOXICOLOGICAL PROFILE FOR

POLYCYCLIC AROMATIC HYDROCARBONS

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

August 1995

DISCLAIMER

The use of company or product name(s) is for identification only and does not imply endorsement by the Agency for Toxic Substances and Disease Registry.

UPDATE STATEMENT

A Toxicological Profile for Polycyclic Aromatic Hydrocarbons was released in December 1990. This edition supersedes any previously released draft or final profile.

Toxicological profiles are revised and republished as necessary, but no less than once every three years. For information regarding the update status of previously released profiles, contact ATSDR at:

Agency for Toxic Substances and Disease Registry
Division of Toxicology/Toxicology Information Branch
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333

FOREWORD

This toxicological profile is prepared in accordance with guidelines developed by ATSDR and EPA. The original guidelines were published in the Federal Register on April 17, 1987. Each profile will be revised and republished as necessary.

The ATSDR toxicological profile succinctly characterizes the toxicologic and adverse health effects information for the hazardous substance being described. Each profile identifies and reviews the key literature (that has been peer-reviewed) that describes a hazardous substance's toxicologic properties. Other pertinent literature is also presented, but described in less detail than the key studies. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced.

Each toxicological profile begins with a public health statement, that describes in nontechnical language, a substance's relevant toxicological properties. Following the public health statement is information concerning levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine a substance's health effects is described in a health effects summary. Data needs that are of significance to protect public health will be identified by ATSDR and EPA. The focus of the profiles is on health and toxicologic information; therefore, we have included this information in the beginning of the document.

Each profile must include the following:

(A) The examination, summary, and interpretation of available toxicologic information and epidemiologic evaluations on a hazardous substance in order to ascertain the levels of significant human exposure for the substance and the associated acute, subacute, and chronic health effects.

(B) A determination of whether adequate information on the health effects of each substance is available or in the process of development to determine levels of exposure that present a significant risk to human health of acute, subacute, and chronic health effects.

(C) Where appropriate, identification of toxicologic testing needed to identify the types or levels of exposure that may present significant risk of adverse health effects in humans.

The principal audiences for the toxicological profiles are health professionals at the federal, state, and local levels, interested private sector organizations and groups, and members of the public.

The toxicological profiles are developed in response to the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499) which amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund). This public law directed the Agency for Toxic Substances and Disease Registry (ATSDR) to prepare toxicological profiles for hazardous substances most commonly found at facilities on the CERCLA National Priorities List and that pose the most significant potential threat to human health, as determined by ATSDR and the Environmental Protection Agency (EPA). The availability of the revised priority list of 275 hazardous substances was announced in the Federal Register on February 28, 1994 (59 FR 9486). For prior versions of the list of substances, see Federal Register notices dated April 17, 1987 (52 FR 12866); October 20, 1988 (53 FR 41280); October 26, 1989 (54 FR 43619); October 17, 1990 (55 FR 42067); and October 17, 1991 (56 FR 52166); and October 28, 1992 (57 FR 48801).

Foreword

Section 104(i)(3) of CERCLA, as amended, directs the Administrator of ATSDR to prepare a toxicological profile for each substance on the list.

This profile reflects our assessment of all relevant toxicologic testing and information that has been peer reviewed. It has been reviewed by scientists from ATSDR, the Centers for Disease Control and Prevention (CDC), and other federal agencies. It has also been reviewed by a panel of nongovernment peer reviewers and was made available for public review. Final responsibility for the contents and views expressed in this toxicological profile resides with ATSDR.



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THE PROFILE HAS UNDERGONE THE FOLLOWING ATSDR INTERNAL REVIEWS:

1. Green Border Review. The Green Border review assures consistency with ATSDR policy.

2. Health Effects Review. The Healths Effects Review Committee examines the health effects chapter of each profile for consistency and accuracy in interpreting health effects and classifying end points.

3. Minimal Risk Level Review. The Minimal Risk Level Workgroup considers issues relevant to substance-specific minimal risk levels (MRLs), reviews the health effects database of each profile, and makes recommendations for derivation of MRLs.

4. Quality Assurance Review. The Quality Assurance Branch assures that consistency across profiles is maintained, identifies any significant problems in format or content, and establishes that Guidance has been followed.

PEER REVIEW

A peer review panel was assembled for the PAHs. The panel consisted of the following members:

1. Dr. Gail Charnley, Consultant in Toxicology, Arlington, Virginia;

2. Dr. Edmond LaVoie, Professor, Rutgers University College of Pharmacy, Piscataway, New Jersey; and

3. Dr. Alexander Wood, Distinguished Research Leader and Director, Department of Oncology, Hoffmann-LaRoche, Inc., Nutley, New Jersey.

These experts collectively have knowledge of the polycyclic aromatic hydrocarbons' physical and chemical properties, toxicokinetics, key health end points, mechanisms of action, human and animal exposure, and quantification of risk to humans. All reviewers were selected in conformity with the conditions for peer review specified in Section 104(i)(13) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended.

Scientists from the Agency for Toxic Substances and Disease Registry (ATSDR) have reviewed the peer reviewers' comments and determined which comments will be included in the profile. A listing of the peer reviewers' comments not incorporated in the profile, with a brief explanation of the rationale for their exclusion, exists as part of the administrative record for this compound. A list of databases reviewed and a list of unpublished documents cited are also included in the administrative record.

The citation of the peer review panel should not be understood to imply its approval of the profile's final content. The responsibility for the content of this profile lies with the ATSDR.

CONTENTS

FOREWORD v

CONTRIBUTORS vii

PEER REVIEW ix

LIST OF FIGURES xv

LIST OF TABLES xvii

1. PUBLIC HEALTH STATEMENT 1
   1.1 WHAT ARE POLYCYCLIC AROMATIC HYDROCARBONS? 1
   1.2 WHAT HAPPENS TO POLYCYCLIC AROMATIC HYDROCARBONS WHEN THEY ENTER THE ENVIRONMENT? 3
   1.3 HOW MIGHT I BE EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS? .. 3
   1.4 HOW CAN POLYCYCLIC AROMATIC HYDROCARBONS ENTER AND LEAVE MY BODY? 5
   1.5 HOW CAN POLYCYCLIC AROMATIC HYDROCARBONS AFFECT MY HEALTH? . 6
   1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS? 7
   1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH? 7
   1.8 WHERE CAN I GET MORE INFORMATION? 9

2. HEALTH EFFECTS 11
   2.1 INTRODUCTION 11
   2.2 DISCUSSION OF HEALTH EFFECTS BY ROUTE OF EXPOSURE 11
      2.2.1 Inhalation Exposure 15
         2.2.1.1 Death 15
         2.2.1.2 Systemic Effects 16
         2.2.1.3 Immunological and Lymphoreticular Effects 19
         2.2.1.4 Neurological Effects 20
         2.2.1.5 Reproductive Effects 20
         2.2.1.6 Developmental Effects 20
         2.2.1.7 Genotoxic Effects 20
         2.2.1.8 Cancer 22
      2.2.2 Oral Exposure 23
         2.2.2.1 Death 23
         2.2.2.2 Systemic Effects 24
         2.2.2.3 Immunological and Lymphoreticular Effects 40
         2.2.2.4 Neurological Effects 41
         2.2.2.5 Reproductive Effects 41
         2.2.2.6 Developmental Effects 43
         2.2.2.7 Genotoxic Effects 45
         2.2.2.8 Cancer 49

2.2.3 Dermal Exposure 53
2.2.3.1 Death 53
2.2.3.2 Systemic Effects 53
2.2.3.3 Immunological and Lymphoreticular Effects 60
2.2.3.4 Neurological Effects 62
2.2.3.5 Reproductive Effects 62
2.2.3.6 Developmental Effects 62
2.2.3.7 Genotoxic Effects 62
2.2.3.8 Cancer 64
2.3 TOXICOKINETICS 77
2.3.1 Absorption 78
2.3.1.1 Inhalation Exposure 78
2.3.1.2 Oral Exposure 81
2.3.1.3 Dermal Exposure 84
2.3.2 Distribution 87
2.3.2.1 Inhalation Exposure 87
2.3.2.2 Oral Exposure 88
2.3.2.3 Dermal Exposure 90
2.3.3 Metabolism 91
2.3.4 Excretion 99
2.3.4.1 Inhalation Exposure 99
2.3.4.2 Oral Exposure 102
2.3.4.3 Dermal Exposure 103
2.3.4.4 Other Routes of Exposure 105
2.3.5 Mechanisms of Action 108
2.4 RELEVANCE TO PUBLIC HEALTH 111
2.5 BIOMARKERS OF EXPOSURE AND EFFECT 169
2.5.1 Biomarkers Used to Identify or Quantify Exposure to Polycyclic Aromatic Hydrocarbons 170
2.5.2 Biomarkers Used to Characterize Effects Caused by Polycyclic Aromatic Hydrocarbons 173
2.6 INTERACTIONS WITH OTHER SUBSTANCES 174
2.7 POPULATIONS THAT ARE UNUSUALLY SUSCEPTIBLE 185
2.8 METHODS FOR REDUCING TOXIC EFFECTS 189
2.8.1 Reducing Peak Absorption Following Exposure 190
2.8.2 Reducing Body Burden 190
2.8.3 Interfering with the Mechanism of Action for Toxic Effects 191
2.9 ADEQUACY OF THE DATABASE 192
2.9.1 Existing Information on Health Effects of Polycyclic Aromatic Hydrocarbons . . . 192
2.9.2 Identification of Data Needs 194
2.9.3 Ongoing Studies 206

3. CHEMICAL AND PHYSICAL INFORMATION 209
3.1 CHEMICAL IDENTITY 209
3.2 PHYSICAL AND CHEMICAL PROPERTIES 209

4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL 223
4.1 PRODUCTION 223
4.2 IMPORT/EXPORT 225

4.3 USE 226
4.4 DISPOSAL 226

5. POTENTIAL FOR HUMAN EXPOSURE 229
5.1 OVERVIEW 229
5.2 RELEASES TO THE ENVIRONMENT 230
5.2.1 Air 230
5.2.2 Water 234
5.2.3 Soil 235
5.3 ENVIRONMENTAL FATE 236
5.3.1 Transport and Partitioning 236
5.3.2 Transformation and Degradation 246
5.3.2.1 Air 246
5.3.2.2 Water 249
5.3.2.3 Sediment and Soil 252
5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT 255
5.4.1 Air 255
5.4.2 Water 258
5.4.3 Sediment and Soil 261
5.4.4 Other Environmental Media 266
5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE 271
5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES 282
5.7 ADEQUACY OF THE DATABASE 282
5.7.1 Identification of Data Needs 284
5.7.2 Ongoing Studies 288

6. ANALYTICAL METHODS 291
6.1 BIOLOGICAL SAMPLES 291
6.2 ENVIRONMENTAL SAMPLES 306
6.3 ADEQUACY OF THE DATABASE 322
6.3.1 Identification of Data Needs 322
6.3.2 Ongoing Studies 325

7. REGULATIONS AND ADVISORIES 327

8. REFERENCES 371

9. GLOSSARY 455

APPENDICES

A. USER'S GUIDE A-1

B. ACRONYMS, ABBREVIATIONS, AND SYMBOLS B-1

LIST OF FIGURES

2-1 Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Inhalation 18

2-2 Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral 32

2-3 Proposed Metabolic Scheme for Benzo[a]pyrene 93

2-4 Proposed Metabolic Scheme for Benzo[b]fluoranthene 100

2-5 Existing Information on Health Effects of Polycyclic Aromatic Hydrocarbons 193

5-1 Frequency of NPL Sites with PAHs Contamination 231

LIST OF TABLES

2-1 Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Inhalation 17

2-2 Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral 25

2-3 Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Dermal 54

2-4 Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo* 133

2-5 Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro* 139

2-6 Summary of Carcinogenicity Studies with Polycyclic Aromatic Hydrocarbons Using Parenteral Routes of Exposure 165

2-7 Ongoing Studies on Polycyclic Aromatic Hydrocarbons 207

3-1 Chemical Identity of Polycyclic Aromatic Hydrocarbons 210

3-2 Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons 216

4-1 Facilities That Manufacture or Process Anthracene 224

5-1 Releases to the Environment From Facilities That Manufacture or Process Anthracene 233

5-2 Polycyclic Aromatic Hydrocarbons (PAHs) Bioconcentration Factors (BCFs) for Selected Species of Aquatic Organisms 242

5-3 Background Soil Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) 262

5-4 Soil Concentrations Polycyclic Aromatic Hydrocarbons (PAHs) at Contaminated Sites 263

5-5 Concentrations of Some Polycyclic Aromatic Hydrocarbons (PAHs) in Tobacco Smoke 272

5-6 Average Indoor Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Different Categories of Sample Homes Occupied by Smokers and Non-smokers 276

5-7 Fish Consumption Advisories 283

6-1 Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples 292

6-2 Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples 307

7-1 Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons 329

1. PUBLIC HEALTH STATEMENT

This statement was prepared to give you information about polycyclic aromatic hydrocarbons (PAHs) and to emphasize the human health effects that may result from exposure to them. The Environmental Protection Agency (EPA) has identified 1,408 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal clean-up activities. PAHs have been found in at least 600 of the sites on the NPL. However, the number of NPL sites evaluated for PAHs is not known. As EPA evaluates more sites, the number of sites at which PAHs are found may increase. This information is important because exposure to PAHs may cause harmful health effects and because these sites are potential or actual sources of human exposure to PAHs.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to substances such as PAHs, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, lifestyle, and state of health.

1.1 WHAT ARE POLYCYCLIC AROMATIC HYDROCARBONS?

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. There are more than 100 different PAHs. PAHs generally occur as complex mixtures (for example, as part of combustion products such as soot), not as single compounds. PAHs usually occur

naturally, but they can be manufactured as individual compounds for research purposes; however, not as the mixtures found in combustion products. As pure chemicals, PAHs generally exist as colorless, white, or pale yellow-green solids. They can have a faint, pleasant odor. A few PAHs are used in medicines and to make dyes, plastics, and pesticides. Others are contained in asphalt used in road construction. They can also be found in substances such as crude oil, coal, coal tar pitch, creosote, and roofing tar. They are found throughout the environment in the air, water, and soil. They can occur in the air, either attached to dust particles or as solids in soil or sediment.

Although the health effects of individual PAHs are not exactly alike, the following 17 PAHs are considered as a group in this profile:

- acenaphthene
- acenaphthylene
- anthracene
- benz[a]anthracene
- benzo[a]pyrene
- benzo[e]pyrene
- benzo[b]fluoranthene
- benzo[g,h,i]perylene
- benzo[j]fluoranthene
- benzo[k]fluoranthene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-c,d]pyrene
- phenanthrene
- pyrene

These 17 PAHs were chosen to be included in this profile because (1) more information is available on these than on the others; (2) they are suspected to be more harmful than some of the others, and they exhibit harmful effects that are representative of the PAHs; (3) there is a greater chance that you will be exposed to these PAHs than to the others; and (4) of all the PAHs analyzed, these were the PAHs identified at the highest concentrations at NPL hazardous waste sites.

More information can be found on the chemical and physical properties of PAHs in Chapter 3 and on their use and disposal in Chapter 4.

1.2 WHAT HAPPENS TO POLYCYCLIC AROMATIC HYDROCARBONS WHEN THEY ENTER THE ENVIRONMENT?

PAHs enter the environment mostly as releases to air from volcanoes, forest fires, residential wood burning, and exhaust from automobiles and trucks. They can also enter surface water through discharges from industrial plants and waste water treatment plants, and they can be released to soils at hazardous waste sites if they escape from storage containers. The movement of PAHs in the environment depends on properties such as how easily they dissolve in water, and how easily they evaporate into the air. PAHs in general do not easily dissolve in water. They are present in air as vapors or stuck to the surfaces of small solid particles. They can travel long distances before they return to earth in rainfall or particle settling. Some PAHs evaporate into the atmosphere from surface waters, but most stick to solid particles and settle to the bottoms of rivers or lakes. In soils, PAHs are most likely to stick tightly to particles. Some PAHs evaporate from surface soils to air. Certain PAHs in soils also contaminate underground water. The PAH content of plants and animals living on the land or in water can be many times higher than the content of PAHs in soil or water. PAHs can break down to longer-lasting products by reacting with sunlight and other chemicals in the air, generally over a period of days to weeks. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms. For more information on what happens to PAHs in the environment see Chapter 5.

1.3 HOW MIGHT I BE EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS?

PAHs are present throughout the environment, and you may be exposed to these substances at home, outside, or at the workplace. Typically, you will not be exposed to an individual PAH, but to a mixture of PAHs.

1. PUBLIC HEALTH STATEMENT

In the environment, you are most likely to be exposed to PAH vapors or PAHs that are attached to dust and other particles in the air. Sources include cigarette smoke, vehicle exhausts, asphalt roads, coal, coal tar, wildfires, agricultural burning, residential wood burning, municipal and industrial waste incineration, and hazardous waste sites. Background levels of some representative PAHs in the air are reported to be 0.02-1.2 nanograms per cubic meter (ng/m^3; a nanogram is one-millionth of a milligram) in rural areas and 0.15-19.3 ng/m^3 in urban areas. You may be exposed to PAHs in soil near areas where coal, wood, gasoline, or other products have been burned. You may be exposed to PAHs in the soil at or near hazardous waste sites, such as former manufactured-gas factory sites and wood-preserving facilities. PAHs have been found in some drinking water supplies in the United States. Background levels of PAHs in drinking water range from 4 to 24 nanograms per liter (ng/L; a liter is slightly more than a quart).

In the home, PAHs are present in tobacco smoke, smoke from wood fires, creosote-treated wood products, cereals, grains, flour, bread, vegetables, fruits, meat, processed or pickled foods, and contaminated cow's milk or human breast milk. Food grown in contaminated soil or air may also contain PAHs. Cooking meat or other food at high temperatures, which happens during grilling or charring, increases the amount of PAHs in the food. The level of PAHs in the typical U.S. diet is less than 2 parts of total PAHs per billion parts of food (ppb), or less than 2 micrograms per kilogram of food (µg/kg; a microgram is one-thousandth of a milligram).

The primary sources of exposure to PAHs for most of the U.S. population are inhalation of the compounds in tobacco smoke, wood smoke, and ambient air, and consumption of PAHs in foods. For some people, the primary exposure to PAHs occurs in the workplace. PAHs have been found in coal tar production plants, coking plants, bitumen and asphalt production plants, coal-gasification sites, smoke houses, aluminum production plants, coal tarring facilities, and municipal trash incinerators. Workers may be exposed to PAHs by inhaling engine exhaust and by using products that contain PAHs in a variety of industries such as mining, oil refining, metalworking, chemical production, transportation, and the electrical industry. PAHs have also been found in other facilities where petroleum, petroleum products, or coal are used

or where wood, cellulose, corn, or oil are burned. People living near waste sites containing PAHs may be exposed through contact with contaminated air, water, and soil. For more information on human exposure to PAHs, see Chapter 5.

1.4 HOW CAN POLYCYCLIC AROMATIC HYDROCARBONS ENTER AND LEAVE MY BODY?

PAHs can enter your body through your lungs when you breathe air that contains them (usually stuck to particles or dust). Cigarette smoke, wood smoke, coal smoke, and smoke from many industrial sites may contain PAHs. People living near hazardous waste sites can also be exposed by breathing air containing PAHs. However, it is not known how rapidly or completely your lungs absorb PAHs. Drinking water and swallowing food, soil, or dust particles that contain PAHs are other routes for these chemicals to enter your body, but absorption is generally slow when PAHs are swallowed. Under normal conditions of environmental exposure, PAHs could enter your body if your skin comes into contact with soil that contains high levels of PAHs (this could occur near a hazardous waste site) or with used crankcase oil or other products (such as creosote) that contain PAHs. The rate at which PAHs enter your body by eating, drinking, or through the skin can be influenced by the presence of other compounds that you may be exposed to at the same time with PAHs. PAHs can enter all the tissues of your body that contain fat. They tend to be stored mostly in your kidneys, liver, and fat. Smaller amounts are stored in your spleen, adrenal glands, and ovaries. PAHs are changed by all tissues in the body into many different substances. Some of these substances are more harmful and some are less harmful than the original PAHs. Results from animal studies show that PAHs do not tend to be stored in your body for a long time. Most PAHs that enter the body leave within a few days, primarily in the feces and urine. More information on how PAHs enter and leave your body can be found in Chapters 2 and 6.

1.5 HOW CAN POLYCYCLIC AROMATIC HYDROCARBONS AFFECT MY HEALTH?

PAHs can be harmful to your health under some circumstances. Several of the PAHs, including benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno [1,2,3-c,d]pyrene, have caused tumors in laboratory animals when they breathed these substances in the air, when they ate them, or when they had long periods of skin contact with them. Studies of people show that individuals exposed by breathing or skin contact for long periods to mixtures that contain PAHs and other compounds can also develop cancer.

Mice fed high levels of benzo[a]pyrene during pregnancy had difficulty reproducing and so did their offspring. The offspring of pregnant mice fed benzo[a]pyrene also showed other harmful effects, such as birth defects and decreased body weight. Similar effects could occur in people, but we have no information to show that these effects do occur.

Studies in animals have also shown that PAHs can cause harmful effects on skin, body fluids, and the body's system for fighting disease after both short- and long-term exposure. These effects have not been reported in people.

The Department of Health and Human Services (DHHS) has determined that benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are known animal carcinogens. The International Agency for Research on Cancer (IARC) has determined the following: benz[a]anthracene and benzo[a]pyrene are probably carcinogenic to humans; benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene are possibly carcinogenic to humans; and anthracene, benzo[g,h,i]perylene, benzo[e]pyrene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene are not classifiable as to their carcinogenicity to humans. EPA has determined that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are probable human carcinogens and that acenaphthylene, anthracene,

benzo[g,h,i]perylene, fluoranthene, fluorene, phenanthrene, and pyrene are not classifiable as to human carcinogenicity. Acenaphthene has not been classified for carcinogenic effects by the DHHS, IARC, or EPA. More information on the health effects associated with exposure to PAHs can be found in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS?

In your body, PAHs are changed into chemicals that can attach to substances within the body. The presence of PAHs attached to these substances can then be measured in body tissues or blood after exposure to PAHs. PAHs or their metabolites can also be measured in urine, blood, or body tissues. Although these tests can show that you have been exposed to PAHs, these tests cannot be used to predict whether any health effects will occur or to determine the extent or source of your exposure to the PAHs. It is not known how effective or informative the tests are after exposure is discontinued. These tests to identify PAHs or their products are not routinely available at a doctor's office because special equipment is required to detect these chemicals. More information on tests used to determine the presence of PAHs in your body is presented in Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has set regulations to protect people from the possible health effects of eating, drinking, or breathing PAHs. EPA has suggested that taking into your body each day the following amounts of individual PAHs is not likely to cause any harmful health effects: 0.3 milligrams (mg) of anthracene, 0.06 mg of acenaphthene, 0.04 mg of fluoranthene, 0.04 mg of fluorene, and 0.03 mg of pyrene per kilogram (kg) of your body weight (one kilogram is equal to 2.2 pounds). Actual exposure for most of the United States population occurs from active or passive inhalation of the compounds in tobacco smoke, wood smoke, and contaminated air, and from eating the compounds in foods. Skin contact

with contaminated water, soot, tar, and soil may also occur. Estimates for total exposure in the United States population have been listed as 3 mg/day.

From what is currently known about benzo[a]pyrene, the federal government has developed regulatory standards and guidelines to protect people from the potential health effects of PAHs in drinking water. EPA has provided estimates of levels of total cancer-causing PAHs in lakes and streams associated with a risk of human cancer development. If the following amounts of individual PAHs are released to the environment within a 24-hour period, EPA must be notified: 1 pound of benzo[b]fluoranthene, benzo[a]pyrene, or dibenz[a,h]anthracene; 10 pounds of benz[a]anthracene; 100 pounds of acenaphthene, chrysene, fluoranthene, or indeno[1,2,3-c,d]pyrene; or 5,000 pounds of acenaphthylene, anthracene, benzo[k]fluoranthene, benzo[g,h,i]perylene, fluorene, phenanthrene, or pyrene.

PAHs are generally not produced commercially in the United States except as research chemicals. However, PAHs are found in coal, coal tar, and in the creosote oils, oil mists, and pitches formed from the distillation of coal tars. The National Institute for Occupational Safety and Health (NIOSH) concluded that occupational exposure to coal products can increase the risk of lung and skin cancer in workers. NIOSH established a recommended occupational exposure limit, time-weighted average (REL-TWA) for coal tar products of 0.1 milligram of PAHs per cubic meter of air (0.1 mg/m^3) for a 10-hour workday, within a 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an occupational exposure limit for coal tar products of 0.2 mg/m^3 for an 8-hour workday, within a 40-hour workweek. The Occupational Safety and Health Administration (OSHA) has established a legally enforceable limit of 0.2 mg/m^3 averaged over an 8-hour exposure period.

Mineral oil mists have been given an IARC classification of 1 (sufficient evidence of carcinogenicity). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist is 5 mg/m^3 averaged over an 8-hour exposure period. NIOSH has concurred with this limit, and has established a recommended occupational exposure limit (REL-TWA) for mineral oil mists

of 5 mg/m^3 for a 10-hour work day, 40-hour work week, with a 10 mg/m^3 Short Term Exposure Limit (STEL).

More information on rules and standards for exposure to PAHs can be found in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

2. HEALTH EFFECTS

2.1 INTRODUCTION

The primary purpose of this chapter is to provide public health officials, physicians, toxicologists, and other interested individuals and groups with an overall perspective of the toxicology of polycyclic aromatic hydrocarbons (PAHs). It contains descriptions and evaluations of toxicological studies and epidemiological investigations and provides conclusions, where possible, on the relevance of toxicity and toxicokinetic data to public health.

A glossary and list of acronyms, abbreviations, and symbols can be found at the end of this profile.

2.2 DISCUSSION OF HEALTH EFFECTS BY ROUTE OF EXPOSURE

To help public health professionals and others address the needs of persons living or working near hazardous waste sites, the information in this section is organized first by route of exposure-inhalation, oral, and dermal; and then by health effect-death, systemic, immunological, neurological, reproductive, developmental, genotoxic, and carcinogenic effects. These data are discussed in terms of three exposure periods-acute (14 days or less), intermediate (15-364 days), and chronic (365 days or more).

Levels of significant exposure for each route and duration are presented in tables and illustrated in figures. The points in the figures showing no-observed-adverse-effect levels (NOAELs) or lowest-observed-adverse-effect levels (LOAELs) reflect the actual doses (levels of exposure) used in the studies. LOAELs have been classified into “less serious” or “serious” effects. “Serious” effects are those that evoke failure in a biological system and can lead to morbidity or mortality (e.g., acute respiratory distress or death). “Less serious” effects are those that are not expected to cause significant dysfunction or death, or those whose significance to the organism is not entirely clear. ATSDR acknowledges that a considerable amount of judgment may be required in establishing whether an end point should be classified as a NOAEL, “less serious” LOAEL, or “serious” LOAEL, and that in some cases, there will be insufficient data to decide whether the effect is indicative of significant dysfunction. However, the Agency has established guidelines and policies that are used to classify these end points. ATSDR believes that there is sufficient merit in this approach to warrant an attempt

at distinguishing between “less serious” and “serious” effects. The distinction between “less serious” effects and “serious” effects is considered to be important because it helps the users of the profiles to identify levels of exposure at which major health effects start to appear. LOAELs or NOAELs should also help in determining whether or not the effects vary with dose and/or duration, and place into perspective the possible significance of these effects to human health.

The significance of the exposure levels shown in the Levels of Significant Exposure (LSE) tables and figures may differ depending on the user’s perspective. Public health officials and others concerned with appropriate actions to take at hazardous waste sites may want information on levels of exposure associated with more subtle effects in humans or animals (LOAELs) or exposure levels below which no adverse effects (NOAELs) have been observed. Estimates of levels posing minimal risk to humans (Minimal Risk Levels or MRLs) may be of interest to health professionals and citizens alike.

Levels of exposure associated with carcinogenic effects (Cancer Effect Levels, CELs) of PAHs are indicated in Tables 2-1, 2-2, and 2-3 and Figures 2-l and 2-2. Because cancer effects could occur at lower exposure levels, Figure 2-2 also shows a range for the upper bound of estimated excess risks, ranging from a risk of 1 in 10,000 to 1 in 10,000,000 (10^{-4} to 10^{-7}), as developed by EPA.

Estimates of exposure levels posing minimal risk to humans (Minimal Risk Levels or MRLs) have been made for PAHs. An MRL is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncarcinogenic) over a specified duration of exposure. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration within a given route of exposure. MRLs are based on noncancerous health effects only and do not consider carcinogenic effects. MRLs can be derived for acute, intermediate, and chronic duration exposures for inhalation and oral routes. Appropriate methodology does not exist to develop MRLs for dermal exposure.

Although methods have been established to derive these levels (Barnes and Dourson 1988; EPA 1990), uncertainties are associated with these techniques. Furthermore, ATSDR acknowledges additional uncertainties inherent in the application of the procedures to derive less than lifetime MRLs. As an example, acute inhalation MRLs may not be protective for health effects that are delayed in development or are acquired following repeated acute insults, such as hypersensitivity reactions,

asthma, or chronic bronchitis. As these kinds of health effects data become available and methods to assess levels of significant human exposure improve, these MRLs will be revised.

A User's Guide has been provided at the end of this profile (see Appendix A). This guide should aid in the interpretation of the tables and figures for Levels of Significant Exposure and the MRLs.

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. PAHs can either be synthetic or occur naturally. Most of these chemicals as individual compounds (i.e., not as part of a combustion product) have no known use except for research purposes. A few PAHs are used in medicines and to make dyes, plastics, and pesticides. Others are contained in asphalt used in road construction. They are found throughout the environment in the air, water, and soil. There are more than 100 different PAH compounds and the health effects of the individual PAHs are not exactly alike.

Fifty-four PAHs have been identified at one or more NPL hazardous waste sites. These 54 are acenaphthene, acenaphthylene, 2-acetoaminofluorene, anthracene, 9, 10-anthracenedione, benz[a]anthracene, benzo[a]pyrene, benzo[e]pyrene, benzo[a]fluoranthene, benzo[b]fluoranthene, benzo[b]fluorene, benzofluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]fluoranthene, benzoperylene, benzo[g,h,i]perylene, benzophenanthrene, benzopyrene, benzothiophene, benzo[b]thiophene, chrysene, 4H-cyclopenta[d,e,f]phenanthrene, dibenz[a,j]anthracene, dibenz[a,h]anthracene, 7,12-dimethylbenz[a]anthracene, 2,7-dimethylbenzo[b]thiophene, 1,4-dimethoxyanthracene, dimethyl phenanthrene, 2,5dimethyl phenanthrene, dodecachlorodecahydrotrim, fluoranthene, fluorene, indeno[1,2,3-c,d] pyrene, 12-methylbenz[a]anthracene, methyl anthracene, 9-methylanthracene, 3-methylcholanthrene, methylfluorene, methylphenanthrene, 2-methylphenanthrene, 1-methylphenanthrene, 4-methylphenanthrene, methylpyrene, phenanthrene, phenanthridine, phenanthroline, pyrene, perylene, 6,7-tetrahydropyrene, tetramethylphenanthrene, 3,4,5,6-tetramethylphenanthrene, and trimethylphenanthrene.

However, only 17 PAHs are discussed in this profile. These 17 PAHs are:

- acenaphthene
- acenaphthylene
- anthracene

- benz[a]anthracene
- benzo[a]pyrene
- benzo[e]pyrene
- benzo[b]fluoranthene
- benzo[j]fluoranthene
- benzo[g,h,i]perylene
- benzo[k]fluoranthene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- indeno[l,2,3-c,d]pyrene
- phenanthrene
- pyrene

These 17 PAHs were selected using the following four criteria:

(1) toxicity
(2) potential for human exposure
(3) frequency of occurrence at NPL hazardous waste sites
(4) extent of information available.

The 17 PAHs were combined into one profile to avoid repetition across multiple profiles on the individual PAHs since these chemicals often occur together in the environment and many have similar toxicological effects, environmental fate, etc. Instances in which it is known that the various PAHs differ with regard to toxicological effects or environmental fate will be pointed out. For example, PAHs can be classified as “alternant” (e.g., benzo[a]pyrene, benz]a]anthracene, chrysene, dibenz[a,h]anthracene) or “nonalternant” (e.g., fluoranthene, benzo[k]fluoranthene, benzol[j]fluoranthene, indeno[1,2,3-c,d]pyrene). This distinction is based on the electron density associated with the molecule. Altemant PAHs have an equally distributed electron density, whereas nonalternant PAHs behave almost as if they were two different molecules because of an uneven distribution of electron density from one portion of the molecule to another. The toxicological significance of this difference is that alternant and nonalternant PAHs appear to behave differently, for example, with regard to how they are metabolized to ultimate carcinogens (see Section 2.3.3, Metabolism).

Reliable health-based and environmental information exists on only a few of the 17 PAHs discussed in this profile, and the potential health effects of the other less well-studied PAHs must be inferred from this information. By combining all 17 PAHs in one profile, these comparisons and inferences can

easily be made. Although a large toxicity database exists on complex mixtures that contain PAHs (such as crude oils, various high boiling point distillates, complex petroleum products, coal tars, creosote, and the products of coal liquification processes), these data generally have not been used in this profile. It is difficult to ascertain the toxicity of the component PAHs in these mixtures because of the potential interactions that could occur and the presence of other toxic substances in the mixtures. Furthermore, ATSDR has developed a profile on one of these complex mixtures, creosote, and the reader is referred to this profile for information on this complex mixture (ATSDR 1994). However, most of the available information on the health effects of PAHs in humans must be inferred from studies that reported the effects of exposure to complex mixtures that contain PAHs. Several epidemiologic studies have shown increased mortality due to lung cancer in humans exposed to coke oven emissions, roofing-tar emissions, and cigarette smoke. Each of these mixtures contains benzo[a]pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, and dibenz[a,h]anthracene as well as other potentially carcinogenic PAHs and other carcinogenic and potentially carcinogenic chemicals, tumor promoters, initiators, and co-carcinogens such as nitrosamines, coal tar pitch, and creosote. It is thus impossible to evaluate the contribution of any individual PAH to the total carcinogenicity of these mixtures in humans because of the complexity of the mixtures and the presence of other carcinogens. Despite these limitations, reports of this nature provide qualitative evidence of the potential for mixtures containing PAHs such as benzo[a]pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, and dibenz[a,h]anthracene to cause cancer in humans. For this reason, and also because of the lack of data on the effects of individual PAHs in humans, such information has been included in this profile on PAHs.

2.2.1 Inhalation Exposure

2.2.1.1 Death

No studies were located regarding death in humans following inhalation exposure to any of the 17 PAHs discussed in this profile. However, a dose-related decrease in survival was noted in hamsters after 60 weeks of inhalation exposure to 46.5 mg/m^3 benzo[a]pyrene for 109 weeks (Thyssen et al. 1981). The authors attributed this reduced survival in part to toxic and carcinogenic effects induced by this PAH (e.g., tumors in the pharynx and larynx that could have inhibited food intake).

2.2.1.2 Systemic Effects

No studies were located regarding cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, dermal, or ocular effects in humans or animals following inhalation exposure to any of the 17 PAHs discussed in this profile. The systemic effects observed after inhalation exposure are discussed below.

The highest NOAELs for respiratory and renal effects in each species and duration category are recorded in Table 2-1 and plotted in Figure 2-1.

Respiratory Effects. Only one study was located regarding respiratory effects in humans following inhalation exposure to PAHs, specifically, benzo[a]pyrene. The respiratory health of 667 workers in a rubber factory was investigated (Gupta et al. 1993). Respiratory health was evaluated and examined for correlations to length of employment at the factory. In addition, total suspended particulate matter and benzo[a]pyrene concentrations were monitored in various parts of the factory and examined for possible correlation with the respiratory health of the workers in the same area of the factory. Statistically significant decrements in ventilatory function occurred following prolonged exposure as assessed by duration of employment. When different sections of the factory were considered, workers in the compounding section were the most affected, which was associated with the highest exposure to particulate matter and benzo[a]pyrene. Workers in the compounding section exhibited radiographic abnormalities including patch opacities, prominent bronchiovascular markings, and pleural effusions. Other symptoms included bloody vomit, breathing problems, chest pains, chest irritation, throat irritation, and cough. Workers in other areas of the plant exposed to lower levels of particulate matter and benzo[a]pyrene were similarly affected although to a lesser degree and in fewer numbers (Gupta et al. 1993). No attempt was made to separate the effects of exposure to benzo[a]pyrene and particulate matter, or to identify possible simultaneous exposure to other toxic chemicals.

Groups of 40 Fischer-344/Crl rats/sex were exposed nose-only to an aerosol of benzo[a]pyrene (7.7 mg/m^3) 2 hours/day, 5 days/week, for 4 weeks (Wolff et al. 1989a). Nasal and left lung sections were examined histopathologically. No treatment-related lesions were noted in the lungs or nasal cavities of the animals exposed to benzo[a]pyrene. Although this was a well-conducted inhalation toxicity study, it is not appropriate for use in risk assessment because only one concentration was

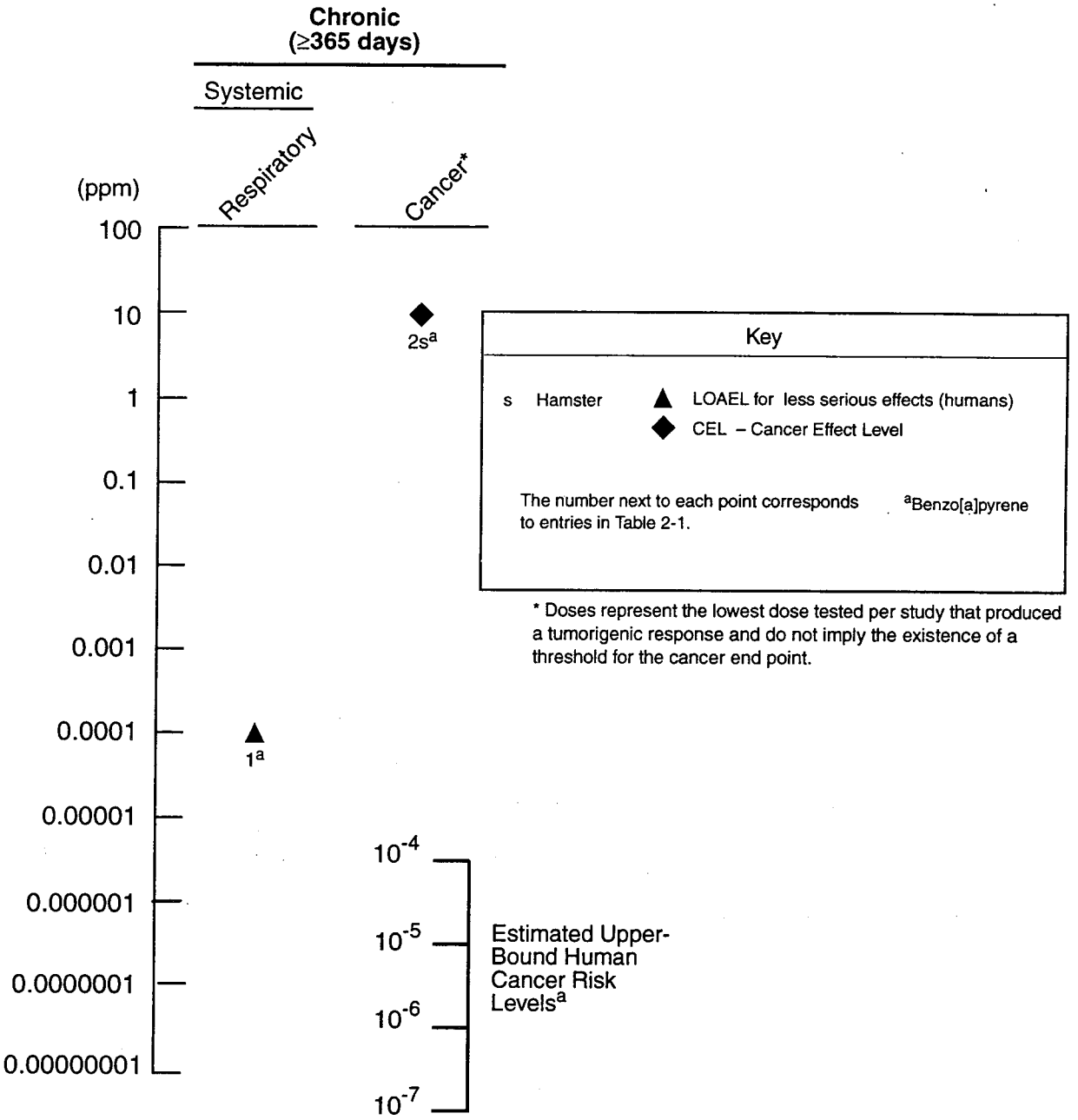
TABLE 2-1. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Inhalation

Key to figure[a]	Species/ (strain)	Exposure/ duration/ frequency	System	NOAEL (mg/m3)	LOAEL Less serious (mg/m3)	LOAEL Serious (mg/m3)	Reference
CHRONIC EXPOSURE							
Systemic							
1	Human	6 mo - >6 yr	Resp			0.0001 NS (reduced lung function, abnormal chest x-ray, cough, bloody vomit, throat and chest irritation.	Gupta et al. 1993 benzo[a]pyrene
Cancer							
2	Hamster (Syrian golden)	109 wk 7 d/wk 3-4.5 hr/d				9.5 M (CEL: 34.6% increase in respiratory tract tumors; neoplasms of the upper digestive tract in 26.9%)	Thyssen et al. 1981 benzo[a]pyrene

[a]The number corresponds to entries in Figure 2-1.

CEL = cancer effect level; d = day(s); hr = hour; LOAEL = lowest-observed-adverse-effect level; M = male; mo = month; NOAEL = no-observed-adverse-effect level; NS = not specified; Resp = respiratory; wk = week(s); yr = year(s)

Figure 2-1. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons – Inhalation



studied (thereby precluding the assessment of a dose-response relationship); no adverse treatment-related effects were observed; and the only parts of the respiratory tract examined histopathologically were the lungs and nose.

Renal Effects. No studies were located regarding renal effects in humans following inhalation exposure to any of the 17 PAHs discussed in this profile.

Groups of 40 Fischer-344/Crl rats/sex were exposed nose-only to an aerosol of benzo[a]pyrene 2 hours/day, 5 days/week, for 4 weeks (Wolff et al. 1989a). Kidney sections were examined histopathologically. No treatment-related lesions were noted in the kidneys of the animals exposed to benzo[a]pyrene.

2.2.1.3 Immunological and Lymphoreticular Effects

Humoral immunity was monitored in male iron foundry workers in Poland (Szczeklik et al. 1994). Coke oven workers (199) were compared to cold-rolling mill workers (76). The groups were similar with respect to age, length of employment, and smoking habits. The results showed that coke oven workers, exposed to high concentrations of atmospheric PAHs, including fluoranthene, perylene, pyrene, benzo[a]pyrene, chrysene, benz[a]anthracene, dibenz[a,h]anthracene, and benzo[g,h,i]perylene, had reduced levels of serum immunoglobins. The workers most exposed to PAHs worked at the topside area of the coke ovens. Benzo[a]pyrene exposure was used as a reference point. Coke oven workers, exposed to 0.0002-0.50 mg/m^3 benzo[a]pyrene, were compared to cold-rolling mill workers, whose exposure to benzo[a]pyrene was 3-5 orders of magnitude less. Average length of employment was 15 years. IgG, IgA, IgM, and IgE concentrations were measured. Coke oven workers exhibited a marked depression of mean serum IgG and IgA, compared to mill workers. IgM tended to decrease, whereas IgE tended to increase in the coke oven workers. The biological significance of this finding is unclear and is not addressed by the authors. However, the authors suggest that serum immunoglobulin levels may be a useful biomarker for PAH exposure. The authors note, however, that the coke oven workers were exposed to higher levels of sulfur dioxide and carbon monoxide than were the cold-rolling mill workers, and they suggest that this additional exposure may have potentiated the effects of the PAH exposure. The potential contribution of the smoking habits of the subjects was not investigated.

No studies were located regarding the following effects in humans or animals following inhalation exposure to any of the 17 PAHs discussed in this profile:

2.2.1.4 Neurological Effects

2.2.1.5 Reproductive Effects

2.2.1.6 Developmental Effects

2.2.1.7 Genotoxic Effects

Becher et al. (1984) evaluated urine and blood samples from 15 aluminum plant workers (average age, 29 years; average years employed, 3.8) exposed to an estimated total PAH concentration of 1 mg per 8-hour work shift. The main PAH components identified by air sampling and also detected in the urine samples included phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[e]pyrene, and benzo[a]pyrene. Results of the cytogenetic analysis of peripheral lymphocytes of the exposed workers indicated that the frequency of sister chromatid exchange was not influenced by the presence of large amounts of PAHs. These findings were reported to be consistent with the negligible increase in lung cancer found in epidemiological studies of aluminum workers. The investigators, therefore, questioned the relevance of PAH air monitoring as a measure of the occupational hazards associated with PAH exposure. Alternatively, it is possible that there are no occupational hazards associated with PAH exposure at these levels. Similar results were obtained with iron factory workers (length of employment: 2-46 years) exposed to 0.0005-0.00 mg/m^3 benzo[a]pyrene (Perera et al. 1993), who exhibited an increased rate of mutations in peripheral lymphocytes that were not correlated with PAH exposure. These authors suggest that both biomonitoring and personal monitoring may be necessary to evaluate exposure.

The high lung cancer rate in Xuan Wei, China, is associated with smokey coal use in unvented homes, but not with wood or smokeless coal use (Mumford et al. 1993). Smoky coal combustion emits higher PAH concentrations than wood combustion. This study evaluated PAH-DNA adducts in placentas, and in peripheral and cord white blood cells (WBC) from Xuan Wei women burning smoky coal or wood and from Beijing women using natural gas. Exposures were based on benzo[a]pyrene concentrations determined by personal monitors. Women in Xuan Wei burning smoky coal without a chimney were

exposed to 0.383 mg/m^3 benzo[a]pyrene, those burning smoky coal with chimneys were exposed to 0.184 mg/m^3, and women burning wood or using natural gas (Beijing) had no detectable exposure to benzo[a]pyrene. Positive results (detection of PAH-DNA adducts) were found in 58, 47, and 5% of the placentas from Xuan Wei women burning smoky coal without a chimney, with a chimney, and Beijing women using natural gas, respectively. Positive results were found in 46, 6.5, 56, and 25% of placentas from Xuan Wei women who lived in houses without and with chimneys, Xuan Wei women burning wood, and Beijing controls, respectively. Peripheral WBC samples were positive in 7 of 9, 8 of 9, and 3 of 9 for the Xuan Wei women who lived in houses without and with chimneys and Beijing women, respectively. No dose-response relationship was observed between the air benzo[a]pyrene concentrations and DNA adduct levels or percentage of detectable samples. However, using the fluorescent color assay, there was a significant association between DNA adduct detection in the placenta and cooking methods. Moreover, individual comparisons of the data revealed a significant difference between both smokey coal groups (chimney, no chimney) and natural gas cooking. The results of this study suggest that DNA adducts can be used as a biomarker to assess human exposure to combustion emissions.

Thirty-four workers in an electrode paste plant were monitored for response to exposure (Ovrebo et al. 1994). Exposure to benzo[a]pyrene was 0.9 μg/m^3; exposure to pyrene was 3.5μg/m^3. 1-Hydroxypyrene was measured in the urine, and PAH-DNA adducts were measured in white blood cells to demonstrate their relationship to the exposure. Results from these workers were compared to two reference control groups: research and development (R&D) workers and nickel refinery workers. Mean values of PAH-DNA adducts in the white blood cells from randomly selected participants in the three groups were only marginally different, with the exception of two smokers in the electrode plant, who had the highest levels. Mean PAH-DNA adduct levels were 10.9 adducts per 108 nucleotides for the electrode workers, 10.8 adducts per 10^8 nucleotides for the R&D personnel, and 10.0 adducts per 10^8 nucleotides for nickel plant workers not occupationally exposed to PAHs. No correlation was found between PAH-DNA adducts and 1-hydroxypyrene in the urine.

In an ongoing comprehensive evaluation of biological markers, workers in or near an iron foundry with varying exposures to PAHs were examined for response to exposure (Santella et al. 1993). Exposure to benzo[a]pyrene, determined by personal monitors, was 2-60 ng/m^3, which are the lowest levels yet analyzed in foundry workers. 1-Hydroxypyrene was measured in the urine, and PAH-DNA adducts were measured in white blood cells to demonstrate their relationship to the exposure.

Cigarette smoking, but not age or charbroiled food, influenced the level of 1-hydroxypyrene but not PAH-DNA adducts. When workers were classified into three categories of exposure (low, <.0005 mg/m^3; medium, 0.0005-0.0012 mg/m^3; high, >0.0012 mg/m^3), PAH-DNA adducts showed an increasing trend, with exposure from 5.2 to 6.2-9.6 adducts per 10^8 nucleotides in the low-, medium, and high-exposure groups, respectively. However, the three exposure groups did not differ significantly from each other, and no independent control group was used.

In order to evaluate the correlation between peripheral blood leukocyte DNA adducts as an indicator of exposure to PAHs and the airborne contamination of PAH at the workplaces, a survey of 69 coke oven workers was carried out (Assennato et al. 1993). In each workplace, total PAH and specific (benz[a]anthracene, benzo[a]pyrene, chrysene) PAH airborne concentrations were measured. Job titles included supervisor, door maintenance, machine operator, gas regulators, temperature operators, and top side workers. For the workplaces evaluated, the range of airborne concentrations (μg/m^3) for benz[a]anthracene, benzo[a]pyrene, and chrysene, respectively, were: supervisor (0.41, 0.29, 0.32), door maintenance (4.26-14.79, 2.31-6.37, 2.34-6.53), machine operator (0.11-33.19, 0.08-13.17, 0.03-12.63), gas regulators (0.21-2.10, 0.12-1.61, 0.13-1.60), temperature operators (1.77-10.07, 1.37-5.03, 0.98-4.78), and top side workers (0.45-3.40, 0.47-4.73, 0.23-2.42). Mean values (fmol/μg DNA) for PAH-DNA adducts in leukocytes by job title were: supervisor (0.059), door maintenance (0.174) machine operator (0.065), gas regulators (0.081), and temperature operators (0.071). Levels of exposure were correlated with PAH-DNA adduct formation. However, the differences were not statistically significant. The major limitations of the study included no record of length of exposure, no independent control group, no reporting of expected background levels of adducts, and no estimation of the length of time individual workers were exposed to particular levels of the PAHs. Other genotoxicity studies are discussed in Section 2.4.

2.2.1.8 Cancer

No studies were located regarding cancer in humans following inhalation exposure to any of the 17 PAHs discussed in this profile. However, epidemiologic studies have shown increased mortality due to lung cancer in humans exposed to coke oven emissions (Lloyd 1971; Mazumdar et al. 1975; Redmond et al. 1976), roofing-tar emissions (Hammond et al. 1976), and cigarette smoke (Maclure and MacMahon 1980; Wynder and Hoffmann 1967). Each of these mixtures contains benzo[a]pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, and dibenz[a,h]anthracene as well as other

potentially carcinogenic PAHs and other carcinogenic and potentially carcinogenic chemicals, tumor promoters, initiators, and co-carcinogens such as nitrosamines, coal tar pitch, and creosote. It is thus impossible to evaluate the contribution of any individual PAH to the total carcinogenicity of these mixtures in humans because of the complexity of the mixtures and the presence of other carcinogens. Furthermore, the levels of individual or total PAHs were not quantified in any of these reports. Despite these limitations, reports of this nature provide qualitative evidence of the potential for mixtures containing PAHs such as benzo[a]pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, and dibenz[a,h]anthracene to cause cancer in humans.

Several inhalation studies for animals given benzo[a]pyrene were located. Shulte et al. (1993) found a significant increase in all lung tumors and a dose-dependent increase in malignant lung tumors for mice exposed to PAH-enriched exhausts containing 0.05 or 0.09 mg/m^3 benzo[a]pyrene. The chronic study of Thyssen et al. (1981) provides clear-cut evidence of a dose-response relationship between inhaled benzo[a]pyrene particles (99% of the benzo[a]pyrene particles were between 0.2 and 0.54 microns in diameter) and respiratory tract tumorigenesis. Respiratory tract tumors were induced in the nasal cavity, pharynx, larynx, and trachea in a dose-related manner in hamsters exposed to 9.5 mg/m^3 or 46.5 mg/m^3 for 109 weeks. No lung tumors were found, and the reason for the absence of lung tumors is not known. Furthermore, the particle sizes were reported to be within the respirable range (0.2-0.5 microns in diameter). Tumors were also observed following exposure to 46.5 mg/m^3 in the esophagus and forestomach (presumably as a consequence of mucocilliary particle clearance) (Thyssen et al. 1981). These tumor types consisted of papillomas, papillary polyps, and squamous cell carcinomas.

The CEL from the Thyssen et al. (1981) study is recorded in Table 2-1 and plotted in Figure 2-l.

2.2.2 Oral Exposure

2.2.2.1 Death

No studies were located regarding death in humans after oral exposure to any of the 17 PAHs discussed in this profile.

Oral exposure to 120 mg/kg/day benzo[a]pyrene has resulted in decreased survival time in two strains of mice (DBA/2N and AKR/N) whose hepatic aryl hydrocarbon hydroxylase (AHH) activity is not induced by PAHs ("nonresponsive" mice) (Robinson et al. 1975). AHH is a microsomal enzyme believed to be responsible for the metabolism of benzo[a]pyrene. All of the mice in the treatment group died, with at least half the deaths occurring within 15 days of dosing. Only three mice in the control group died. Death appeared to be caused by bone marrow depression (aplastic anemia, pancytopenia), leading to hemorrhage or infection. In contrast, only 6 of 90 (7%) mice with inducible AHH activity ("responsive" mice) similarly exposed to benzo[a]pyrene died over the same period of time. The authors concluded that the decreased survival in the nonresponsive mice was associated with a single gene difference encoding aromatic hydrocarbon responsiveness and was dependent on route of exposure. Benzo[a]pyrene was not as rapidly metabolized by the liver and excreted following oral administration in nonresponsive mice as in responsive mice. Therefore, more benzo[a]pyrene was available to reach the target tissue (i.e., bone marrow) in the nonresponsive mice, resulting in bone marrow depression and death.

A LOAEL for death for intermediate-duration exposure in mice is recorded in Table 2-2 and plotted in Figure 2-2.

2.2.2.2 Systemic Effects

No studies were located regarding respiratory, cardiovascular, hematological, musculoskeletal, hepatic, dermal, or ocular effects in humans following oral exposure to any of the 17 PAHs discussed in this profile. The systemic effects observed in humans or animals after oral exposure are discussed below.

The highest NOAEL values and all LOAEL values from each reliable study for each species and duration category are recorded in Table 2-2 and plotted in Figure 2-2.

Respiratory Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of respiratory distress were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, and 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral

Key to figure[a]	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference
	ACUTE EXPOSURE						
	Systemic						
1	Rat (Wistar/Af/Ha n/Mol/ Kuo)	4 d 1 x/d (G)	Gastro	150 M			Nouslainen et al. 1984 benz[a]anthracene
			Hepatic	150 M			
			Renal	150 M			
2	Rat (Wistar/Af/Ha n/Mol/ Kuo)	4 d 1 x/d (G)	Gastro	150 M			Nouslainen et al. 1984 benzo[a]pyrene
			Hepatic	150 M			
			Renal	150 M			
	Reproductive						
3	Mouse (CD-1)	10 d Gd 7-16 (G)		40 F		160 F (reduced pregnancy)	Mackenzie and Angevine 1981 benzo[a]pyrene
	Developmental						
4	Mouse (B6AKF1, AKR/J)	8 d Gd 2-10 (F)				120 F (fetal resorption in Ahd/Ahd)	Legraverend et al. 1984 benzo[a]pyrene
5	Mouse (CD-1)	10 d Gd 7-16 (G)		10 F		40 F (reduced pup weight at 20 days)	Mackenzie and Angevine 1981 benzo[a]pyrene
	Cancer						
6	Mouse (CFW Swiss)	1-7 d ad lib (F)		13.3		33.3 (CEL: gastric neoplasms)	Neal and Rigdon 1967 benzo[a]pyrene

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral (continued)

Key to figure[a]	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference
	INTERMEDIATE EXPOSURE						
	Systemic						
7	Mouse (CD-1)	13 wk 1 x/d (GO)	Resp	700			EPA 1989c acenaphthene
			Cardio	700			
			Gastro	700			
			Hemato	700			
			Musc/skel	700			
			Hepatic		175[b]	(increased relative liver weight)	
			Renal	700			
			Endocr	700			
			Dermal	700			
			Ocular	700			
			Bd Wt	700			
8	Mouse (CD-1)	13 wk 1 x/d (GO)	Resp	1000			EPA 1989d anthracene
			Cardio	1000			
			Gastro	1000			
			Hemato	1000			
			Musc/skel	1000			
			Hepatic	1000[c]			
			Renal	1000			
			Endocr	1000			
			Dermal	1000			
			Ocular	1000			
			Bd Wt	1000			

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral (continued)

Key to figure[a]	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference
9	Mouse (DBA/2,ARR/ N); (C57B1/b, C3H/HeN, BALB/cAnN)	6 mo (F)	Hemato			120 (aplastic anemia)	Robinson et al. 1975 benzo[a]pyrene
			Hepatic		120 (increased liver weight)		
10	Mouse (CD-1)	13 wk 1 x/d (GO)	Resp	500			EPA 1988e fluoranthene
			Cardio	500			
			Gastro	500			
			Hemato	125 F 500 M	250 F (decrease in packed cell volume)		
			Musc/skel	500			
			Hepatic		125[d] M (increased relative liver weight)		
				125 F	250 F (increased relative liver weight; centrilobular pigmentation, increased enzymes)		
			Renal	250 M 125 F	500 M (renal tubular 250 F regeneration; interstitial lymphocytic infiltrates and/or fibrosis)		
			Endocr	500			
			Dermal	500			
			Ocular	500			
			Bd Wt	500			

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral (continued)

Key to figure[a]	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference
11	Mouse (CD-1)	13 wk 1 x/d (GO)	Resp	500			EPA 1989e fluorene
			Cardio	500			
			Gastro	500			
			Hemato	125	250 (decreased PCV and MCHC in males; decreased RBC, PCV, MCH, and MCHC in females)		
			Musc/skel	500			
			Hepatic		125[e] (increased relative liver weight)		
			Renal	250 M 500 F	500 M (increased absolute and relative kidney weight)		
			Endocr	500			
			Dermal	500			
			Ocular	500			
			Bd Wt	500 M 250 F	500 F (increased body weight)		
	Immunological/Lymphoreticular						
12	Mouse (CD-1)	13 wk 1 x/d (GO)		700			EPA 1989c acenaphthene
13	Mouse (CD-1)	13 wk 1 x/d (GO)		1000			EPA 1989d anthracene
14	Mouse (CD-1)	13 wk 1 x/d (GO)		500 F	500 M (increased serum globulin values)		EPA 1988e fluoranthene

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral (continued)

Key to figure[a]	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference
15	Mouse (CD-1)	13 wk 1 x/d (GO)		125	250 M (increased spleen weight)		EPA 1989e fluorene
	Neurological						
16	Mouse (CD-1)	13 wk 1 x/d (GO)		700			EPA 1989e acenaphthene
17	Mouse (CD-1)	13 wk 1 x/d (GO)		1000			EPA 1989d anthracene
18	Mouse (CD-1)	13 wk 1 x/d (GO)		500			EPA 1988 fluoranthene
19	Mouse (CD-1)	13 wk 1 x /d (GO)		500			EPA 1989e fluorene
	Reproductive						
20	Mouse (CD-1)	13 wk 1 x/d (GO)		700 M 350 F	700 F (decreased ovary weights correlated with increased incidence and degree of inactivity of the ovary and uterus)		EPA 1989c acenaphthene
21	Mouse (CD-1)	13 wk 1 x/d (GO)		1000			EPA 1989d anthracene

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral (continued)

Key to figure[a]	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference
22	Mouse (White Swiss)	19-29 d ad lib (F)		133.3 F				Rigdon and Neal 1965 benzo[a]pyrene
23	Mouse (CD-1)	13 wk 1 x/d (GO)		500				EPA 1988 fluoranthene
24	Mouse (CD-1)	13 wk 1 x/d (GO)		500				EPA 1989e fluorene
	Cancer							
25	Mouse (CFW Swiss)	30-197 d ad lib (F)		1.3		2.6	(CEL: gastric tumor)	Neal and Rigdon 1967 benzo[a]pyrene
26	Mouse (Swiss)	23-238 d ad lib (F)				33.3	(CEL: papillomas; squamous cell carcinomas)	Rigdon and Neal 1966 benzo[a]pyrene

TABLE 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Oral (continued)

Key to[a] figure	Species/ (Strain)	Exposure/ Duration/ Frequency (Specific Route)	System	NOAEL (mg/kg/day)	LOAEL				Reference
					Less Serious (mg/kg/day)		Serious (mg/kg/day)		
27	Mouse (Swiss)	80-140 d ad lib (F)					33.3	(CEL: tumors of the forestomach in 69/108)	Rigdon and Neal 1969 benzo[a]pyrene

[a]The number corresponds to entries in Figure 2-2.

[b]Used to derive an intermediate-duration oral minimal risk level (MRL) of 0.6 mg/kg/day for acenaphthene; dose divided by an uncertainty factor of 300 (3 for use of a LOAEL, 10 for extrapolation from animals to humans and 10 for human variability)

[c]Used to derive an intermediate-duration oral MRL of 10 mg/kg/day for anthracene; dose obtained by dividing the NOAEL value by 100 (10 for extrapolation from animals to humans and 10 for human variability)

[d]Used to derive an intermediate-duration oral MRL of 0.4 mg/kg/day for fluoranthene; dose divided by an uncertainty factor of 300 (3 for use of a minimal LOAEL, 10 for extrapolation from animals to humans and 10 for human variability)

[e]Used to derive an intermediate-duration oral MRL of 0.4 mg/kg/day for fluorene; dose divided by an uncertainty factor of 300 (3 for use of a minimal LOAEL, 10 for extrapolation from animals to humans and 10 for human variability)

ad lib = ad libitum; BaP = benzo(a)pyrene; Bd Wt = body weight; Cardio = cardiovascular; CEL = cancer effect level; d = day(s); Endocr = endocrine; F = female; (F) = feed; (G) = gavage; Gastro = gastrointestinal; Gd = gestation day(s); (GO) = gavage (oil); Hemato = hematological; LOAEL = lowest-observed-adverse-effect level; M = male; MCH = mean cell hemoglobin; MCHC = mean cell hemoglobin concentration; mo = month(s); Musc/skel = musculoskeletal; NOAEL = no-observed-adverse-effect level; PCV = packed cell volume; RBC = red blood cells; Resp = respiratory; TPA = tetradecanoyl phorbol acetate; wk = week(s); x = time(s)

Figure 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons – Oral

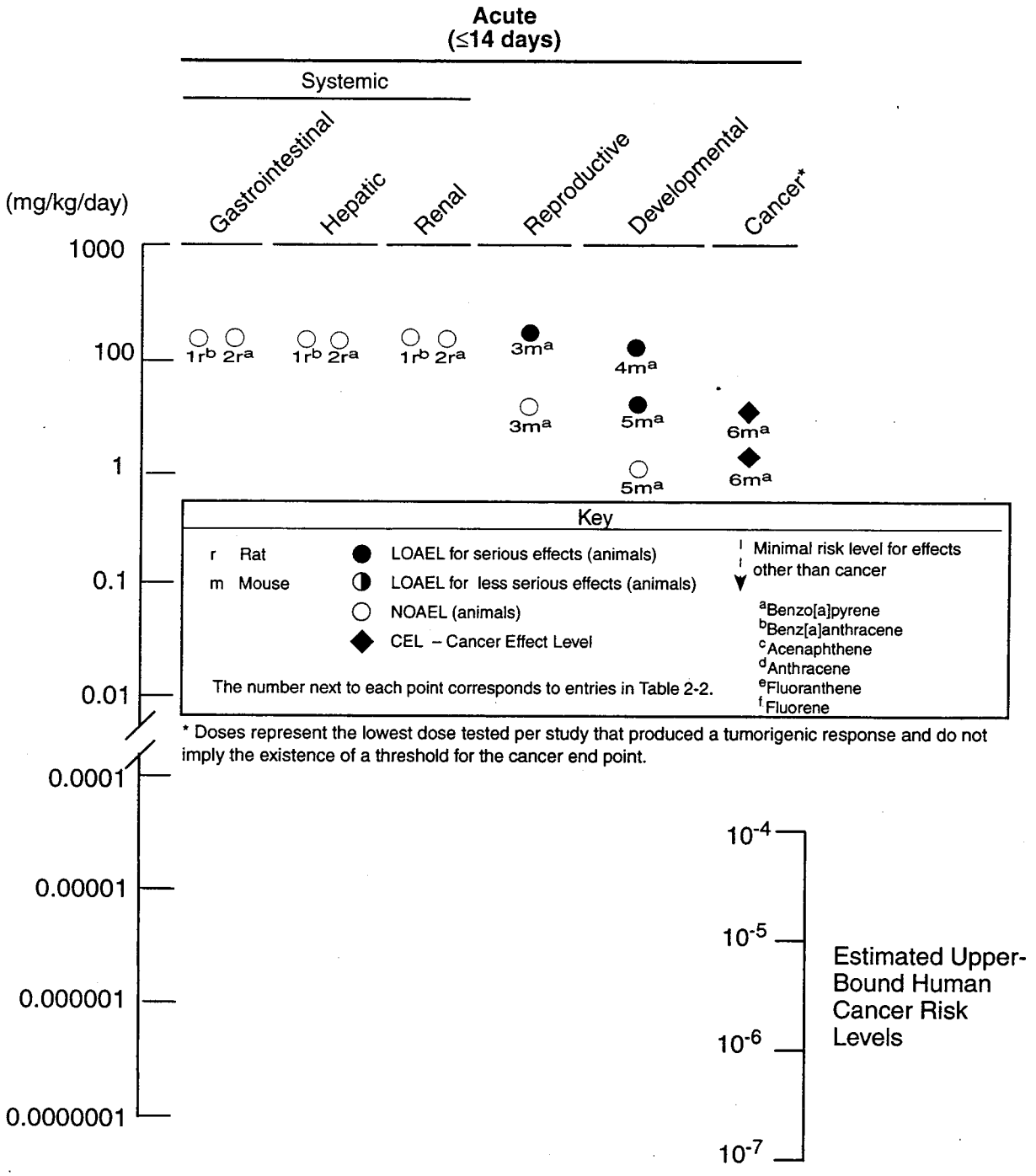


Figure 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons – Oral (continued)

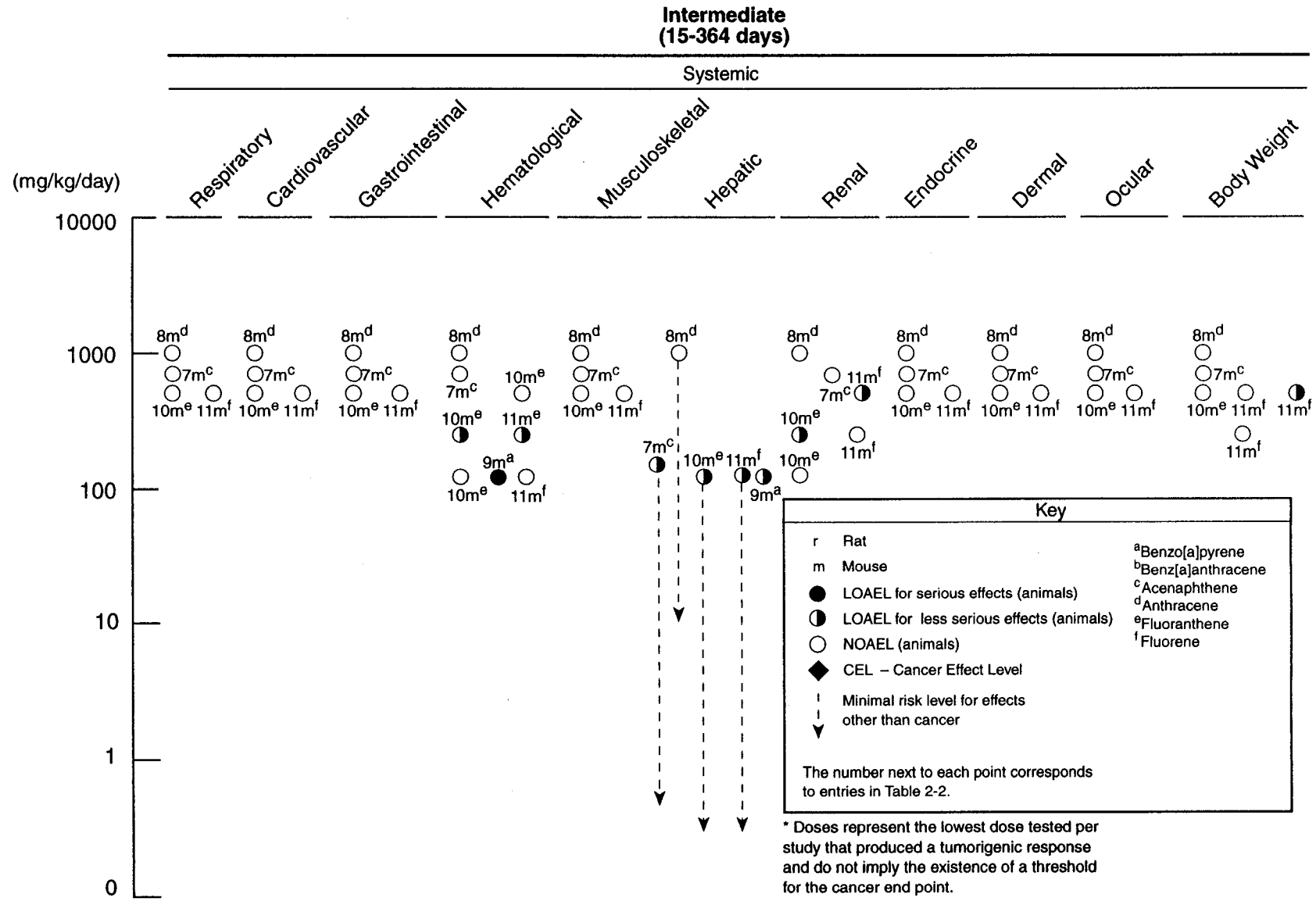
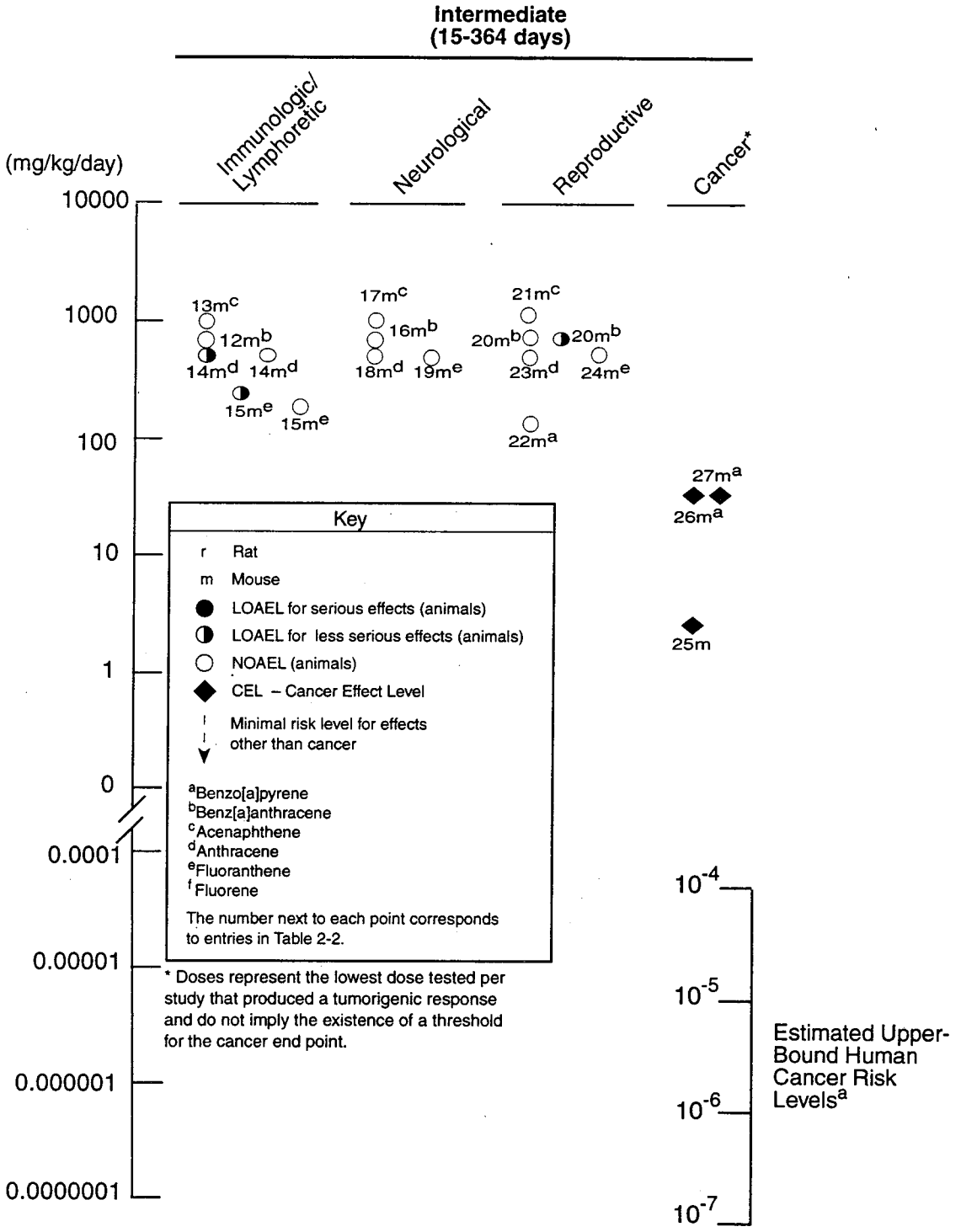


Figure 2-2. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons – Oral (continued)



Cardiovascular Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of cardiovascular distress were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, and 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

Gastrointestinal Effects. Minimal information is available on the gastrointestinal effects of human oral exposure to PAHs. In one study, humans that consumed anthracene-containing laxatives (the anthracene concentration was not specified) for prolonged periods of time were found to have an increased incidence of melanosis of the colon and rectum (i.e., unusual deposits of black pigments in the colon and rectum) compared to patients who did not consume anthracene laxatives. However, no definitive conclusions can be drawn from these results because of study limitations that include possible misclassification of patients with respect to the level of anthracene laxative use over 30 years and no accounting for other factors involved in the pathogenesis of melanosis (Badiali et al. 1985).

Enzyme alterations in the mucosa of the gastrointestinal tract have been observed in animals acutely exposed to anthracene, benz[a]anthracene, benzo[a]pyrene, or phenanthrene. In rats, acute intragastric administration of 50 or 150 mg/kg/day benz[a]anthracene or benzo[a]pyrene, respectively, for 4 days resulted in suppression of carboxylesterase activity in the intestinal mucosa (reduction of activity by 30% and 44%, respectively); rats exposed to 100 mg/kg/day of anthracene or phenanthrene exhibited carboxylesterase activity that was increased by 13% and 30%, respectively (Nousiainen et al. 1984). Enzyme alteration in the absence of other signs of gastrointestinal toxicity is not considered an adverse health effect, but it may precede the onset of more serious effects. Based on this very limited information, it would appear that acute ingestion of anthracene, benz[a]anthracene, benzo[a]pyrene, or phenanthrene at these doses may not adversely affect the gastrointestinal tract of animals; however, exposed animals exhibited biochemical changes and it is possible that more serious effects could occur at high doses.

Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No adverse effects on the gastrointestinal system were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, 500 mg/kg/day fluoranthene, or mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

Hematological Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989). No hematological effects were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene (EPA 1989d). Administration of 250 mg/kg/day fluoranthene by gavage for 13 weeks to mice resulted in decreased packed cell volume in females, but not in males, given doses up to 500 mg/kg/day (EPA 1988e). Both male and female mice exposed to 250 mg/kg/day fluorene exhibited hematologic effects, including decreased packed cell volume and hemoglobin content (EPA 1989e).

Adverse hematopoietic effects (e.g., aplastic anemia, pancytopenia) that ultimately led to death were reported in the Ah-nonresponsive strains of mice, DBA/2N and AKR/N, following oral exposure to 120 mg benzo[a]pyrene/kg/day for 180 days. Death was attributed to hemorrhage or infection that resulted from pancytopenia (Robinson et al. 1975). Similar results were obtained by Legraverend et al. (1983). The Ah gene encodes a cytosolic receptor (Ah receptor) that regulates the induction of the cytochrome P-450 enzymes. Differences in this gene locus determine whether the Ah receptor will be "high-affinity" (i.e., will allow for the induction of the cytochrome P-450 enzymes [more specifically, AHH] and is found in responsive mice) or "low-affinity" (i.e., does not allow for the induction of the AHH and is found in nonresponsive mice). Mice with a high-affinity Ah receptor (i.e., responsive mice) were administered 120 mg/kg/day benzo[a]pyrene in the diet for 3 weeks and exhibited no myelotoxicity. However, all nonresponsive mice that were treated according to the same regimen died from myelotoxic effects within 3 weeks (Legraverend et al. 1983). These results support the results of Robinson et al. (1975).

Musculoskeletal Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of musculoskeletal effects were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

Hepatic Effects. The induction of foci of altered hepatocytes is often seen in rats and mice that also develop liver tumors. These foci have altered enzyme activities and higher rates of cell proliferation than normal hepatocytes. A l-day intragastric administration of 200 mg/kg of benzo[a]pyrene or dibenz[a,h]anthracene, or of 180 mg/kg benz[a]anthracene to rats was followed by a

diet containing 2-acetylaminofluorene (2-AAF) and carbon tetrachloride induced gamma-GT foci (Tsuda and Farber 1980). Partially hepatectomized rats and sham hepatectomized rats were used, to provide proliferating and non-proliferating hepatocytes, respectively. Partially hepatectomized rats were more responsive to treatment than the sham-operated animals. For partially hepatectomized rats, benzo[a]pyrene was a more potent foci inducer than either benz[a]anthracene or dibenz[a,h]anthracene. Increased relative liver weight was seen in male mice and increased absolute and relative liver weight was seen in female mice given 175 mg/kg/day acenaphthene daily by gavage for 13 weeks; these effects were unaccompanied by other hepatic effects (EPA 1989c). Increased absolute and relative liver weight correlated with hepatocellular hypertrophy was seen in male and female mice given 350 mg/kg/day acenaphthene daily by gavage for 13 weeks (EPA 1989c). Increased serum cholesterol was also seen in females receiving 350 mg/kg/day acenaphthene (EPA 1989c). Increased liver weight and dose-related centrilobular pigmentation accompanied by an increase in liver enzymes were observed in both male and female mice receiving 250 mg/kg/day fluoranthene by gavage for 13 weeks (EPA 1988e). Male mice exposed to 125 mg/kg/day fluoranthene exhibited a slight increase in centrilobular pigmentation, and an increase in relative liver weight (EPA 1988e). Increased relative liver weight was observed in all treated groups, whereas increased absolute and relative liver weight was observed in the mid- and high-dose animals receiving 0, 125, 250, and 500 mg/kg/day fluorene for 13 weeks (EPA 1989e). However, there were no accompanying histopathological changes. No statistically significant effects of treatment were reported after 13-week administration of 1,000 mg/kg/day anthracene (EPA 1989d)

The ability to induce aldehyde dehydrogenase (ADH) in animals has been correlated with carcinogenic potency. Rats that were intragastrically administered 100 mg/kg/day of benzo[a]pyrene, benz[a]anthracene, anthracene, chrysene, or phenanthrene for 4 days exhibited cytosolic ADH induction (Torronen et al. 1981). However, benzo[a]pyrene and benz[a]anthracene were much more effective than phenanthrene, chrysene, or anthracene. Exposure to benzo[a]pyrene and benz[a]anthracene also increased the relative liver weights by 27% and 19%, respectively (Torronen et al. 1981). The authors concluded that anthracene, phenanthrene, and chrysene, which have been characterized as either noncarcinogens or equivocal carcinogens (see Section 2.2.2.8), are poor ADH inducers (Torronen et al. 1981).

The induction of carboxylesterase activity has also been observed in animals exposed to PAHs (Nousiainen et al. 1984). Benzo[a]pyrene, benz[a]anthracene, and chrysene were moderate inducers of

hepatic carboxylesterase activity in rats that were intragastrically administered 50, 100, and 150 mg/kg/day (100 mg/kg/day for chrysene), respectively, for 4 days. However, rats administered 100 mg/kg/day anthracene or phenanthrene did not exhibit induction of hepatic carboxylesterase activity. Induction of hepatic microsomal enzymes generally results in enhanced biotransformation of other xenobiotics (to either more or less toxic forms).

Increases in liver weight following partial hepatectomy have also been examined following acute oral exposure to various PAHs. Partially hepatectomized rats were fed diets containing various PAHs for 10 days. Administration of 51.4 mg/kg/day acenaphthene or 180 mg/kg/day fluorene resulted in statistically significant increases in liver weight compared to controls, which may have indicated an effect on regeneration, although rates of cell proliferation were not determined. Administration of 15.4 mg/kg/day acenaphthene, 51.4 mg/kg/day benzo[a]pyrene, or 51.4 mg/kg/day pyrene, anthracene, or phenanthracene had no effect. Diets containing 51.4 mg/kg/day acenaphthene or dibenz[a,h]anthracene, 180 mg/kg/day anthracene or phenanthracene, or 437 mg/kg/day pyrene produced no increase in the liver-to-body-weight ratio. Rats that were fed a diet containing 514 mg/kg/day chrysene exhibited equivocal results: in one trial, a significant increase in liver weight gain was noted, while in another trial, no increase in. liver-to-body-weight ratio was observed (Gershbein 1975). Thus, both suspected carcinogenic and noncarcinogenic PAHs can affect liver weights, although much higher doses are required for noncarcinogenic PAHs. The livers of rats administered single doses of ,fluorene by gavage in dimethyl sulfoxide (DMSO) were evaluated for the promotion of growth (i.e., cell proliferation as determined by organ weight and mitotic index) (Danz et al. 1991). The authors claimed that liver weight was increased in a dose-dependent manner to 20% over control values, and that the mitotic index of the hepatocytes was increased by 6-fold after 48 hours. However, the organ weight data were not presented, and the mitotic index data presented graphically in the text do not indicate a 6-fold increase over controls.

Ah-responsive strains of mice (C57BL/6, C3H/HeN, BALB/cAnN) that were orally administered 120 mg benzo[a]pyrene/kg/day in their diet for 180 days exhibited a 13% increase in relative liver weights (Robinson et al. 1975).

The hepatic effects observed in animals following oral exposure to PAHs are generally not considered serious. However, the enzyme alterations, gamma-GT foci induction, liver regeneration, and increased liver weight may precede the onset of more serious hepatic effects.

Renal Effects. The kidney microsomal carboxylesterase activity of rats was moderately induced by 50-150 mg/kg of benzo[a]pyrene following 4 days of intragastric administration; however, rats administered 100 mg/kg/day of anthracene or phenanthrene and 50-150 mg/kg benz[a]anthracene did not exhibit increased activity. The authors conclude that anthracene, phenanthrene, and benz[a]anthracene are not inducers of kidney carboxylesterase activity (Nousiainen et al. 1984). Enzyme induction is considered an adverse effect when observed concurrently with more serious effects such as impaired renal function and/or histopathological changes of the kidney.

Increasing dietary doses of pyrene ranging from 1,000 mg/kg food (127 mg/kg/day) up to 25,000 mg/kg food (917 mg/kg/day) for a mean dose of 426.6 mg/kg/day over a 25-day study produced dilation of the renal tubules in an unspecified number of mice. This effect was not observed until the highest dose was administered (Rigdon and Giannukos 1964). The limitations of this study (e.g., doses changed throughout exposure period and no statistical analyses performed) render these results of questionable toxicological significance.

Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of renal toxicity were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene (EPA 1989d). Increased absolute and relative kidney weight was observed in males, but not females receiving 500 mg/kg/day fluorene for 13 weeks (EPA 1989e). Renal tubular regeneration, and interstitial lymphocytic infiltrates and/or fibrosis were observed after 13-week oral administration of fluoranthene to female mice at 250 mg/kg/day, and male mice at 500 mg/kg/day (EPA 1988e).

Endocrine Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of endocrine imbalance were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

Dermal Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of derrnal effects were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings

were reported after 13-week administration of 1,000 mg/kg/day anthracene, 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

Ocular Effects. Male and female mice were exposed to 0, 17.5, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No signs of ocular toxicity were seen during life for any dose group, and no gross or microscopic damage was seen upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene (EPA 1988e, 1989d, 1989e).

Body Weight Effects. Male and female mice were exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). No adverse effects on body weight were seen during life or upon necropsy. Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, and 500 mg/kg/day fluoranthene (EPA 1988e, 1989d). After administration of 500 mg/kg/day fluorene for 13 weeks; however, female mice exhibited increased body weight, although male mice showed no effect at the same dose level (EPA 1989e).

Other Systemic Effects. The number of thymic glucocorticoid receptors in 6-week-old rats treated once with 2 mg/kg benzo[a]pyrene was measured (Csaba et al. 1991). It is assumed that administration was by oral gavage, but this was never explicitly stated. The number of these receptors was decreased by 40% in females and unaffected in males relative to the vehicle control animals. The statistical significance of these effects was not indicated, nor was the functional consequences of a decrease in receptor number assessed by examination of functional parameters.

2.2.2.3 Immunological and Lymphoreticular Effects

No studies were located regarding immunological effects in humans following oral exposure to any of the 17 PAHs discussed in this profile.

A single gavage dose of 150 mg/kg fluorene to male Sprague-Dawley rats had no effect on thymus or spleen weight (Danz and Brauer 1988). Little useful information can be obtained from this study as only one dose was tested (thereby precluding assessment of the validity of the negative response) and no tests of immune function were evaluated. Male and female mice exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks showed no effect of treatment on splenic weight

or histopathology (EPA 1989c). Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, and 500 mg/kg/day fluoranthene (EPA 1988e, 1989d). After administration of 2.50 mg/kg/day fluorene for 13 weeks, however, increased absolute and relative spleen weight was seen in both sexes (EPA 1989e).

Lee and Strickland (1993) looked for antibodies specific to PAH-DNA adducts in the serum of BALB/c mice treated orally twice per week for 8 weeks with 0.5 or 5 mg/kg benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene, dibenz[a,h]anthracene, or fluoranthene. Increased antibody response was noted in animals treated with the low dose of benz[a]anthracene and benzo[b]fluoranthene, but not any of the other PAHs.

2.2.2.4 Neurological Effects

No studies were located regarding neurological effects in humans following oral exposure to any of the 17 PAHs discussed in this profile.

Male and female mice exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks showed no effect of treatment on behavior, or histopathologic effects on nerve or brain samples (EPA 1989c). Similar findings were reported after 13-week administration of 1,000 mg/kg/day anthracene, and 500 mg/kg/day fluoranthene (EPA 1988e, 1989d). After administration of 500 mg/kg/day fluorene for 13 weeks, however, increased brain weight was observed in females, but not in males (EPA 1989e). No histopathologic changes were observed.

2.2.2.5 Reproductive Effects

No studies were located regarding reproductive effects in humans following oral exposure to the PAHs discussed in this profile. Three animal studies were located that evaluated the reproductive effects of benzo[a]pyrene in animals. The results of two oral studies in mice (Mackenzie and Angevine 1981; Rigdon and Neal 1965) and one in rats (Rigdon and Rennels 1964) indicate that benzo[a]pyrene induces reproductive toxicity in animals. The incidence and severity of these effects depends on the strain, method of administration, and dose levels used. In one study, benzo[a]pyrene administered by gavage to pregnant CD-l mice decreased the percentage of pregnant females that reached parturition and produced a high incidence of sterility in the progeny (Mackenzie and Angevine 1981). In

contrast, benzo[a]pyrene administered in the diet caused no adverse effects on fertility of Swiss mice (Rigdon and Neal 1965) but reduced the incidence of pregnancy in female rats (Rigdon and Rennels 1964). Based on these studies, the LOAEL for benzo[a]pyrene-induced reproductive toxicity in parental mice was 160 mg/kg/day, and the LOAEL for these effects in the progeny of exposed animals was 10 mg/kg/day (Mackenzie and Angevine 1981). Because only the parental doses are quantifiable, these are the only data presented in Table 2-2.

When CD-l mice were administered benzo[a]pyrene by gavage daily for 10 days during gestation, there was a significant reduction in the percentage of pregnant females to reach parturition at 160 mg/kg/day, the highest dose tested (Mackenzie and Angevine 1981). When F_1 progeny were bred with untreated animals, the fertility index decreased significantly in all treatment groups. At 10 mg/kg/day, the lowest dose tested, the reduced fertility noted was associated with significant alterations in gonadal morphology and germ cell development. The treatment at higher doses resulted in total sterility. Contrary to these results, no adverse effects on reproduction were observed in Swiss mice fed benzo[a]pyrene in the diet at ≤133 mg/kg/day over varying time spans during mating, gestation, and parturition (Rigdon and Neal 1965). The apparent discrepancy in the results of the two studies may be attributable to the method of benzo[a]pyrene administration and metabolic differences in the two strains of mice used.

Dietary administration of benzo[a]pyrene for 28 days revealed no treatment-related effects on the estrous cycle of female rats. These rats experienced no significant adverse effects on their fertility when bred to untreated male rats (Rigdon and Rennels 1964). In another series of experiments, when benzo[a]pyrene-fed male and female rats were bred, only two of seven females became pregnant (as compared to 3 of 6 controls); the offspring of one rat were stillborn while those of others were resorbed (Rigdon and Rennels 1964). Although the data suggest that benzo[a]pyrene may induce reproductive toxicity in rats, they are inconclusive because of the use of a single dose level, small number of animals, and inadequate reporting of data.

Male mice exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks showed no effect of treatment on reproductive organ weight or histology (EPA 1989c). Female mice, however, exhibited decreased ovary weights correlated with an increase of inactivity of the ovary and uterus (EPA 1989c). No adverse effects on reproductive organs were reported after 13-week

administration of 1,000 mg/kg/day anthracene, 500 mg/kg/day fluoranthene, or 500 mg/kg/day fluorene to male and female mice (EPA 1988e, 1989d, 1989e).

The available information from animal studies suggests that benzo[a]pyrene may have the potential to produce adverse reproductive effects in exposed humans. The highest NOAEL and all LOAEL values from each reliable study for reproductive effects following acute- and intermediate-duration exposures are reported in Table 2-2 and plotted in Figure 2-2.

2.2.2.6 Developmental Effects

No studies were located regarding developmental effects in humans following oral exposure to PAHs. Three animal studies were reviewed that assessed developmental effects of benzo[a]pyrene in inbred strains of rats and mice. The data from these studies indicate that prenatal exposure to benzo[a]pyrene produced reduced mean pup weight during postnatal development and caused a high incidence of sterility in the F_1 progeny of mice (Mackenzie and Angevine 1981). Using Ah-responsive and Ah-nonresponsive strains of mice, the increased incidences of stillboms, resorptions, and malformations observed correlated with the maternal and/or embryonal genotype (Legraverend et al. 1984). In another study, negative results were obtained when benzo[a]pyrene was administered to Swiss (responsive) mice (Rigdon and Neal 1965).

Benzo[a]pyrene was administered by gavage to pregnant CD-l mice during gestation at doses of 10, 40, and 160 mg/kg/day. The viability of litters at parturition was significantly reduced in the highest dose group (Mackenzie and Angevine 1981). The mean pup weight was significantly reduced in all treatment groups by 42 days of age. The F_1 progeny that were exposed prenatally to benzo[a]pyrene (10, 40, and 160 mg/kg/day) were bred with untreated animals and further studied for postnatal development and reproductive function. The F_1 progeny from the 10-mg/kg/day group experienced decreased fertility with associated alterations in gonadal morphology and germ-cell development. Because only the parental doses are quantifiable, these are the only data presented in Table 2-2. Therefore, the LOAEL of 10 mg/kg/day noted in the F_1 progeny discussed above is not presented in Table 2-2. Higher doses produced total sterility. This study provides good evidence for the occurrence of developmental effects following *in utero* exposure to benzo[a]pyrene.

The effect of genetic differences in metabolism of orally administered benzo[a]pyrene on *in utero* toxicity and teratogenicity was evaluated in mice that either metabolize benzo[a]pyrene readily (Ah-responsive) or not (Ah-nonresponsive) (Legraverend et al. 1984). Pregnant mice, either B6AKFl (Ah-responsive) or AKR/J (Ah-nonresponsive), were fasted prior to a diet containing 120 mg/kg/day benzo[a]pyrene on days 2-10 of gestation. The mice were killed on day 18 of gestation. On day 16 of gestation, intraperitoneal injections of napthoflavone were administered to distinguish between fetuses with different Ah-genotypes (Ahb/Ahd and Ahd/Ahd). Oral administration of benzo[a]pyrene to the pregnant AKR/J mice (non-responsive) caused more stillbirths, decreased weight gain, resorptions, and birth defects among Ahd/Ahd (Ah-nonresponsive) than among Ahb/Ahd (Ah-responsive) embryos. However, no differences in *in utero* toxicity or teratogenicity were observed in Ah-genetically different embryos (Ahd/Ahd and Ahb/Ahd) of B6AKFl mothers (responsive). The authors concluded that differences in *in utero* toxicity and teratogenicity are specific to the route of administration and can be attributed to "first pass" liver metabolism occurring with oral dosing. They also concluded that *in utero* toxicity and teratogenicity are directly related to the maternal and/or embryonal genotype controlled by the Ah-locus; that is, both maternal metabolism as well as target organ metabolism (embryo/fetus) were important in determining susceptibility to developmental toxicity. Specifically, metabolism by a responsive mother reduces *in utero* toxic effects in the fetus. Similarly, responsive fetuses in the uterus of a non-responsive mother show fewer *in utero* toxic effects. Non-responsive fetuses in the uterus of a non-responsive mother show the highest incidence of *in utero* toxic effects. Although the study emphasizes the importance of administrative route in benzo[a]pyrene metabolism and resulting toxicity, it had the following limitations: 1) only one dose was evaluated; 2) no quantitative comparisons between treated groups and corresponding control animals were presented for any of the reported *in utero* toxicity or teratogenic effects; 3) small sample size; 4) purity of benzo[a]pyrene was not specified.

In another study, negative results were obtained when the potential developmental effects of benzo[a]pyrene were studied in mice (Rigdon and Neal 1965). Dietary administration of this chemical to mice at concentrations equivalent to 33.3, 66.7, or 133.3 mg/kg/day at various times before and after mating elicited no adverse effects on the developing embryos. Maternal weight gain was reduced in the mice administered the higher levels of benzo[a]pyrene, but this effect was reversed when the animals were changed to the control ration. Limitations of this study that preclude its inclusion in Table 2-2 consist of the use of an inconsistent protocol, varying number of animals, and varying time of gestation exposure.

The highest NOAEL values and all LOAEL values from each reliable study for developmental effects in mice for acute-duration exposure is recorded in Table 2-2 and plotted in Figure 2-2.

2.2.2.7 Genotoxic Effects

No studies were located regarding genotoxic effects in humans following oral exposure to any of the 17 PAHs discussed in this profile.

Pregnant *Erythrocebus patas* monkeys were treated once on gestation day (Gd) 50, 100, or 150 (term = 160 days) with 5-50 mg/kg benzo[a]pyrene (Lu et al. 1993). Fetuses were removed by Cesarean section l-50 days after treatment and fetal organs, placentae, and maternal livers were assayed for DNA adducts. Benzo[a]pyrene-DNA adducts were high in fetal organs, placentae, and maternal livers in all three trimesters of gestation. Adduct levels were higher in mid-gestation compared to early or late gestation. dG-N2-BPDE was the major adduct detected. The adduct levels in fetal tissues increased with benzo[a]pyrene dose, but at a much lower rate that placentae or maternal livers. Preference in binding to DNA of various fetal tissues was more apparent in early gestation compared to late gestation, and at lower doses compared to higher doses. During early gestation and at lower doses, benzo[a]pyrene produced a similar level of DNA binding in fetal lung, liver, maternal liver, and placenta. Individual fetal organ adduct levels correlated significantly with placental adduct levels, indicating placental and/or maternal contribution to adduct formation in fetuses. Evidence of fetal contribution to adduct formation was also found. DNA adduct levels in fetal skin were lowest of all fetal organs tested and less affected by gestational stage at time of treatment. In contrast, DNA adduct levels in fetal liver exhibited distinct gestation stage specificity with higher adduct, levels attained during mid-gestation compared to other stages of gestation. Adduct levels decreased at a much faster rate during the first 10-15 days compared to 15-50 days after treatment. However, 10% of the DNA adducts persisted 50 days after treatment in all organs studied. Together, the results suggest that placental adduction accurately indicates fetal exposure.

Male B6C3F_1 mice were fed 0, 0.325, 0.1825, 1.625, 3.25, or 6.5 mg/kg/day benzo[a]pyrene for 21 days (Culp and Beland 1994). Animals were killed and the liver, lung, and forestomach DNA extracted and analyzed for benzo[a]pyrene-DNA adducts. The major adduct, dG-N2-BPDE, was quantified. Adduct levels in liver and lung increased in a linear manner. Adduct levels in the forestomach appeared to plateau at the highest dose. At doses below the highest, adduct levels were in

the order of forestomach > liver > lung, with the values of average slopes being 3.0 + 0.59, 2.1 + 0.17, 1.3 + 0.37 fmol adduct/mg DNA/μg benzo[a]pyrene/day, respectively. At these doses, the lung and the forestomach were not significantly different. At the high dose, liver > forestomach > lung, and each tissue was significantly different from the other.

DNA binding of coal tar components in male mice was investigated following the ingestion of coal tar obtained from a manufactured coal plant (Weyand et al. 1991). One of four different samples (A-D) of coal tar or a mixture of four equal portions of the four samples was administered in a gel diet which contained 0.25% coal tar. The coal tar contained phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-c,d]pyrene, and benzo[g,h,i]perylene, among other PAHs. In addition, a diet containing benzo[a]pyrene at the same level as the 0.25% diet prepared with Sample C was administered; animals consuming this diet ingested 0.01-0.02 mg benzo[a]pyrene per day. The diets were administered for 15 days. Chemical-DNA adduct formation was evaluated in animals following 14 days of treatment. Chemical-DNA adduct formation was also evaluated in animals maintained on a 0.1, 0.2, 0.5, and 1.0% coal tar diet prepared with one of the coal tar samples (C). Chemical-DNA adduct formation in animals dosed with 0.l-1.0% Sample C indicated a dose-related effect in lung DNA adduct formation, but no dose-related effect was observed for forestomach tissue. In addition, overall adduct levels in lung tissue were considerably higher than forestomach levels for animals on the 0.5 or 1% diet. In contrast, adduct levels were highest in the forestomach of animals on diets lower in coal tar content (0.1 or 0.2%). Chemical-DNA adducts of coal tar components evaluated for Samples A-D and the mixture of the four coal tar samples at 0.25% in the diet administered for 15 days indicated adducts in the lung, liver, and spleen of all animals. Adduct patterns were similar, but quantitative differences were observed between coal tar samples and tissue sites. The highest adduct levels were detected in lung DNA. Adduct formation in animals fed the benzo[a]pyrene diet, could not account for the differences in the adduct levels observed in animals given the mixtures. Also, adduct formation in animals fed the coal tar mixtures correlated with benzo[a]pyrene content in the coal tar, indicating the adducts arose from a variety of PAHs in the coal tar mixtures. The levels of 1-hydroxypyrene in the urine of these animals correlated with the pyrene content of these coal tars.

The DNA binding of manufactured gas plant residue (MGP) components in male B6C3Fl mice was investigated following oral administration (Weyand and Wu 1994). Male mice were fed a gel diet containing manufactured gas plant (MGP) residue (coal tar) at 0.3% for 28 days, or the corresponding

control diet. Two mixtures of MGP residue were used: Mix of 3 combining equal amounts of samples from three different MGP plant sites, and Mix of 7 combining equal amounts of samples from seven different MGP plant sites, including those used in the Mix of 3. The mixtures contained pyrene, benz[a]anthracene, chrysene, benzo[b]fluorene, benzo[k]fluorene, benzo[a]pyrene, indeno[l,2,3-cd] pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene. Data was presented in terms of pyrene consumed. Animals were sacrificed on the twenty-ninth day and lung and forestomach were excised and DNA isolated. Chemical-DNA adduct formation was evaluated. Ingestion of the adulterated diets resulted in a relatively low level of DNA adducts in the forestomach in comparison with the lung (one-tenth the level). PAH-DNA adduct levels in the lung of mice maintained on the Mix of 3 (1.4 mg/kg/day pyrene) were two times greater than the level induced by the Mix of 7 (1.2 mg/kg/day pyrene) suggesting that the composition of the MGP residue may have influence PAH absorption or DNA adduct formation.

Oral exposure to a total dose of 10 mg/kg benzo[a]pyrene produced gene mutations in the mouse coat color spot test (Davidson and Dawson 1976, 1977). Dose-related increases in the frequency of micronuclei were seen in bone marrow cells harvested from MS/Ae and CD-l male mice (four mice/strain/dose) 48 hours after administration of a single oral dose of benzo[a]pyrene ranging from 62.5 to 500 mg/kg (Awogi and Sato 1989). Although the response appeared to be stronger in the MS/Ae strain, the reduction in polychromatic erythrocytes, indicative of target cell toxicity at all levels in the CD-1 strain, limited the comparative evaluation of strain specificity.

In another study, a dose of benzo[a]pyrene (150 mg/kg) known to induce a clastogenic response was orally administered to groups of five adult males and females, pregnant females, and fetal ICR mice. An increased incidence of micronuclei in bone marrow cells harvested from the various groups of adult animals and also in the livers of the fetuses was observed (Harper et al. 1989). Genetic damage was most severe in the fetuses. The approximately 7-fold increase in micronuclei in fetal livers as compared to maternal bone marrow suggests that the transplacentally-induced genotoxicity was probably associated with the immature detoxification processes of fetal liver as compared to adult bone marrow. It would, nevertheless, appear that the fetus may be at an increased risk.

Data showing that orally administered benzo[a]pyrene induces micronuclei were confirmed in subsequent studies (Shimada et al. 1990, 1992) using rats (Sprague-Dawley) and mice (CD-l and BDF_1), different dosing regimes (single, double, or triple doses), and different target cells (bone

marrow and peripheral blood reticulocytes). A single oral gavage dose of 63 mg/kg benzo[a]pyrene significantly ($p<0.0l$) increased the yield of chromosomes with abnormal morphology in bone marrow cells collected from hybrid $lC3F_1$ male mice (Adler and Ingwersen 1989).

There is conflicting evidence that the genetic damage induced by benzo[a]pyrene is partially controlled by the expression of structural genes for benzo[a]pyrene-specific cytochromes P-450. In one study, two inbred strains of mice differing in AHH inducibility (AHH-inducible strain C57BL/6 and AHH-noninducible strain DBA/2) received two consecutive daily doses of either 10 or 100 mg/kg of the test material (Wielgosz et al. 1991). Animals were sacrificed 5 days postexposure, and bone marrow and spleen cells were examined for sister chromatid exchange and DNA adducts. Results showed a marked increase in sister chromatid exchange induction and the formation of DNA adducts in bone marrow and spleen cells recovered from the DBA/2 mice (AHH-noninducible) in both dose groups compared to the C57BL/6 (AHH-inducible) mice. However, no clear correlation between AHH inducibility and the positive clastogenic response induced by 150 mg/kg benzo[a]pyrene was found in adult male and female mice with genetically determined differences in AHH induction (Adler et al. 1989). Similarly, the transplacental exposure of 11-day-old homozygous and hybrid embryos (dams received a single oral gavage dose of 150 mg/kg and embryos were sampled 15 hours after treatment) to benzo[a]pyrene showed that the clastogenic response was independent of genetic constitution.

In contrast to the relatively uniform evidence that benzo[a]pyrene is a genotoxin in whole animals, the test material failed to induce unscheduled DNA synthesis (UDS) in the parenchymal liver cells of Brown Norway rats exposed by oral gavage to 12.5 mg/mL (Mullaart et al. 1989). There was, however, a clear increase in single-strand DNA breaks in cells from the two major centers of metabolism (the parenchymal liver and intestinal cells) of the treated animals that was not apparent in the nonparenchymal liver cells.

Significant ($p<0.05$), but marginal, increases in the frequency of abnormal sperm were found in CD-l mice (8-12/group) exposed via oral gavage to benzo[a]pyrene doses ranging from 360 to 432 mg/kg (Salamone et al. 1988). The effect, however, was not clearly dose related, and the wide variation in the background frequency rendered the data inconclusive. Comparable doses produced no adverse effects in $B6C3F_1$ mice. Similarly, the evaluation of pyrene (241-844 mg/kg) in this study yielded uniformly negative results.

Orally administered fluoranthene (400 and 750 mg/kg) did not increase the sister chromatid exchange frequency in mice (Palitti et al. 1986). Gene mutations were not produced in bacteria or yeast in a host-mediated assay in which anthracene, benzo[a]pyrene, chrysene, or fluoranthene were administered to mice by gavage; positive results were produced in bacteria in the same test system in which mice were exposed to benz[a]anthracene and injected intraperitoneally with the bacteria (Simmon et al. 1979). Other genotoxicity studies are discussed in Section 2.4.

2.2.2.8 Cancer

No studies were located regarding cancer in humans following oral exposure to the 17 PAHs discussed in this profile. The animal studies discussed in this section are presented first by exposure duration (acute, intermediate, and chronic), and within each duration category the information on individual PAHs is discussed in alphabetical order. PAHs for which no information was available for specified exposure durations were omitted.

Acute-Duration Exposure. Mice acutely administered 1.5 mg/day benz[a]anthracene by oral gavage two times over 3 days exhibited increased incidences of hepatomas and pulmonary adenomas (80% and 85%, respectively) as compared to control incidences (10% and 30% for hepatomas and pulmonary adenomas, respectively) after 568 days of observation (Klein] 1963). No malignant tumors were observed in this study.

Mice fed benzo[a]pyrene in the diet at a concentration equivalent to 33.3 mg/kg/day exhibited forestomach neoplasms following 2 or more days of consumption. However, a lower concentration of benzo[a]pyrene (equivalent to 13.3 mg/kg/day) administered for up to 7 days did not produce forestomach tumors (Neal and Rigdon 1967) (see Table 2-2). Hamsters have also been observed to develop papillomas and carcinomas of the alimentary tract in response to gavage or dietary exposure to benzo[a]pyrene (Chu and Malmgren 1965). A 77% mammary tumor incidence was observed 90 weeks after a single oral dose of 50 mg benzo[a]pyrene (100 mg/kg) was administered to rats, as compared to a 30% incidence in untreated animals (McCormick et al. 1981).

A single dose of 0.05 mg/kg dibenz[a,h]anthracene in polyethylene glycol (PEG)-400 failed to induce tumors in male Swiss mice after 30 weeks. However, forestomach papillomas were found in 10% of mice administered a single dose of 0.05 mg/kg dibenz[a,h]anthracene followed by 30 weekly doses of

PEG alone, and in 21% of the mice when the dibenz[a,h]anthracene dose was followed by 30 weekly doses of PEG plus 3% croton oil (Berenblum and Haran 1955). Treatment with croton oil alone yielded a 14-16% tumor incidence. These results suggest that the carcinogenic activities of croton oil and dibenz[a,h]anthracene are additive in the mouse forestomach.

Intermediate-Duration Exposure. One intermediate-duration study was located that evaluated the carcinogenic potential of acenaphthene. Male and female mice exposed to 0, 175, 350, or 700 mg/kg/day acenaphthene by gavage for 13 weeks showed no evidence of tumorigenesis at necropsy (EPA 1989c).

Similarly, only one intermediate-duration study was located that evaluated the carcinogenic potential of anthracene. Male and female mice exposed to 0, 250, 500, 1,000 mg/kg/day anthracene by gavage for 13 weeks showed no evidence of tumorigenesis at necropsy (EPA 1989d).

One intermediate-duration study was located that evaluated the carcinogenic potential of benz[a]anthracene. Mice that received intermittent gavage doses of 1.5 mg/kg/day benz[a]anthracene for 5 weeks (Klein 1963). Mice were sacrificed at a median age of 437 or 547 days. The treated mice killed at 437 days exhibited a 95% incidence of pulmonary adenomas at an average of 3 per lung and a 46% incidence of hepatomas, with an average of 2.1 per tumor-bearer. Forestomach papillomas were found in 5% of the mice. Control animals killed after 441 days exhibited a 10% incidence of pulmonary adenomas. Treated mice sacrificed after 547 days exhibited a 95% pulmonary adenoma incidence, as was observed in the group sacrificed earlier, but an increased hepatoma incidence of 100%. Control animals sacrificed after 600 days had 30 and 10% incidences of pulmonary adenomas and hepatomas, respectively. This study was not adequately reported; it did not include complete histopathology, adequate treatment durations, large enough sample sizes, or statistical analysis. Although this study is inconclusive because of methodological limitations, it does provide some qualitative evidence for the potential carcinogenicity of benz[a]anthracene by the oral route.

Intragastric doses of 67-100 mg/kg benzo[a]pyrene have been shown to elicit pulmonary adenomas and forestomach papillomas in mice (Sparnins et al. 1986; Wattenberg and Leong 1970). Intermittent gavage exposure of mice to 67-100 mg/kg benzo[a]pyrene resulted in increased forestomach (100%) and pulmonary tumor incidences relative to controls at 30 weeks of age (Sparnins et al. 1986;

Wattenberg and Leong 1970). The study by Wattenberg and Leong (1970) involved gavage administration of approximately 1.0 mg of benzo[a]pyrene once a week for 8 weeks.

The incidence of forestomach tumors (papillomas and carcinomas) in mice was related to the duration of oral exposure to benzo[a]pyrene following intermediate-duration administration of dietary benzo[a]pyrene at various doses up to 250 ppm (33.3 mg/kg/day) for 30-197 days (Neal and Rigdon 1967, see Table 2-2). The tumor incidence also increased with increasing dose. In the same study, mice fed 250 ppm (33 mg/kg/day) for periods of 1-7 days exhibited increased forestomach tumor incidences following 2 or more days of benzo[a]pyrene exposure (total dose of 2 mg), while mice fed 10 ppm (13.3 mg/kg/day) for 110 days (total dose of 4.48 mg) did not develop tumors. The authors suggest that these findings provide evidence that there are no cumulative carcinogenic effects of benzo[a]pyrene or its metabolites in mice. These data suggest that differences in susceptibility may be strongly influenced by the age of the mice at the time that they were initially exposed. This study provides the best dose-response information available for the oral route of exposure despite the irregular protocol employed, although the relevance of forestomach tumors in rodents to human cancer is the subject of some controversy because humans lack a forestomach.

An association between dietary benzo[a]pyrene and the development of leukemia and tumors of the forestomach and lung has been observed in mice. Tumor incidence was related to both dose and length of exposure (except in the case of leukemia). Mice administered dietary doses of up to 1,000 ppm (up to 133 mg/kg/day) for intermediate lengths of time (23-238 days) exhibited an increased incidence of forestomach tumors (papillomas and carcinomas) (Rigdon and Neal 1966, 1969) (see Table 2-2). Mice administered 250 ppm (33.3 mg/kg/day) benzo[a]pyrene developed papillomas or carcinomas of the forestomach (64%) and all the mice in the 1,000-ppm (133 mg/kg/day) group exhibited forestomach tumors after 86 days of benzo[a]pyrene consumption. A similar relationship was observed for the incidence of lung tumors: mice fed 250 ppm (33.3 mg/kg/day) benzo[a]pyrene exhibited an increased lung adenoma incidence. The occurrence of leukemia was related to the ingestion of 250 ppm (33.3 mg/kg/day) benzo[a]pyrene; 37% of the treated mice developed leukemias (Rigdon and Neal 1969) (see Table 2-2). The lack of consistent protocol in these experiments and the short exposure duration and observation periods preclude the assessment of a dose-response relationship. Furthermore, because tumors were reported as combined papillomas and carcinomas, no distinction between these benign and malignant tumors can be made.

Mammary tumors have also been observed following intermediate-duration exposure to benzo[a]pyrene in rats. Eight weekly oral doses of 6.25 mg benzo[a]pyrene (12.5 mg/kg) administered to rats resulted in a 67% increase in the incidence of mammary tumors in female rats after 90 weeks of observation (McCormick et al. 1981). A 30% incidence of these tumors was observed in the control animals.

Two intermediate-duration studies investigated the carcinogenicity of dibenz[a,h]anthracene in animals following oral exposure. Mammary carcinomas were observed in 5% of the female BALB/c mice dosed with 0.5% dibenz[a,h]anthracene after 15 weeks of dosing; however, no control group was included (Biancifiori and Caschera 1962). In the other study, male and female rats were administered an emulsion of aqueous olive oil and dibenz[a,h]anthracene in place of their drinking water for up to 200 days (Snell and Stewart 1963). Pulmonary adenomatosis, alveologenic carcinoma, mammary carcinoma, and hemangioendotheliomas were observed in the treated rats. These tumors were not observed in the control animals. However, extensive dehydration and emaciation occurred because the animals did not tolerate the vehicle well, which lead to early death and the need to periodically remove the animals from the treatment vehicle. Neither of these studies was adequately reported: they did not perform appropriate histopathologic evaluations, treatment or study durations were inadequate, and the sample size was inadequate. Despite these methodological limitations, these studies do provide some evidence of dibenz[a,h]anthracene's carcinogenicity by the oral route.

One intermediate-duration study was located that evaluated the carcinogenic potential of fluoranthene. Male and female mice exposed to 0, 125, 250, or 500 mg/kg/day fluoranthene by gavage for 13 weeks showed no evidence of tumorigenesis at necropsy (EPA 1988e).

Similarly, only one intermediate-duration study was located that evaluated the carcinogenic potential of fluorene. Male and female mice exposed to 0, 125, 250, or 500 mg/kg/day fluorene by gavage for 13 weeks showed no evidence of tumorigenesis at necropsy (EPA 1989e).

Chronic-Duration Exposure. Benzo[a]pyrene was administered in the diet of 32 Sprague-Dawley rats/sex/group either every 9th day or 5 times/week at a dose of 0.15 mg/kg until the animals were either moribund or dead (Brune et al. 1981). An untreated control group consisted of 32 animals/sex. There was no treatment-related effect on survival and no treatment-related increase in tumors at any one site. However, a statistically significant increase in the proportion of animals with tumors of the forestomach, esophagus, and larynx combined was noted among animals receiving treatment

5 times/week (the combined incidence of animals with these tumors was 3/64, 10/64, and 3/64 in the controls, the group fed benzo[a]pyrene 5 times/week, and the group fed benzo[a]pyrene every 9th day). In the same study, groups of 32 Sprague-Dawley rats/sex were administered 0.15 mg/kg benzo[a]pyrene by gavage in a 1.5% caffeine solution either every 9th day (Group 3), every 3rd day (Group 2), or 5 times/week (Group 1) until the animals were moribund or dead, resulting in average annual doses of 6, 18, or 39 mg/kg, respectively. Survival was adversely affected only in Group 3 (mean survival.time = 87 weeks versus 102 weeks in the controls). Treatment with benzo[a]pyrene significantly increased the proportion of animals with tumors of the forestomach, esophagus, and larynx (the combined tumor incidence was 3/64, 6/64, 13/64, 2664, and 14/64 for the untreated controls, the gavage controls, and Groups 3, 2, and 1, respectively).

Summary. These results indicate that benz[a]anthracene, benzo[a]pyrene, dibenz[a,h]anthracene, and possibly other PAHs are carcinogenic to rodents following oral exposure at high doses.

All reliable CELs in mice for acute- and intermediate-duration exposure are recorded in Table 2-2 and plotted in Figure 2-2.

2.2.3 Dermal Exposure

2.2.3.1 Death

No studies were located regarding death in humans or animals after dermal exposure to the 17 PAHs discussed in this profile.

2.2.3.2 Systemic Effects

No studies were located regarding respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, renal, or ocular effects in humans or animals after dermal exposure to any of the 17 PAHs discussed in this profile. Other systemic effects observed after dermal exposure are discussed below.

The highest NOAEL values and all LOAEL values from each reliable study for each species and duration category are recorded in Table 2-3.

TABLE 2-3. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Dermal

Species/ (Strain)	Exposure/ Duration/ Frequency/ (Specific Route)	System	NOAEL	LOAEL			Reference
				Less Serious		Serious	
ACUTE EXPOSURE							
Systemic							
Mouse (C57BL/6)	1-2 d 1 x/d	Dermal	0.05 M mg/c m2				Iwata et al. 1981 anthracene
Mouse (C57BL/6)	1-2 d 1 x/d	Dermal	0.001 M mg/c m2	0.005 M mg/cm 2	(induction of melanocytes)	0.025 M (substantial melanocytes)	Iwata et al. 1981 benzo[a]pyrene
Mouse (C34/HeN)	5 d 2 x/5d	Dermal		120 mg F	(contact hypersensitivity)		Klemme et al. 1987 benzo[a]pyrene
Mouse (C57BL/6)	1-2 d 1 x/d	Dermal		0.0125 M mg/cm 2	(slight increase melanocytes)		Iwata et al. 1981 chrysene
Mouse (C57BL/6)	1-2 d 1 x/d	Dermal	0.05 M mg/c m2				Iwata et al. 1981 fluoranthene
Mouse (C57BL/6)	1-2 d 1 x/d	Dermal	0.05 M mg/c m2				Iwata et al. 1981 fluorene
Mouse (C57BL/6)	1-2 d 1 x/d	Dermal	0.05 M mg/c m2				Iwata et al. 1981 pyrene
Immunological/Lymphoreticular							
Mouse (C34/HeN)	5 d 2 x/5d			120 F	(contact hypersensitivity)		Klemme et al. 1987 benzo[a]pyrene

TABLE 2-3. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Dermal (continued)

Species/ (Strain)	Exposure/ Duration/ Frequency/ (Specific Route)	System	NOAEL	LOAEL Less Serious	LOAEL Serious	Reference
Cancer						
Mouse (CD-1)	20 d 10 x				10.1µg F [CEL: 35% (7/20) tumor incidence]	Weyand et al. 1993b benzo[b]fluoranthene
INTERMEDIATE EXPOSURE						
Immunological/Lymphoreticular						
Gn pig (Hartley)	2-3 wk 2 x			0.001% F (slight contact sensitivity)	1.0% F (contact sensitivity)	Old et al. 1963 benzo[a]pyrene
Cancer						
Mouse (C3H/HeJ)	6 mo 2 x/wk				0.05 mg M (CEL: 1/13 (8%) had a papilloma with coadministration of 0.0005 mg BaP)	Warshawshy et al. 1993 anthracene
Mouse (CD-1)	1 d 1 x/d, then 25 wk 3 d/wk (TPA)		0.09 F mg/kg		0.57 F mg/kg (CEL: 36% skin tumor incidence)	Levin et al. 1984 benz[a]anthracene
Mouse (SENCAR)	once then 23 wk 2 d/wk (TPA)				0.2 mg F (CEL: 6 papillomas/mouse)	Cavalieri et al. 1988b benzo[a]pyrene
Mouse (Swiss)	20 wk 2 x/wk 1 x/d				0.025 F mg (CEL: tumors in 90%)	Cavalieri et al. 1988b benzo[a]pyrene

TABLE 2-3. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Dermal (continued)

Species/ (Strain)	Exposure/ Duration/ Frequency/ (Specific Route)	System	NOAEL	LOAEL			Reference
				Less Serious	Serious		
Mouse (Crl:CD-1)	20 d every other day				0.01 mg F	(CEL: 35% developed skin tumors)	LaVoie et al. 1993a benzo[b]fluoranthene
Mouse (CD-1)	20 d every other day				0.006 mg F	(CEL: 5% developed skin tumors)	LaVoie et al. 1993b benzo[j]fluoranthene
Mouse (C3H/HeJ)	6 mo 2 x/wk				0.05 mg M	(CEL: 1/15 (7%) had a papilloma from chrysene alone; 3/13 (23%) having papillomas or malignancies with coadministration of 0.0005 mg BaP)	Warshawshy et al. 1993 chrysene
Mouse (C3H/HeJ)	6 mo 2 x/wk				0.05 mg M	(CEL: 1/12 (8%) had papillomas with coadministration of 0.0005 mg BaP)	Warshawsky et al. 1993 fluoranthene
Mouse (CD-1)	20 d 1 x/2d, then 22 wks (TPA)				100 mg F	(CEL: 80% incidnece of tumors)	Rice et al. 1985a indeno(1,2,3-c,d)pyr
Mouse (Swiss)	12 mo 3 x/wk		50 F		100 µg F	(CEL: 6/20 had papillomas, 3/20 had carcinomas)	indeno(1,2,3-cd)pyre

TABLE 2-3. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Dermal (continued)

Species/ (Strain)	Exposure/ Duration/ Frequency/ (Specific Route)	System	NOAEL	LOAEL			Reference
				Less Serious	Serious		
Mouse (C3H/HeJ)	6 mo 2 x/wk				0.05 mg M	(CEL: 3/13 (23%) had a tumor (papillomas and malignant) from the mixture alone; 8/17 (47%) with coadministration of 0.0005 mg BaP)	Warshawsky et al. 1993 mix
Mouse (C3H/HeJ)	6 mo 2 x/wk				0.05 mg M	(CEL: 1/12 (8%) had papillomas from phenanthrene alone; 1/17 (6%) had a malignant tumor with coadministration of 0.0005 mg BaP)	Warshawsky et al. 1993 phenanthrene
Mouse (C3H/HeJ)	6 mo 2 x/wk				0.05 mg M	(CEL: 1/13 (8%) had a papillomas from pyrene alone)	Warshawsky et al. 1993 pyrene
CHRONIC EXPOSURE							
Cancer							
Mouse (NMRI)	17-22 mo 2 d/wk 1 x/d				2 mg F	(CEL: 45% developed skin tumors)	Habs et al. 1984 benzo[a]pyrene
Mouse (C3H/HrJ)	99 wk 2 d/wk 1 x/d				12.5 µg M	(CEL: malignant tumors in 47/50)	Warshawsky and Barkley 1987 benzo[a]pyrene
Mouse (Swiss)	lifetime 3 d/wk 1 x/d				0.01% F	(CEL: papillomas in 5%)	Wynder and Hoffmann 1959b benzo[b]fluoranthene

TABLE 2-3. Levels of Significant Exposure to Polycyclic Aromatic Hydrocarbons - Dermal (continued)

Species/ (Strain)	Exposure/ Duration/ Frequency/ (Specific Route)	System	NOAEL	LOAEL		Reference
				Less Serious	Serious	
Mouse (NMRI)	19-20 mo 2 d/wk 1 x/d				15 µg F (CEL: skin carcinomas in 1/20)	Habs et al. 1984 mix

BaP = benzo(a)pyrene; CEL = cancer effect level; d = day(s); F = female; LOAEL = lowest-observed-adverse-effect level; M = male; mo = month(s); NOAEL = no-observed-adverse-effect level; TPA = tetradecanoyl phorbol acetate; wk = week(s); x = time(s)

Dermal Effects. Mixtures of carcinogenic PAHs cause skin disorders in human and animals; however, specific effects in humans of individual PAHs, except for benzo[a]pyrene, have not been reported. Mixtures of PAHs are also used to treat some skin disorders in humans. From these patients comes much of the data describing dermal effects of PAH exposure.

Regressive verrucae (i.e., warts) was reported following up to 120 dermal applications of 1% benzo[a]pyrene in benzene to human skin over 4 months (Cottini and Mazzone 1939). Although reversible and apparently benign, the changes were thought to represent neoplastic proliferation.

Adverse dermal effects have been noted in humans following intermediate-duration dermal exposure to benzo[a]pyrene in patients with the preexisting dermal conditions of pemphigus vulgaris (acute or chronic disease characterized by occurrence of successive crops of blisters) and xeroderma pigmentosum (a rare disease of the skin marked by disseminated pigment discolorations, ulcers, and cutaneous and muscular atrophy) (Cottini and Mazzone 1939). A 1% benzo[a]pyrene solution topically applied to patients with pemphigus resulted in local bullous eruptions characteristic of the disease. Patients with xeroderma pigmentosum exposed to 1% benzo[a]pyrene slightly longer than the pemphigus patients exhibited only pigmentary and slight verrucous effects. Similarly treated patients with preexisting active skin lesions due to squamous cell cancer showed a general improvement and/or retardation of the lesion. The severity of abnormal skin lesions appeared to be related to age; those in the lowest age range exhibited fewer and less-severe effects than those in the mid-range groups. No such age relationship of effects involving those patients with normal or preexisting skin lesions was noted.

Adverse dermal effects have also been ohserved in animals following both acute- and intermediate-duration dermal exposure to various PAHs. For example, acute topical application of benzo[a]pyrene, benz[a]anthracene, or dibenz[a,h]anthracene applied to the shaved backs of Swiss mice were all reported to suppress sebaceous glands (Bock and Mund 1958). However, controls were not employed; therefore, it is not possible to determine if the effects seen were due to the solvent and/or the application procedures.

Benzo[a]pyrene was applied once weekly to the skin of female ICR/Harlan mice (43-50/group) at doses of 16, 32, or 64 μg per application for 29 weeks (Albert et al. 1991b). Cell cycle kinetics and

morphometrics were evaluated. Evidence of epidermal cytotoxicity and death followed by regeneration was seen in animals administered 64 μg benzo[a]pyrene beginning the first weeks of exposure and later in the lower dose groups. This evidence included dose-related epidermal thickening and vertical nuclei stacking, increased mitotic labeling (2-4-fold with increasing dose), increased incidence of pyknotic and dark cells, and a pronounced inflammatory response in the dermis. The increase in cell proliferation was accompanied by only a minor increase in the size of the epidermal cell population, indicating that the proliferation was a regenerative response.

An acute (96-hour) dermal application of anthracene to the backs of hairless mice followed by ultraviolet radiation exposure for 40 minutes resulted in enhanced dermal inflammation compared to mice exposed exclusively to ultraviolet radiation. However, this effect was reversed within 48 hours (Forbes et al. 1976). Anthracene thus potentiates the skin damage elicited by sunlight exposure and may be considered a photosensitizer in hairless mice.

In animals, dermal application of 1% benzo[a]pyrene to the skin of hairless mice resulted in epidermal cell growth alterations (Elgjo 1968). Increases were observed in mitotic rates, mitotic counts, and mitotic duration and the author suggested that these were indicative of a regenerative reaction. However, concurrent controls were not utilized. The authors concluded that the alterations in the kinetics of epidermal cell growth produced by benzo[a]pyrene were more sustained than after application of croton oil. The study is limited for drawing conclusions concerning the dermal toxicity of benzo[a]pyrene because experimental data were compared with historical controls only, no acetone control was evaluated, and the statistical significance of the increased values was not determined.

2.2.3.3 Immunological and Lymphoreticular Effects

No studies were located regarding immunological effects in humans following dermal exposure to the 17 PAHs discussed in this profile.

Benzo[a]pyrene can elicit an immune response when applied dermally to the skin of animals. In mice, acute application of 120 μg benzo[a]pyrene elicited an allergic contact hypersensitivity in C3H mice that was antigen specific (Klemme et al. 1987). Slight contact hypersensitivity was also observed in guinea pigs following two dermal applications of 0.001% benzo[a]pyrene given over a period of 2-3 weeks. This response was more severe at a dose of 1.0% benzo[a]pyrene (Old et al. 1963).

In addition to eliciting a contact hypersensitivity response, benzo[a]pyrene has been shown to suppress this response to other sensitizers. The effects of dermally applied benzo[a]pyrene (alone or following dermal pretreatment with the prostaglandin synthetase inhibitor, indomethacin) on contact hypersensitivity (cell-mediated immunity), and production of antibodies to dinitrophenol (DNP) (humoral immunity) were studied in male BALB/c mice treated for 6 weeks to 6 months (Andrews et al. 1991a). A group of mice treated with acetone served as controls. Benzo[a]pyrene alone caused a significant reduction ($p<0.01$) in the contact hypersensitivity response to dinitrofluorobenzene (DNFB) as measured by increases in ear thickness when compared to the vehicle controls. However, indomethacin pretreatment prevented the benzo[a]pyrene-induced contact hypersensitivity response. Benzo[a]pyrene also reduced antibody titres to DNP in treated mice. This suppressive effect on humoral immune function was not restored by pretreatment with indomethacin. These findings led the authors to conclude that the mechanism of benzo[a]pyrene-induced suppression of cell-mediated immunity involved prostaglandins, whereas benzo[a]pyrene-induced suppression of humoral immunity operated via a mechanism independent of prostaglandins. In a subsequent experiment, the effects of dermally applied benzo[a]pyrene (alone or following subcutaneous implantation of the prostaglandin synthetase inhibitor, indomethacin) on Langerhans cells and on skin prostaglandin (PGE_2) levels were studied in male BALB/c mice treated for 3 weeks (Andrews et al. 1991b). Langerhans cells are antigen-presenting cells involved in cell-mediated immunity in skin. A group of mice treated with indomethacin served as controls. Benzo[a]pyrene alone caused a significant increase in the number of skin Langerhans cells, but reduced the percentage of Langerhans cells with dendritic morphology. Skin PGE_2 levels were also significantly increased by benzo[a]pyrene. Indomethacin attenuated the increase in Langerhans cell number and the changes in their morphology, and increased PGE_2 levels, such that all of these parameters were similar to those measured in the control animals. Based on these results, the authors suggested that benzo[a]pyrene induces increases in skin PGE_2 that in turn alter Langerhans cell number and morphology such that the cell-mediated immune response to skin antigens is suppressed.

An earlier study also demonstrated that benzo[a]pyrene affects epidermal Langerhans cells and dermal immunological responses. Female BALB/c mice were administered dermal applications on the dorsal skin of 0.5% benzo[a]pyrene in acetone twice weekly for up to 6 months (Ruby et al. 1989). Animals treated with acetone served as controls. The density, area, perimeter, and morphology of epidermal Langerhans cells were evaluated, along with the contact hypersensitivity response to DNFB. Benzo[a]pyrene treatment caused an increase in the number of epidermal Langerhans cells (as

determined by Ia antigens and -glucuronidase) from week 2 to week 5 of treatment and after weeks 10 and 18. The area and perimeter of these cells were unaffected by benzo[a]pyrene treatment, but the morphology was altered in that the dendrites appeared shortened. The contact hypersensitivity response to DNFB was significantly reduced in the benzo[a]pyrene-treated mice from 4 to 24 weeks of treatment. The authors propose that benzo[a]pyrene alters Langerhans cell number and morphology such that the cell-mediated immune response to skin antigens is suppressed. Skin tumors appeared in 20% of the benzo[a]pyrene-treated mice after 18 weeks of treatment, and 35% of the mice had l-3 tumors after 24 weeks of treatment. The tumors were squamous papillomas (58%) and squamous cell carcinomas (42%). The changes in Langerhans cell number, distribution, and morphology coincided with the onset of tumors and other nonneoplastic skin lesions that were observed (epidermal hyperplasia and cellular atypia).

All reliable LOAELs from each reliable study for immunological effects for each species and duration category are recorded in Table 2-3.

No studies were located regarding the following health effects in humans or animals following dermal exposure to the 17 PAHs discussed in this profile:

2.2.3.4 Neurological Effects

2.2.3.5 Reproductive Effects

2.2.3.6 Developmental Effects

2.2.3.7 Genotoxic Effects

No studies were located regarding genotoxic effects in humans following dermal exposure to the 17 PAHs discussed in this profile. A single topical application of benzo[a]pyrene (0.5-500 μg/mouse) or chrysene (50-1,000 μg/mouse) to groups of HRA/Skh hairless mice (four mice/dose/group) resulted in significantly increased frequencies of micronucleated keratinocytes (He and Baker 1991). In the same study, micronuclei were not induced in the mouse skin cells following application of 2.5-2,500 μg/pyrene per mouse. Male SENCAR mice receiving two topical applications of 20 μg benzo[a]pyrene at 72-hour intervals exhibited increased DNA adduct formation in both epidermal and

lung tissue (Mukhtar et al. 1986). Following a single topical application, 100 μg benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene were reported to bind to DNA in CD-l mouse skin (Weyand et al. 1987). The relative extent of binding was benzo[b]fluoranthene > benzo[j]fluoranthene > benzo[k]fluoranthene > indeno[1,2,3-c,d]pyrene. Covalent binding of chemicals to DNA can result in strand breaks and DNA damage, ultimately leading to mutations.

Benzo[a]pyrene (62.5 or 500 μg) was applied once to the shaved backs of male C57BL/6 mice (Bjelogrlic et al. 1994). Mice were killed at different time intervals after the treatment. DNA was isolated from the skin, purified, and analyzed for benzo[a]pyrene-7,8-diol-9,10-epoxide-DNA adducts. Skin was also evaluated for monoclonal antibody binding to mouse p53 protein, which has been shown to increase in response to DNA damage. Alterations in p53 are the most frequently observed mutations in human cancer. Benzo[a]pyrene-7,8-diol-9,10-epoxide-DNA adducts reached their maximum concentration 24 hours after the treatment, and decreased sharply within 1 week, regardless of the dose. An increase in p53 protein was seen only after treatment with 500 μg benzo[a]pyrene.

Benzo[j]fluoranthene, benzo[j]fluoranthene-4,5-diol, and benzo[j]fluoranthene-9,10-diol were applied to the shaved backs of CD-l mice and the DNA adducts were isolated and separated using multidimensional thin-layer chromatography (TLC) and reverse-phase high performance liquid chromatography (HPLC) (Weyand et al. 1993a). The highest level of adducts was observed with benzohlfluoranthene-4,5-diol, which resulted in the formation of 383 pmol of DNA adducts/mg DNA. This level of DNA modification was more than 2 orders of magnitude greater than that observed with benzo[j]fluoranthene. In contrast, the major DNA adducts detected with benzo[j]fluoranthene-9,10-diol had chromatographic properties distinctly different than the adducts formed from either benzo[j]fluoranthene or B[j]F-4,5-diol. The adducts of the diols corresponded to DNA adducts produced *in vitro* from the respective diolepoxides. In a companion study, benzo[b]fluoranthene, benzo[b]fluoranthene-9,10 diol, 6-hydroxy-benzo[b]fluoranthene-9,10-diol, or 5-hydroxybenzo[b]fluoranthene-9,10-diol were applied to the shaved backs of CD-1 mice and the DNA adducts were isolated and separated using multidimensional TLC and reverse-phase HPLC (Weyand et al. 1993b). Benzo[b]fluoranthene formed one major adduct and 4 minor adducts. The DNA adducts formed from 5-hydroxybenzo[b]fluoranthene-9, l0 diol had identical retention to the major and one of the minor adducts of benzo[b]fluoranthene. These two adducts accounted for 58% of the modified nucleotides produced by benzo[b]fluoranthene application to mouse skin.

The DNA binding of manufactured gas plant residue (MGP) components in male B6C3Fl mice was investigated following topical administration (Weyand and Wu 1994). For topical exposure, male mice were treated with 10 mg MGP residue in 200 μL acetone, and sacrificed 24 hours later. Two mixtures of MGP residue were used: Mix of 3 combining equal amounts of samples from three different MGP plant sites, and Mix of 7 combining equal amounts of samples from seven different MGP plant sites, including those used in the Mix of 3. The mixtures contained pyrene, benz[a]anthracene, chrysene, benzo[b]fluorene, benzo[k]fluorene, benzo[a]pyrene, indeno[l,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene. Data were presented in terms of pyrene. Animals were sacrificed 24 hours after treatment, and skin and lung were excised and DNA isolated. Chemical-DNA adduct formation was evaluated. Topical application MGP residue in acetone resulted in similar levels of DNA adduct in the skin for both the Mix of 3 and the Mix of 7. The total level of adducts detected in the lung after topical administration was identical to the response after dietary exposure, i.e., the Mix of 3 (1.4 mg/kg/day pyrene) produced adduct levels that were two times greater than the levels induced by the Mix of 7 (1.2 mg/kg/day pyrene). Other genotoxicity studies are discussed in Section 2.4.

2.2.3.8 Cancer

No studies were located that gave evidence of a direct association between human dermal exposure to individual PAHs and cancer induction. However, reports of skin tumors among individuals exposed to mixtures containing PAHs lend some qualitative support to their potential for carcinogenicity in humans. The earliest of these is the report by Pott (1775) of scrotal cancer among chimney sweeps. More recently, skin cancer among those dermally exposed to shale oils has been reported (Purde and Etlin 1980). However, these reports provide only qualitative suggestions pertaining to the human carcinogenic potential of all of the 17 PAHs discussed in this profile, or at least the compounds found in chimneys and shale oils, such as benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, benz[a]anthracene, and benzo[b]fluoranthene. Limitations in these reports include no quantification of exposure to individual PAHs and concurrent exposure to other putative carcinogens in the mixtures.

It has been suggested that an increase in the number of skin melanocytes correlates with the sebaceous gland suppression index, and that the short-term melanocyte-activation test is useful for the detection of skin carcinogens and promoters. Some chemical carcinogens have been shown to induce melanogenesis in melanoblasts in the skin. Anthracene, benzo[a]pyrene, chrysene, fluoranthene,

fluorene, and pyrene were examined for their ability to induce melanocyte activation by topical application to the backs of mice for 1 or 2 consecutive days. Benzo[a]pyrene, an animal skin carcinogen, was a potent melanocyte inducer at doses of 20-100 μg/mouse (0.005-0.025 mg/cm^2) as demonstrated by an increase of up to 19 times over controls in the number of dopa-positive cells, whereas no effects were seen at 4 μg/mouse (0.001 mg/cm^2). Chrysene, a weak skin carcinogen (in animals), increased the number of dopa-positive cells to four times that of controls following an application of 50 μg/mouse (0.0125 mg/cm^2), while larger doses did not cause further increases in the numbers of these cells. Other PAHs such as anthracene, fluoranthene, fluorene, and pyrene (PAHs that are considered to be noncarcinogenic) produced no increases in the number of active melanocytes when applied at a dose of 200 μg/mouse (0.05 mg/cm^2) (Iwata et al. 1981).

Complete Carcinogenesis Studies. Studies in laboratory animals have demonstrated the ability of benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, and indeno[l,2,3-c,d]pyrene to induce skin tumors (i.e., they are complete carcinogens) following intermediate dermal exposure. Anthracene, fluoranthene, fluorene, phenanthrene, and pyrene do not act as complete carcinogens. The data supporting these conclusions are discussed below by chemical. Only those studies considered adequate and reliable with respect to study design and adequacy of reporting are presented in Table 2-3.

Anthracene. Skin painting experiments were conducted on groups of 20 male C3H/HeJ mice (Warshawsky et al. 1993). Anthracene dissolved in toluene was applied to shaved skin twice weekly for six months at a dose of 0.05 mg. Tumor incidence was determined at the end of the study. For anthracene, administration alone produced tumors in 0 of 14 animals. With coadministration of 0.05 mg benzo[a]pyrene, 1 of 13 (8%) had a papilloma, with a mean latency period of 85 weeks. Anthracene was negative as a complete carcinogen following chronic dermal exposure (Habs et al. 1980). Swiss mice receiving 10% anthracene in acetone topically applied to their backs three times a week throughout their lifetime did not develop any skin tumors after 20 months (Wynder and Hoffmann 1959a).

Benz[a]anthracene. Benz[a]anthracene has been shown to cause skin tumors in mice following intermediate-duration dermal application. Graded concentrations of benz[a]anthracene in toluene or *n*-dodecane applied to the backs of mice for 50 weeks resulted in dose-related increases in tumor incidence (Bingham and Falk 1969). This response was enhanced when *n*-dodecane was the solvent

compared with toluene. Malignant tumors were observed at dose levels of about 0.02% benz[a]anthracene (0.15 mg/kg/day) and above when toluene was the solvent; however, when n-dodecane was the solvent, tumors were observed.at much lower concentrations of 0.0002% benz[a]anthracene (0.0015 mg/kg/day). The dose-response relationship reported in this study is extremely shallow (sublinear) over two orders of magnitude. A possible explanation for this is that the tumorigenic potency of certain PAHs is tempered by their cytotoxicity. Thus, the cytotoxic effects to epithelial cells may self-limit their potency as tumorigens. No solvent controls were included for comparison (Bingham and Falk 1969).

Intermediate-duration topical application of benz[a]anthracene to the backs of mice for 30 weeks resulted in a slightly elevated (2.6%) (but not statistically significant) skin tumor incidence. No definitive conclusions can be drawn from this study since only one dose was employed and no statistical analysis was performed.

Benzo[b]fluoranthene. A dose-response relationship for the dermal carcinogenicity of benzo[b]fluoranthene has been demonstrated over a one order-of-magnitude dose range in Swiss mice receiving (0.0l-0.5%) benzo[b]fluoranthene throughout their lifetime. Survival was also dose related. Although this study was designed as a long-term (chronic) bioassay, malignant tumors (90% carcinomas) appeared as early as 4 months in the high-dose group. Papillomas and carcinomas (65% and 85%, respectively) also appeared after 5 months in the mid-dose group. As a result, this study provides evidence that benzo[b]fluoranthene is carcinogenic following intermediate-duration exposure. The lowest dose at which benzo[b]fluoranthene elicited malignant tumors was 0.l%, which is approximately equal to a dose of 2.9 mg/kg received three times weekly, or an average daily dose of 1.2 mg/kg (Wynder and Hoffmann 1959b, see Table 2-3). In another chronic dermal study, benzo[b]fluoranthene produced a significant carcinogenic response of approximately one-third the potency of benzo[a]pyrene. The lowest dose at which tumors appeared was 3.4 μg benzo[b]fluoranthene; however, no distinction was made between papillomas and carcinomas (Habs et al. 1980).

Benzo[j]fluoranthene. Benzofilfluoranthene (0.1% or 0.5%) applied to the skin of female Swiss mice thrice weekly for life induced skin papillomas in 70% and 95% of the animals, respectively, and skin carcinomas in 105% and 95% of the animals, respectively, after 9 months of treatment (Wynder and Hoffmann 1959b).

No statistically significant increase in the incidence of skin tumors was noted in female NMRI mice dermally administered 3.4, 5.6, or 9.2 μg benzo[j]fluoranthene in acetone twice weekly for life (Habs et al. 1980). A total of 4 benzo[j]fluoranthene-treated mice developed skin tumors (application site sarcoma, papillomas, and a carcinoma).

Benzo[k]fluoranthene. Chronic dermal application of benzo[k]fluoranthene to Swiss mice resulted in no tumors, but skin papillomas were observed in 10% of animals when the concentration of benzo[k]fluoranthene was increased. Statistical analyses were not performed (Wynder and Hoffmann 1959b). In another study, no significant increase in tumor incidence was observed in NMRI mice painted with up to 9.2 μg of benzo[k]fluoranthene twice a week for a lifetime; no effect on mortality was noted (Habs et al. 1980).

Benzo[a]pyrene. Benzo[a]pyrene is a potent experimental skin carcinogen, and it is often used as a positive control in bioassays of other agents. Mixtures of PAHs that include benzo[a]pyrene such as coal tar were shown to be dermal carcinogens in animals as early as 1918 (Yamagiwa and Ichikawa 1918). In its role as a positive control, benzo[a]pyrene is usually administered at a single dose level, and thus quantitative evaluation of dose-response relationships is not possible.

Intermediate (19-20 weeks) topical application of a benzo[a]pyrene solution to the backs of mice resulted in a dose-related development of skin papillomas and squamous cell carcinomas (Cavalieri et al. 1988b, see Table 2-3; Shubik and Porta 1957). Benzo[a]pyrene was applied once weekly to the skin of female ICR/Harlan mice (43-50/group) at doses of 16, 32, or 64 μg for 29 weeks (Albert et al. 1991ba). Cell kinetics, morphometrics, and tumor formation were evaluated. Skin tumors were first apparent 12-14 weeks after the start of exposure in the 32- and 64-μg groups and after 18 weeks in the 16-μg group. The overwhelming majority of these tumors were benign. The average time of progression from benign papillomas to malignant carcinomas was 8.1 ± 4.5 weeks. Because there was good correspondence between the dose-response patterns for epidermal damage and the occurrence of skin tumors, and because tumors that initially appear as benign can be the result of tumor promoting agents that increase cell proliferation rates, the authors proposed that the tumors seen after benzo[a]pyrene treatment were the result of promotion related to benzo[a]pyrene-induced tissue damage. However, benign tumors can be formed as a result of genetic damage as well. Because benzo[a]pyrene causes genetic damage in addition to increased rates of cell proliferation, it is likely that genetic damage also played a role. Following a similar protocol in mice (once weekly dermal

applications of benzo[a]pyrene in acetone at doses of 16, 32, and 64 μg/mouse for 34 weeks), tumor development was reported to be best described by a dose-squared response. Quantitative data for tumor incidence were not presented (Albert et al. 1991b).

Carcinogenicity experiments on mouse skin were conducted with groups of 20 female CD-l mice. Benzo[a]pyrene (0.05 mg) dissolved in 50 mL toluene was applied to shaved skin of mice twice weekly for 6 months (Warshawsky et al. 1993). Tumor incidence was determined at the end of the study. Benzo[a]pyrene produced no tumors.

In mice, the tumorigenic dose of benzo[a]pyrene is influenced by the solvent used for delivery. Graded concentrations of benzo[a]pyrene dissolved in decalin or a solution of n-dodecane and decalin were topically administered to the backs of mice for 50 weeks (Bingham and Falk 1969). Use of the n-dodecane and decalin solvent mixture significantly enhanced the potency of benzo[a]pyrene at lower doses in comparison with decalin alone. Malignant tumors appeared in 21% of the animals at 0.00002% (0.0054 mg/kg/day) benzo[a]pyrene in dodecane and decalin solvent. In contrast, a 42% skin tumor incidence was not observed until 0.02% (4.8 mg/kg/day) benzo[a]pyrene in decalin alone was applied. The method of application was not specified, sample sizes were small and no decalin solvent controls were included; however, decalin is not considered to be carcinogenic. In this same study, intermediate (50 weeks) dermal application of benzo[a]pyrene dissolved in the co-carcinogens 1-dodecanol or 1-phenyldodecane produced skin tumors in animals exposed to 0.05% benzo[a]pyrene in either solvent. The tumor incidence varied depending on the solvent concentration; however, the latency period was reduced only when 1-dodecanol was the solvent (Bingham and Falk 1969).

Mice receiving 0.00l-0.01% of benzo[a]pyrene dermally applied to their backs throughout their lifetimes exhibited a dose-response relationship for skin tumors (Wynder and Hoffmann 1959a). A dose of 0.001% benzo[a]pyrene produced skin carcinoma and papilloma incidences of 4% and 45%, respectively. In another study conducted by Wynder and Hoffmann (1959b), higher concentrations of benzo[a]pyrene produced an 85% incidence of combined papillomas and carcinomas. These studies had a number of weaknesses, including no statistical treatment and no solvent control group. Dose quantification is difficult because of the method of application (Wynder and Hoffmann 1959a, 1959b). NMRI mice topically administered 2 μg benzo[a]pyrene throughout their lifetime also developed skin papillomas and carcinomas (45%) (Habs et al. 1984, see Table 2-3). CH3 mice administered a higher dose of 12.5 μg benzo[a]pyrene for 99 weeks exhibited malignant skin tumors (94%) (Warshawsky

and Barkley 1987, see Table 2-3). Increasing malignant carcinoma incidences in these dermal application studies can be correlated to increasing benzo[a]pyrene concentrations.

In mice, the tumorigenic dose of benzo[a]pyrene is dependent on the strain. For example, Habs et al. (1980) tested 1.7-4.6 μg benzo[a]pyrene (0.016-0.04 mg/kg/day) in order to determine its dose-response relationship as a carcinogen when topically applied to the backs of NMRI mice throughout their lifetimes. A clear-cut dose-response relationship was seen for benzo[a]pyrene and the induction of tumors. The lowest dose at which skin tumors appeared was 1.7 μg (0.016 mg/kg/day). This strain of NMRI mice also has a high (70%) background incidence rate of systemic tumors, so an evaluation of the effects of benzo[a]pyrene on any organ other than the site of administration was not possible:

Chrysene. Skin painting experiments with intermediate (6 months) dermal exposure with chrysene were conducted on groups of 20 male C3H/HeJ mice (Warshawsky et al. 1993). Chrysene (0.05 mg) dissolved in toluene was applied to shaved skin twice weekly for 6 months. Tumor incidence was determined at the end of the study. For chrysene, administration alone produced papillomas in 1 of 15 animals (7%), with a mean latency period of 81 weeks. With coadministration of 0.0005 mg benzo[a]pyrene, 3 of 13 (23%) had tumors (papillomas and malignant), with a mean latency period of 70 weeks.

Chrysene has elicited skin tumors in mice following chronic (68-82 weeks) dermal exposure. Topical application of a chrysene solution in *n*-dodecane/decalin to the skin of mice produced a significant increase in the carcinogenic potency of chrysene compared with the use of decalin alone; 26% and 63% of mice exhibited papillomas and carcinomas, respectively, at 49 weeks (Horton and Christian 1974). Because only one dose level was employed, no dose-response relationship can be inferred, and no solvent control was included. However, in other experiments decalin and *n*-dodecane have been shown to be noncarcinogenic in mice (Bingham and Falk 1969). An average dose of 1.2 mg/kg/day is the lowest dose of chrysene that has been found to elicit malignant tumors in laboratory animals.

In another chronic study, a higher concentration of chrysene applied dermally to the backs of Swiss mice for a lifetime also resulted in increased papilloma and carcinoma incidences (48% and 42%, respectively) compared to controls (Wynder and Hoffmann 1959a). Since only one dose was employed, no dose-response information can be inferred from this study.

Dibenz[a,h]anthracene: Dibenz[a,h]anthracene has also demonstrated a dose-response relationship for skin tumors over a two-orders-of-magnitude dose range following chronic exposure. Swiss mice received concentrations of 0.00l-0.1% dibenz[a,h]anthracene applied to their backs throughout their lifetimes and exhibited dose-related papilloma and carcinoma incidences at the site of application at the two lowest doses. A decreased tumor rate at the highest dose tested probably reflects dibenz[a,h]anthracene's toxicity and the resulting decreased survival observed. The lowest concentration at which dibenz[a,h]anthracene elicited tumors was 0.001% (40% incidence of papillomas and 40% incidence of carcinomas), which is approximately equal to a dose of 0.029 mg/kg (0.012 mg/kg/day) (Wynder and Hoffmann 1959a). In another chronic derrnal study of dibenz[a,h]anthracene, a dose-related increase in skin carcinoma formation was observed, as well as decreased survival time and tumor latency period (Van Duuren et al. 1967).

Groups of 50 female NMRI mice received dermal applications of dibenz[a,h]anthracene in acetone (total doses = 0, 136, 448, or 1,358 nmol) three times a week for a total of 112 weeks (Platt et al. 1990). Papillomas were observed in 6%, 8%, and 32% of the treated animals, respectively.

Fluoranthene. Skin painting experiments with intermediate-duration (6 months) dermal exposure were conducted on groups of 20 male C3H/HeJ mice (Warshawsky et al. 1993). Fluoranthene was dissolved in toluene and applied to shaved skin twice weekly for 6 months. Tumor incidence was determined at the end of the study. For fluoranthene, administration alone produced tumors in 0 of 15 animals. With coadministration of 0.0005 mg benzo[a]pyrene, 1 of 12 (8%) had papillomas, with a mean latency period of 95 weeks.

Chronic dermal application of up to 1% fluoranthene to the backs of mice did not induce skin tumors following a lifetime of application (Hoffmann et al. 1972; Horton and Christian 1974; Wynder and Hoffmann 1959a).

Fluorene. Fluorene has been reported to be negative as a complete carcinogen (dose not specified) (Kennaway 1924). This information was obtained from an old, secondary source and therefore, its reliability is not known.

Indeno[1,2,3-c,d]pyrene. Indeno[1,2,3-c,d]pyrene was applied to the skin of female Swiss mice three times weekly for 12 months in concentrations of 0.5% (500 μg/application), 0.l%, 0.05%, and 0.01%

(20 mice per group) using acetone as the solvent. A tumor dose-response with 7 papilloma-bearing mice and 5 carcinoma-bearing mice for 0.5%, 6 papilloma-bearing and 3 carcinoma-bearing mice for 0.l%, and no skin tumors for 0.05% and 0.01% solutions was observed (Hoffmann and Wynder 1966). Chronic dermal application of indeno[1,2,3-c,d]pyrene in dioxane to mice did not produce an increased incidence of skin tumors. Similarly, chronic topical application of up to 9.2 μg of indeno[l,2,3-c,d]pyrene in acetone to the backs of mice for a lifetime resulted in no tumor induction (Habs et al. 1980).

Phenanthrene. Phenanthrene tested negative as a complete carcinogen in a mouse study inadequately reported in an old secondary source (Kennaway 1924). Skin painting experiments with intermediate-duration (6 months) dermal exposure were conducted on groups of 20 male C3H/HeJ mice (Warshawsky et al. 1993). Phenanthrene dissolved in toluene was applied to shaved skin twice weekly for 6 months. Tumor incidence was determined at the end of the study. For phenanthrene, administration alone produced papillomas in 1 of 12 animals (8%), with a mean latency period of 100 weeks. With coadministration of 0.0005 mg benzo[a]pyrene, 1 of 17 (6%) had malignant tumors, with a mean latency period of 53 weeks.

Pyrene. Skin painting experiments with intermediate-duration (6 months) exposure were conducted on groups of 20 male C3H/HeJ mice. Pyrene dissolved in toluene was applied to shaved skin twice weekly for 6 months. Tumor incidence was determined at the end of the study. For pyrene, administration alone produced papillomas in 1 of 13 animals (8%), with a mean latency period of 96 weeks. With coadministration of 0.0005 mg benzo[a]pyrene, 0 of 13 animals had tumors.

Mice chronically administered a 10% pyrene solution throughout their lifetimes did not develop skin tumors (Wynder and Hoffmann 1959a). However, prolonged dermal exposure of mice to 0.5% pyrene in decalin/n-dodecane solvent produced a slightly elevated (15%) skin carcinoma incidence; the level of statistical significance was not provided (Horton and Christian 1974).

Mixtures. Chronic dermal exposure of NMRI mice to a tar condensate that contained several PAHs (pyrene, fluoranthene, chrysene, benz[a]anthracene, benzo[a]pyrene, indeno[1,2,3-c,d]pyrene, benzo[g,h,i]perylene) in addition to other compounds produced a carcinogenic effect as evidenced by an increase in the incidence of skin papillomas and carcinomas (Habs et al. 1984). Because of the

presence of other compounds in the tar condensate, the carcinogenic effect cannot be definitely attributed to the PAHs present in the mixture.

Skin painting experiments of a mixture of anthracene, chrysene, fluoranthene, phenanthrene, and pyrene were conducted on groups of 20 male C3H/HeJ mice (Warshawsky et al. 1993). Compounds dissolved in toluene were applied to shaved skin twice weekly for 6 months. Tumor incidence was determined at the end of the study. Treatment included solutions of a mixture of the five noncarcinogenic PAHs at 0.05 mg, or the same compounds in solution with 0.0005 mg benzo[a]pyrene, a dose known to be noncarcinogenic in a similar study design. For the mixture of the 5 PAHs at 0.05 mg each, administration alone produced papillomas and malignant tumors in 3 of 13 animals (23%), with a mean latency period of 73 weeks. With coadministration of benzo[a]pyrene, 8 of 17 (47%) had tumors (papillomas and malignant), with a mean latency period of 66 weeks.

Initiation-Promotion Studies. Carcinogenesis has been demonstrated to be a multistage process in the cells of certain animal tissues, including skin, lung, liver, and bladder. This process is believed to occur in human tumorigenesis as well. The PAHs have been studied extensively for their ability to act as tumor initiators and/or promoters. Following is a brief discussion, by chemical, of the results of the initiation-promotion studies performed with 13 of the 17 PAHs discussed in this profile. Only those studies considered adequate and reliable are presented in Table 2-3.

The difficulty inherent in extrapolating initiation-promotion experiments to human exposure precludes their being used as the basis for human cancer effect levels. Since PAHs occur in complex mixtures of chemicals that may include tumor promoters, their activity as initiating agents is noteworthy. Thus, it is possible that humans dermally exposed to PAHs that are initiating agents, concomitantly with other chemicals that may be active as tumor promoters (including other PAHs) found at nearby hazardous waste sites, may have an increased risk of skin cancer.

Anthracene. Anthracene has been found to be inactive as an initiating agent under a dermal initiation/promotion protocol using tetradecanoyl phorbol acetate (TPA) as the promoter (LaVoie et al. 1983a).

Benz[a]anthracene. Benz[a]anthracene has been observed to be a tumor initiator in an intermediate-duration dermal study. CD-l mice topically administered 2.5 μmol (0.57 mg) benz[a]anthracene

followed by promotion with TPA (for 25 weeks) exhibited an increased skin tumor incidence (36%) as compared to controls (Levin et al. 1984, see Table 2-3).

Benzo[a]pyrene. Benzo[a]pyrene is active as a tumor initiator using initiation/promotion protocols. Topical application of a single initiating dose of benzo[a]pyrene to the backs of mice followed by promotion with TPA or croton oil resulted in an 80-92% incidence of skin papillomas (Cavalieri et al. 1988b, see Table 2-3). Ten doses of benzo[a]pyrene (0.1 mg/dose) topically applied to the backs of Swiss mice followed by promotion with croton oil (for 20 weeks) also resulted in the development of skin tumors (Hoffmann et al. 1972).

In a dermal initiation/promotion assay, groups of 24 female SENCAR mice were administered a single dermal application of benzo[a]pyrene at doses ranging from 4 to 300 nmol (initiating dose), followed 7 days later by twice weekly applications of the promoter TPA, for a total of 24 weeks. Benzo[a]pyrene was active as a skin tumor initiator; the number of tumors per tumor bearing mouse, the percentage of tumor bearing mice, and the number of tumors per mouse were all significantly greater than in acetone controls and increased in a dose-related manner at doses ≥20 nmol (Cavalieri et al. 1991).

In a similar experiment, 24 8-week-old female SENCAR mice were treated dermally with 0.0002 mg (1 nmol) of benzo[a]pyrene in acetone on a shaved portion of dorsal skin (Higginbotham et al. 1993). One week later, tumor promotion was begun with TPA twice weekly for 27 weeks. The number of skin tumors was charted weekly and the mice were killed after experimental weeks. Complete necropsies were performed and tissues were fixed in formalin. Benzo[a]pyrene-treated mice had no skin tumors.

Benzo[e]pyrene. Benzo[e]pyrene is inactive as a skin tumor initiator in mouse skin (Slaga et al. 1980a).

Benzo[b]fluoranthene. The ability of benzo[b]fluoranthene to initiate skin tumor formation has been demonstrated using a standard initiation/promotion protocol with either croton oil or phorbol myristate acetate as a tumor promoter (Amin et al. 1985a; LaVoie et al. 1982). In another study, dermal applications of initiation doses of benzo[b]fluoranthene (10-100 μg) followed by TPA (for 20 weeks)

to the backs of CD-l mice elicited a dose-related skin tumor incidence, predominantly consisting of squamous cell papillomas (LaVoie et al. 1982).

In a dermal initiation/promotion assay, groups of 20 female CD-l mice were administered 10 dermal applications of benzo[b]fluoranthene at total doses of 0, 1, and 4 umol (initiating dose), followed 10 days later by thrice weekly applications of the promoter TPA for a total of 20 weeks (Weyand et al. 1991). Benzo[b]fluoranthene was active as a skin tumor initiator; the number of tumors per tumor-bearing mouse (8.5) and the percentage of tumor-bearing mice (100%) were significantly greater than in acetone controls and were increased in a dose-related manner.

Tumor initiation experiments were conducted with groups of 20 female CD-1 mice. Benzo[b]fluoranthene was applied to the shaved backs of the mice every other day using a total of 10 subdoses (Weyand et al. 1993b). Total doses were 10.1, 30.3, and 100.9 μg in acetone. Negative control mice were treated with acetone. Ten days after the last dose, promotion was begun by applying 2.5 μg TPA thrice weekly for 20 weeks. Tumors were counted weekly. Benzo[b]fluoranthene produced a 35%, 90%, and 95% incidence of tumor-bearing mice with 0.45, 3.70, and 8.65 tumors per mouse for the low, mid and high doses, respectively. No distinction was made between papillomas and carcinomas (Weyand et al. 1993b). Groups of 20 female Crl:CD-1 mice were dermally exposed to a total of 0, 0.01, 0.03, or 0.1 mg of benzo[b]fluoranthene in acetone applied every other day for 20 days in 10 subdoses (LaVoie et al. 1993a). Negative control mice were treated with acetone only. Ten days after the last application of acetone or hydrocarbon, tumor promotion was begun by applying 2.5 μg TPA in acetone three times weekly for 20 weeks. Tumor incidence was recorded after 20 weeks of promotion. The study was repeated for the 0.03 and 0.1 mg doses. Of the mice receiving 0.01 mg benzo[b]fluoranthene, 35% had developed tumors, with an average of 0.45 tumors/mouse. For the 0.03 mg dose, 70-90% of the mice developed tumors with an average of 1.4-3.7 tumors per mouse, whereas the 0.1 mg dose caused 95% of the mice to develop and average of 7.1-8.6 tumors. Of the animals treated with acetone only, 5-15% developed skin tumors. In this study, tumors were not identified as papillomas or carcinomas.

Benzo[j]fluoranthene. Benzo[j]fluoranthene has also been demonstrated to be a tumor initiator in mice, although it is not as potent as benzo[b]fluoranthene. Benzo[j]fluoranthene, however, is more potent than benzo[k]fluoranthene. Mice receiving initiating doses of benzo[j]fluoranthene (30-1,000 μg) followed by TPA promotion exhibited a dose-related increase in tumor incidence

(LaVoie et al. 1982, 1993a; Weyand et al. 1992). Groups of 20 female Crl:CD-1 mice were dermally exposed to a total of 0, 0.006, 0.012, 0.025, or 0.25 mg of benzojjlfluoranthene in acetone applied every other day for 20 days in 10 subdoses (LaVoie et al. 1993b). Negative control mice were treated with acetone only. Ten days after the last application of acetone or hydrocarbon, tumor promotion was begun by applying 2.5 μg TPA in acetone three times weekly for 20 weeks. Tumor incidence was recorded after 20 weeks of promotion. Five percent of the mice receiving 0.006 mg benzo[j]fluoranthene had developed tumors, with an average of 0.4 tumors per mouse. For the 0.012 mg dose, 10% of the mice developed tumors with an average of 0.4 tumors per mouse; 0.025 mg PAH caused 45% of the mice to develop tumors at an average of 0.65 tumors per mouse, whereas the 0.25 mg dose caused 95% of the mice to develop an average of 8.7 tumors. The control animals developed no tumors.

Benzo[k]fluoranthene. Benzo[k]fluoranthene has also been demonstrated to be a tumor initiator in mice, although it too, is not as potent as benzo[b]fluoranthene. Mice receiving initiating doses of benzo[k]fluoranthene (30-1,000 μg) followed by TPA promotion exhibited a dose-related increase in ‘tumor incidence (LaVoie et al. 1982).

Benzo[g,h,i]perylene. Benzo[g,h,i]perylene has been shown to be inactive as an initiating agent when applied at a total dose of 0.25 mg/animal and negative as a complete carcinogen when a 1% solution was applied thrice weekly for 12 months (IARC 1983).

Chrysene. Chrysene is a tumor initiator in classic initiation/promotion bioassays on mouse skin using croton oil or phorbol myristate acetate as promoting agents (Slaga et al. 1980a; Wood et al. 1979a). Initiating doses of chrysene followed by promotion with TPA or croton resin induced a dose-related papilloma incidence in mice (Slaga et al. 1980a; Wood et al. 1979a).

Dibenz[a,h]anthracene. Dibenz[a,h]anthracene has also demonstrated tumor-initiating activity using a standard initiation/promotion protocol (Slaga et al. 1980a). Dibenz[a,h]anthracene has been reported to initiate skin development in a dose-response relationship at doses as low as 0.028 μg followed by promotion with TPA (for 25 weeks) (Buening et al. 1979a).

In a dermal initiation/promotion assay, groups of 50 female NMRI mice were administered a single dermal application of dibenz[a,h]anthracene at doses of 0, 300, or 600 nmol (initiating dose) followed

7 days later by twice weekly applications of the promoter, TPA, for a total of 24 weeks (Platt et al. 1990). Dibenz[a,h]anthracene was active as a skin tumor initiator only at the highest dose tested; 93% of the animals administered 600 nmol dibenz[a,h]anthracene developed skin tumors by 24 weeks.

Fluoranthene. Fluoranthene did not exhibit initiating activity in Swiss mice topically administered 10 doses followed by promotion with croton oil (for 20 weeks) (Hoffmann et al. 1972).

Indeno[1,2,3-c,d]pyrene. A pronounced dose-response relationship has been exhibited by indeno[l,2,3-c,d]pyrene in an initiation-promotion bioassay when TPA was employed as the promoting agent, although it was not as potent an initiator as benzo[b]fluoranthene (Rice et al. 1985a). In another study, 2.83 tumors/mouse were noted after a total initiating dose of 1.0 mg indeno[1,2,3-c,d]pyrene and promotion with TPA for 20 weeks (Rice et al. 1986).

The skin tumor initiating activity of indeno[1,2,3-c,d]pyrene and several of its metabolites generated *in* viva in mouse skin was tested in female Crl:CD/l mice (Rice et al. 1986). Initiating doses of indeno[1,2,3-c,d]pyrene or the metabolites were applied every other day to the shaved skin of groups of 25 mice for a total of 10 doses, which was followed 10 days later by thrice weekly applications of the tumor promotor, TPA, for 20 weeks. None of the metabolites were as active in inducing skin tumors as the parent compound (2.83 tumors/mouse as compared to 0.48-1.68 tumors/mouse at 20 weeks). These findings led the authors to conclude that the principal ultimate mutagenic metabolite, indeno[l,2,3-c,d]pyrene-1,2-oxide, is not the ultimate carcinogenic metabolite of indeno[l,2,3-c,d]pyrene.

Phenanthrene. Phenanthrene was ineffective as an initiator in various mouse strains (LaVoie et al. 1981b; Salaman and Roe 1956; Wood et al. 1979a). CD-1 mice topically administered a single dose of 10 μmol phenanthrene followed by a promoter were observed to have a papilloma incidence 2-4 times that of background; however, the incidences were not statistically significant in comparison to controls because of the small number of animals tested and the high spontaneous tumor incidence (Wood et al. 1979a).

Pyrene. Pyrene has been shown to be inactive as an initiating agent (Salaman and Roe 1956; Van Duuren and Goldschmidt 1976).

Mixtures. Co-administration of pyrene and benzo[a]pyrene to the backs of ICR/Ha mice has produced an enhancement of benzo[a]pyrene tumorigenicity (Van Duuren and Goldschmidt 1976). There is evidence that benzo[g,h,i]perylene is a co-carcinogen with benzo[a]pyrene when both are applied simultaneously to the skin of Swiss mice (Van Duuren et al. 1973). Dermal pretreatment with 100 μg pyrene substantially enhanced benzo[a]pyrene tumor initiation in CD-1 mice, while 100 μg fluoranthene produced a marginal enhancement (Slaga et al. 1979).

2.3 TOXICOKINETICS

Occupational studies provide evidence that inhaled PAHs are absorbed by humans. Animal studies also show that pulmonary absorption of benzo[a]pyrene occurs and may be influenced by carrier particles and solubility of the vehicle; however, the extent of absorption is not known. Absorption of benzo[a]pyrene following ingestion is low in humans, while oral absorption in animals varies among the PAH compounds depending on the lipophilicity. Oral absorption increases with more lipophilic compounds or in the presence of oils in the gastrointestinal tract. Percutaneous absorption of PAHs appears to be rapid for both humans and animals, but the extent of absorption is variable among these compounds and may be affected by the vehicle used for administration. Therefore, absorption of PAHs following inhalation, oral, or dermal exposure may be affected by vehicle of administration.

There was no information available on the distribution of PAHs in humans. PAHs appear to be widely distributed in tissues of animals following oral and inhalation exposure; peak tissue concentrations occurred earlier with higher exposure levels. Placental transfer of PAHs appears to be limited, and therefore, fetal levels are not as high as maternal levels.

Metabolism of PAHs occurs in all tissues and involves several possible pathways. Metabolism of PAHs has been studied extensively *in vitro* and *in vivo.* The metabolism products include epoxide intermediates, dihydrodiols, phenols, quinones, and their various combinations. The phenols, quinones, and dihydrodiols can all be conjugated to glucuronides and sulfate esters; the quinones also form glutathione conjugates.

Quantitative data on the excretion of PAHs in humans are lacking. In general, feces is the major elimination route of PAHs in animals following inhalation exposure. Excretion of benzo[a]pyrene appears to be high following low-level exposure in rats but low in dogs and monkeys. PAHs are

eliminated to a large extent within 2 days following low- and high-level oral exposure in rats. Following dermal exposure, elimination of PAHs occurs rapidly in the urine and feces of guinea pigs and rats.

Absorption of inhaled PAHs appears to occur through the mucous lining of bronchi, while ingested PAHs are taken up by the gastrointestinal tract in fat-soluble compounds. Percutaneous absorption is through passive diffusion. The mechanism of action of most PAHs involves covalent binding to DNA by PAH metabolites. The bay region diol epoxide intermediates of PAHs are currently considered to be the ultimate carcinogen for alternant PAHs. Once the reactive bay region epoxide is formed, it may covalently bind to DNA and other cellular macromolecules and presumably initiate mutagenesis and carcinogenesis.

2.3.1 Absorption

2.3.1.1 Inhalation Exposure

Absorption of PAHs in humans following inhalation exposure can be inferred from the presence of urinary metabolites of PAHs in workers exposed to these compounds in an aluminum plant (Becher and Bjorseth 1983). The high concentration of PAHs in the occupational setting did not correspond to the amount of PAHs deposited, metabolized, and excreted in the urine in this study. The authors suggested that PAHs adsorbed to airborne particulate matter may not be bioavailable and that the dose-uptake relationship may not be linear over the entire PAH concentration range.

Twelve workers from a coke plant participated in an intensive skin monitoring program combined with personal air sampling and biological monitoring during 5 consecutive 8-hour shifts (Van Rooij et al. 1993b). The mean concentration of total pyrene in the breathing zone air of the 12 workers ranged from 0.1 to 5.4 μg/m^3. The mean respiratory uptake of pyrene varied between 0.5 and 32.2 μg/day. Based on the estimates of the dermal and respiratory pyrene uptake, it is concluded that an average of 75% of the total absorbed amount of pyrene enters the body through the skin. The total excreted amount of urinary 1-hydroxypyrene as a result of exposure to PAHs during the five consecutive work shifts varied between 36 and 239 nmol. Analysis indicated that dermal absorption was most important in contributing to 1-hydroxypyrene excretion. Of the total dose absorbed by both routes combined,

13-49% is excreted as 1-hydroxypyrene. Variation in excretion is influenced by smoking habits, and consumption of alcohol (see Section 2.3.1.3).

Eleven healthy male smokers and 11 male smokers with lung cancer between the ages of 30-60 years, with a smoking history of 15-25 cigarettes per day for over 10 years were involved in a study (Likhachev et al. 1993). Urinary excretion of benzo[a]pyrene-7,8-diol and 3-hydroxybenzo[a]pyrene was determined. Both benzo[a]pyrene metabolites were detected in the urine, but quantities of 3-hydroxybenzo[a]pyrene were very low. The level of benzo[a]pyrene-7,8-diol in the urine varied considerably both in healthy smokers and smokers with lung cancer. However, the average value of this metabolite in the urine of healthy smokers was significantly higher than in the urine of lung cancer patients who smoked (1.06 mg/kg/day versus 0.56 mg/kg/day).

Animal studies on inhalation absorption of PAHs are limited to benzo[a]pyrene exposure. Rapid absorption was evident following inhalation exposure of low and high levels of benzo[a]pyrene to rats. Acute and intermediate-duration exposure to 4.8 mg/m^3 [^{14}C]-benzo[a]pyrene by nose-only inhalation in rats resulted in elevated levels of radioactivity in tissues and excreta within 3 hours of exposure (Wolff et al. 1989c). High levels of radioactivity were detected in the gastrointestinal tract, which may be due to biliary excretion or mucocilliary clearance of benzo[a]pyrene from the upper respiratory tract. Intratracheal administration of 0.001 mg/kg [^{3}H]-benzo[a]pyrene to rats also resulted in rapid absorption through the lungs. Radioactivity in the liver reached a maximum of 21% of the administered dose within 10 minutes of instillation (Weyand and Bevan 1986, 1988). Presence of radioactivity in other tissues and the bile was also indicative of its absorption in rats. Similar results were also seen in guinea pigs and hamsters following intratracheal exposure to benzo[a]pyrene (Weyand and Bevan 1986, 1987b, 1988).

Pregnant Wistar rats were exposed head-only to 200, 350, 500, 650, or 800 mg/m^3 of [^{14}C]-benzo[a]pyrene aerosol for 95 minutes on gestational day 17 (Withey et al. 1993a). Animals were killed immediately or 6 hours postexposure. Concentration of benzo[a]pyrene and metabolites in maternal blood sampled immediately after exposure were elevated 10-fold over the 4-fold increase in dose. At 6 hours postdosing, the increase was still approximately 10-fold, although the actual concentrations were 2-7-fold less than at 0 hours. Concentrations of benzo[a]pyrene and metabolites in fetal blood sampled immediately after exposure were elevated 5-fold over the 4-fold increase in exposure concentrations. Fetal tissues sampled 6 hours post-dosing had a 9-fold increase in

benzo[a]pyrene and metabolite concentration over the dose range, due to lower concentration in the 200-650 mg/m^3 dose groups at 6 hours compared to 0 hours. Fetal concentrations were 2-10-fold less than maternal concentrations. Benzo[a]pyrene concentrations in blood, lung, liver, and fetal tissues were significantly decreased from 0 to 6 hours postexposure while levels in fat tissue increased. For benzo[a]pyrene sampled immediately postdosing, lung > blood > liver > kidney > fat > fetus. For total metabolites sampled immediately postdosing, lung > blood > liver > kidney > fetus > fat. For benzo[a]pyrene sampled 6 hours postdosing, fat > lung > kidney > liver > blood > fetus. For total metabolites sampled 6 hours postdosing, lung = fat > kidney > liver = blood > fetus.

Twenty male Fisher 344 DuCrj rats were divided into two groups and exposed to diesel exhaust containing 0.151 mg/m^3 pyrene or HEPA-filtered air for 8 weeks, 5 days/week, 7 hours/day (Kanoh et al. 1993). At 2, 4, and 8 weeks during the exposure, the rats from each group were put into a metabolic cage and their urine was collected for 24 hours. Urinary levels of 1-hydroxypyrene in the rats of the exposure group increased remarkably over those of the control group, reaching 2.4 times as much by the end of the 2nd week, and 5.6 times by the 4th and 8th weeks.

Inhalation absorption of benzo[a]pyrene may be affected by the size of particles on which benzo[a]pyrene is adsorbed. The elimination of benzo[a]pyrene from the lungs was studied following intratracheal administration of pure benzo[a]pyrene crystals or benzo[a]pyrene coated on carbon particles in two size ranges (0.5-1.0 μm and 15-30 μm) (Creasia et al. 1976). Fifty percent of the pure benzo[a]pyrene crystals was cleared from the lungs within 1.5 hours and >95% cleared within 24 hours, while only 50% of the benzo[a]pyrene adsorbed to the small carbon particles cleared within 36 hours. Elution of benzo[a]pyrene was even slower with the larger particle size (approximately 4-5 days). These results indicate that the bioavailability of benzo[a]pyrene is altered by the particle size of the carrier. The initial lung deposition of [^{3}H]-benzo[a]pyrene adsorbed onto gallium oxide (Ga_2O_3) particles was 4.9 μg of which 3.1% remained after 30 minutes (Sun et al. 1982). A control study, conducted without the Ga_2O_3 particles at a concentration of 1 mg/m^3, found that 8.2 μg was inhaled, of which 0.9% remained in lungs after 30 minutes. The excretion of hydrocarbon was monitored for over 2 weeks at which time nearly all the initial lung burden was recovered in the excreta, indicating complete absorption of the instilled hydrocarbon. Significant differences in the clearance of benzo[a]pyrene coated with Ga_2O_3 and pure benzo[a]pyrene suggested that a substantial amount of benzo[a]pyrene/Ga_2O_3 particles was removed from the lungs by mucocilliary clearance and subsequent ingestion.

The above results corroborate findings in an *in vitro* experiment by Gerde and Scholander (1989) who developed a model of the bronchial lining layer. These investigators concluded that the release rate of PAHs from carrier particles is the rate-determining step in the transport of PAHs from these particles to the bronchial epithelium.

The absorption of benzo[a]pyrene may also be affected by the solubility of the vehicle used in administration. Approximately 70% of benzo[a]pyrene administered with triethylene glycol was excreted 6 hours following intratracheal instillation (Bevan and Ulman 1991). Excretion rates of benzo[a]pyrene were only 58.4% and 56.2% with ethyl laurate and tricaprylin, respectively, within a 6-hour period. The small volume of benzo[a]pyrene instilled is probably deposited in the bronchial region which allows more water-soluble materials (triethylene glycol) to pass the mucous layer lining than water-insoluble compounds (ethyl laurate and tricaprylin) (Bevan and Ulman 1991).

Nasal instillation of [^{3}H]-benzo[a]pyrene (0.13 mg/kg) to hamsters resulted in the metabolism of [^{3}H]-benzo[a]pyrene in the nasal cavity (Dahl et al. 1985). A large fraction of the metabolites was recovered from the epithelial surface, indicating that benzo[a]pyrene was first absorbed in the mucosa, metabolized, and returned to the mucus. Monkeys and dogs received nasal instillation of [^{14}C]-benzo[a]pyrene at doses of 0.16-0.21 mg/kg (Petridou-Fischer et al. 1988). Radiolabeled metabolites were detected in the nasal cavity, but little or no activity was detected in the blood and excreta of either species during the 48 hours after exposure. These results indicate that absorption of benzo[a]pyrene and/or its metabolites was poor or very slow following nasal instillation in monkeys and dogs.

2.3.1.2 Oral Exposure

There is evidence suggesting that benzopyrene is orally absorbed in humans (Buckley and Lioy 1992; Hecht et al. 1979). Following ingestion of diets containing very low levels of benzo[a]pyrene, the metabolite, 1-hydroxypyrene, was detected in the urine (Buckley and Lioy 1992). No quantitative data on the excretion of the benzo[a]pyrene were provided. The concentration of benzo[a]pyrene in human feces was examined in eight volunteers who ingested broiled meat that contained approximately 9 µg of benzo[a]pyrene (Hecht et al. 1979). The feces of these individuals did not contain detectable levels of benzo[a]pyrene (<0.1 µg/person), which is similar to what was seen following consumption of

control meat that contained undetectable amounts of benzo[a]pyrene by these same volunteers, suggesting that most of the ingested benzo[a]pyrene was absorbed.

Oral absorption of benzo[a]pyrene in rats is incomplete and may be influenced by the presence of oils and fat in the gastrointestinal tract. Oral absorption of benzo[a]pyrene was estimated to be 40%, with a bioavailability of 7.8-11.5%, in Sprague-Dawley rats infused intraduodenally to a total dose of approximately 0.0005 mg/kg for 90 minutes (Foth et al. 1988a). Nearly 80% of a gavage dose of 0.0527 mg/kg [^{14}C]benzo[a]pyrene in peanut oil was detected in the excreta of rats 48 hours after exposure; however, some of the recovered radioactivity may never have been absorbed by the alimentary tract of the rats, but may have passed into the excreta in the peanut oil (Hecht et al. 1979). Radioactivity found in the liver, lungs, kidneys, and testis following a low dose of [^{3}H]-benzo[a]pyrene to Sprague-Dawley rats provides supporting evidence of oral absorption (Yamazaki and Kakiuchi 1989; Yamazaki et al. 1987). The extent of oral absorption in rats is enhanced when benzo[a]pyrene is solubilized in a vehicle (triolein, soybean oils, high-fat diet) that is readily absorbed following low- and high-dose levels (Kawamura et al. 1988; O'Neill et al. 1991).

Oral absorption of benzo[a]pyrene was estimated to be 38-58% following dietary or gavage exposure to high levels in rats (Chang 1943). Anthracene was absorbed to a slightly higher extent (53-74%) than benzo[a]pyrene in rats while phenanthracene was poorly absorbed (4-7%) (Chang 1943). However, the data were limited because an inadequate number of rats was used and study details were lacking.

In general, the oral absorption of chrysene, dibenzanthracene, and pyrene was high following exposure to high doses in rats (Chang 1943; Grimmer et al. 1988; Withey et al. 1991). Following dietary or gavage administration of chrysene in rats, 64-87% of the dose was excreted in the feces (Chang 1943). Recovery of chrysene in excreta of Wistar rats was 74% four days after a single gavage dose of 22 mg/kg chrysene in corn oil (Grimmer et al. 1988). Administration of dibenz[a,h]anthracene in the diet (250 mg) or by stomach tube (200 mg) resulted in more than 90% of the dose being excreted in the feces of white rats (Chang 1943). As with chrysene, absorption of dibenz[a,h]anthracene could not be quantified. Male Wistar rats administered 2-15 mg/kg of [^{14}C]-pyrene recovered 68-92% of the dose in the excreta by 6 days postexposure (Withey et al. 1991). Bioavailability of pyrene and its metabolites was 65-84% over a period of 8 hours following administration.

Blood levels of fluoranthene, pyrene, and benz[a]anthracene after oral administration were examined in rats (Lipniak and Brandys 1993). Fluoranthene, pyrene, or benz[a]anthracene in Tween 80/isotonic saline, was administered orally to rats at a dose of 20 mg/kg. Blood levels after administration indicated that peak concentrations of the three compounds were reached at 1-2 hours after administration. The peak concentration of fluoranthene (≈30 mg/cm^3) was twice as high as that of pyrene, and 5 times higher than benz[a]anthracene.

The effect of diet matrix (gel or powder) on urinary excretion of 1-hydroxypyrene and hydrocarbon binding to DNA was investigated in mice (Wu et al. 1994). Female mice were fed a gel or powder diet containing manufactured gas plant (MGP) residue (coal tar) at 0.1% or 0.3% for 15 days, or the corresponding control diet. Two mixtures of MGP residue were used: Mix of 3 combining equal amounts of samples from three different MGP plant sites, and Mix of 7 combining equal amounts of samples from seven different MGP plant sites, including those used in the Mix of 3. The mixtures contained pyrene, benz[a]anthracene, chrysene, benzo[b]fluorene, benzo[k]fluorene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene. Data were presented in terms of pyrene consumed and 1-hydroxypyrene excreted. Urine was collected on the first, seventh, and fourteenth day of diet administration. 1-Hydroxypyrene levels in the urine were determined using HPLC and fluorescence. Diet matrix had little effect on the bioavailability of the PAHs.

The intestinal absorption of PAHs is highly dependent on the presence of bile (Rahman et al. 1986). To study the role of bile in the intestinal absorption of PAHs, conscious rats with bile duct and duodenal catheters were given [^{3}H]-benzo[a]pyrene, phenanthrene, anthracene, 2,6-dimethylnaphthalene (DMN), and 7,12-dimethylbenz[a]anthracene (DMBA) with or without exogenous bile. The efficiency of PAH absorption was estimated from the cumulative recovery of radioactivity in the bile and urine over 24 hours. The efficiencies of absorption without bile (as a percentage of absorption with bile) were benzo[a]pyrene, 22.9%; phenanthrene, 96.7%; anthracene, 70.8%; DMN, 91.6%; DMBA, 43.4%. Absorption of the four- or five-membered rings (DMBA and benzo[a]pyrene) was strongly dependent on the presence of bile in the intestinal lumen. The absorption of the tricyclic PAHs (phenanthrene and anthracene) differed with respect to their dependency on bile for efficient absorption. This difference correlated with a difference in water solubility, with anthracene being 18 times less water-soluble than phenanthrene. Those products with low water solubility are dependent on the creation of an intermediate phase of the products of lipolysis and bile salts (Rahman et al. 1986). These reactions occur during the normal process of lipid digestion and absorption in the intestine.

2.3.1.3 Dermal Exposure

Application of 2% crude coal tar to the skin of humans for 8-hour periods on 2 consecutive days yielded evidence of PAH absorption (Storer et al. 1984). Phenanthrene, anthracene, pyrene, and fluoranthene were detected in the blood, but benzo[a]pyrene (which is present in coal tar) was not detected. This difference was attributed to differences in percutaneous absorption, rapid tissue deposition after absorption, or metabolic conjugation with rapid urine excretion. In another study, coal tar ointment was applied to skin of volunteers at various sites (Van Rooij et al. 1993a). The surface disappearance of PAH and the excretion of urinary 1-hydroxy-pyrene were used as parameters for dermal absorption. Surface disappearance measurements showed low but significant differences in dermal PAH absorption between anatomical sites: shoulder > forehead, forearm, groin > ankle, hand (palmar site). An *in vitro* study using human skin revealed that the extent of permeation across viable human skin after 24 hours was estimated to be 3% of the total applied radioactivity from [^{14}C]-benzo[a]pyrene (10 µg/cm^2) (Kao et al. 1985). Using human cadaver skin, it was shown that 23.7±9.7% of the applied benzo[a]pyrene penetrated into the skin (Wester et al. 1990). These results suggest that substantial metabolism and/or binding of benzo[a]pyrene takes place in viable human skin which limits the amount of PAH available to penetrate the skin into the systemic circulation.

Twelve workers from a coke plant participated in an intensive skin monitoring program combined with personal air sampling and biological monitoring during 5 consecutive 8-hour shifts (Van Rooij et al. 1993b). Measurements on exposure pads at six skin sites (jaw/neck, shoulder, upper arm, wrist, groin, ankle) showed that mean total skin contamination of the 12 workers ranged between 21 and 166 µg pyrene per day. The dermal uptake of pyrene ranged between 4 and 34 µg/day, which was about 20% of the pyrene contamination on the skin. The mean concentration of total pyrene in the breathing zone air of the 12 workers ranged from 0.1 to 5.4 µg/m^3. The mean respiratory uptake of pyrene varied between 0.5 and 32.2 µg/day. Based on the estimates of the dermal and respiratory pyrene uptake, it is concluded that an average of 75% of the total absorbed amount of pyrene enters the body through the skin. The total excreted amount of urinary 1-hydroxy-pyrene as a result of exposure to PAHs during the 5 consecutive work shifts varied between 36 and 239 nmol. Analysis indicated that dermal absorption was most important in contributing to 1-hydroxy-pyrene excretion. Of the total dose absorbed by both routes combined, 13-49% is excreted as 1-hydroxy-pyrene. Variation in excretion is influenced by smoking habits, and consumption of alcohol.

Percutaneous absorption of [^{14}C]-benzo[a]pyrene in mice, rats, monkeys, and guinea pigs is rapid and high (Ng et al. 1992; Sanders et al. 1986; Wester et al. 1990; Yang et al. 1989). A single dose of 7 μg/cm^2 [^{14}C]-benzo[a]pyrene in acetone was applied to a 4-cm^2 area of the dorsal skin of female hairless guinea pigs for 24 hours (Ng et al. 1992). Approximately 73% of the administered dose was absorbed dermally by 7 days postexposure; most of the dose was absorbed by day 3. The skin wash at 24 hours of exposure contained about 10.6% of dose (Ng et al. 1992). *In vitro* absorption of benzo[a]pyrene through guinea pig skin demonstrated similar results; 67% absorption in a 24-hour exposure (Ng et al. 1992). Seven days after exposure to 125 μg/cm^2 benzo[a]pyrene, 80% of the total recovered radioactivity was eliminated in the feces of mice (Sanders et al. 1986). The site of application still retained 7% of the recovered radioactivity after 7 days. However, the area of application was not covered to prevent animals from licking the test material which may have lead to ingestion of benzo[a]pyrene.

Groups of 12 male Wistar rats were dosed with 2, 6, or 15 mg/kg of [^{14}C]-pyrene applied to 4 cm^2 of a shaved area of the mid-back (Withey et al. 1993b). Three animals in each dose group were killed at 1,2,4, and 6 days postdosing, and the brain, lungs, heart, liver, spleen, kidneys, testes, muscle, and perirenal fat were removed and analyzed for pyrene and [^{14}C]-pyrene equivalents. Blood, urine, and feces, as well as the skin from the application site were also analyzed. The rate of uptake from the skin was rapid (t1/2 = 0.5-0.8 d) relative to rate processes for the other organs, and about 50% of the applied dose was excreted over the 6 days of the study. Levels of pyrene were highest in the liver, kidneys, and fat. Levels of metabolites were also high in the lung.

Dermal absorption of benzo[a]pyrene in rats and monkeys may be affected by the vehicle of administration (Wester et al. 1990; Yang et al. 1989). Following application of 10 ppm benzo[a]pyrene on the skin of rhesus monkeys, an average absorption of 51 ± 22% was reported with acetone vehicle and 13.2 ± .4% with soil; however, absorption data were based on radioactivity recovered in urine only, and not in feces (Wester et al. 1990). The great variation in the absorption with the acetone vehicle limits these results. This may be related, in part, to the dependence on monitoring radioactivity recovered in urine only as opposed to monitoring radioactivity recovered in urine and feces. Disappearance of the applied dose from the application site was 40% at 24 hours following administration (Wester et al. 1990). Sprague-Dawley rats absorbed 4-5 times more of a 1 ppm dose of benzo[a]pyrene when it was applied dermally alone, compared to a soil-sorbed crude oil mixture (Yang et al. 1989). The greater lipophilicity of the crude oil alone probably increased the

rate of dermal uptake of the test material, since the authors determined that absorption was dependent on the monolayer of soil in contact with the skin, which is comparable to the contact between the skin and oil. Therefore, the soil binding of the PAHs may have slowed absorption. However, no quantitative data were available.

Female Sprague-Dawley rats were exposed dermally to [^{3}H]-benzo[a]pyrene (1 ppm) containing petroleum crude oil alone or in fortified soil matrix for 4 days (Yang et al. 1989). Recovery of radioactivity was 35.3% of the dose applied in oil, as follows: urine (5.3% of dose), feces (27.5%), and tissues (2.5%) 96 hours after beginning of exposure. Recovery was 9.2% of applied dose with benzo[a]pyrene from petroleum crude-fortified soil; recoveries in urine, feces, and tissues were 1.9%, 5.8%, and 1.5%, respectively, at 96 hours. Benzo[a]pyrene (10 ppm) with acetone vehicle or in soil was applied to a 12 cm^{2} area of abdominal skin of female rhesus monkeys for 24 hours (Wester et al. 1990). Urine contained 5l ± 22% of the dose with acetone vehicle and 13.2 ± 3.4% with soil.

The percutaneous absorption of [^{14}C]-anthracene (9.3 µg/cm^{2}) was 52.3% in rats, estimated from radioactivity in urine, feces, and tissues over a 6-day period (Yang et al. 1986). Over time, the permeation of anthracene significantly decreased suggesting that anthracene was dermally absorbed in a dose-dependent manner. Diffusion of anthracene through the skin (stratum corneum) depended on the amount of anthracene on the skin's surface.

When 6.25 µg/cm^{2} [^{14}C]-phenanthrene and pyrene was applied to guinea pigs, dermal absorption was 80% and 94%, respectively (Ng et al. 1991, 1992). *In vitro* absorption of phenanthrene and pyrene in guinea pig skin was about 79-89% and 70%, respectively (Ng et al. 1991, 1992).

Monitoring the removal of compounds from the epidermis is indicative of measuring the compound's dermal absorption. The disappearance of radiolabeled benzo[a]pyrene and its metabolites from the epidermis was monophasic, following first order kinetics with a half-life of approximately 2 hours (Melikian et al. 1987). Recovery of the radiolabel was 99-100% throughout the period of the experiment (8 hours), indicating that volatilization of benzo[a]pyrene from the skin was not a confounding factor (Melikan et al. 1987). In contrast, removal of one of its metabolites, 7,8-dihydroxy-9,10-epoxy-7,8,9,l0-tetrahydrobenzo[a]pyrene (anti-BPDE), from the epidermis was biphasic. The second, slower phase of removal suggested that the stratum comeum, the outermost layer of skin which consists of several layers of inactive, keratinized cells surrounded by extracellular

lipids, may act as a reservoir that can retain and slowly release topically applied lipophilic substances such as benzo[a]pyrene but is penetrated rapidly by more polar compounds such as anti-BPDE.

2.3.2 Distribution

2.3.2.1 Inhalation Exposure

No studies were located regarding the distribution of PAHs in humans following inhalation exposure. In general, tissue distribution of benzo[a]pyrene following inhalation exposure is qualitatively similar for different species (Bevan and Weyand 1988; Weyand and Bevan 1986, 1987a, 1988; Wolff et al. 1989c). Highest radioactivity was distributed to the cecum, small intestine, trachea, kidneys, and stomach in rats following a 3-hour or 4-week inhalation exposure to 4.8 mg/m^3 [^{14}C]-benzo[a]pyrene (Wolff et al. 1989c). The lungs and liver of rats contained 2.7% and 4.6% of the recovered dose 6 hours after intratracheal administration of 0.001 mg/kg [^{3}H]-benzo[a]pyrene (Bevan and Weyand 1988). [^{3}H]-Benzo[a]pyrene intratracheally administered to rats demonstrated that the highest fractions were distributed to the lung, liver, kidney, gastrointestinal tract, and carcass (Weyand and Bevan 1986, 1987a, 1988). The concentration of benzo[a]pyrene and its metabolites in the intestine increased with time, suggesting the occurrence of biliary excretion and enterohepatic recirculation. Tissue distribution of radioactivity was qualitatively similar in guinea pigs and hamsters (Weyand and Bevan 1987b). Mice that received 2.5 mg/kg benzo[a]pyrene intratracheally also experienced a similar tissue distribution, but Schnizlein et al. (1987) noted that as the lung burden of benzo[a]pyrene diminished, radioactivity continued to increase in the lung-associated lymph nodes for 6 days. This accumulation may eventually affect humoral immunity.

The distribution pattern of benzo[a]pyrene was not significantly affected following aerosol exposure with or without Ga_2O_3 particles (Sun et al. 1982). However, significant differences in the levels of benzo[a]pyrene delivered to the different tissues did exist. Maximum levels were achieved in the liver, esophagus, small intestine, and blood at 30 minutes following exposure. At 12 hours, maximum levels were seen in the lower gastrointestinal tract. Higher tissue levels of hydrocarbon resulted from absorption of benzo[a]pyrene-Ga_2O_3 particles. Inhaled benzo[a]pyrene adsorbed on insoluble Ga_2O_3 particles was cleared predominantly by mucocilliary transport and ingestion. This latter mechanism of

absorption led to the increased levels and longer retention times of benzo[a]pyrene in the stomach, liver, and kidneys (Sun et al. 1982).

Pregnant Wistar rats inhaled head-only high levels of [^{14}C]-pyrene aerosol on gestational day 17 (Withey et al. 1992). Concentrations of pyrene and metabolites in maternal and fetal blood were elevated 8-fold with a fourfold increase in exposure concentrations. However, pyrene levels in fetal blood were about 10 times lower than maternal blood immediately after exposure. In general, radioactivity increased in fat but decreased in blood, lungs, and liver tissues from 0 to 6 hours postexposure. There was only a small increase in the concentration of radioactivity in fetuses over the whole exposure range compared to maternal levels, suggesting placental transfer of pyrene and its metabolites are limited or that metabolism in fetal tissues is limited.

In a similar study, pregnant Wistar rats were exposed head-only to 200, 350, 500, 650, or 800 mg/m^3 of [^{14}C]-benzo[a]pyrene aerosol for 95 minutes on gestational day 17 (Withey et al. 1993a). Animals were killed immediately or 6 hours postexposure. Concentration of benzo[a]pyrene and metabolites in maternal blood sampled immediately after exposure were elevated 10-fold over the 4-fold increase in dose. At 6 hours postdosing, the increase was still approximately 10-fold, although the actual concentrations were 2-7-fold less than at 0 hours. Concentrations of benzo[a]pyrene and metabolites in fetal blood sampled immediately after exposure were elevated 5-fold over the 4-fold increase in exposure concentrations. Fetal tissues sampled 6 hours post-dosing had a 9-fold increase in benzo[a]pyrene and metabolite concentration over the dose range, due to lower concentration in the 200-650 mg/m^3 dose groups at 6 hours compared to 0 hours. Fetal concentrations were 2-10-fold less than maternal concentrations. Benzo[a]pyrene concentrations in blood, lung, liver, and fetal tissues were significantly decreased from 0 to 6 hours postexposure while levels in fat tissue increased. For benzo[a]pyrene sampled immediately postdosing, lung > blood > liver > kidney > fat > fetus. For total metabolites sampled immediately postdosing, lung > blood > liver > kidney > fetus > fat. For benzo[a]pyrene sampled 6 hours postdosing, fat > lung > kidney > liver > blood > fetus. For total metabolites sampled 6 hours postdosing, lung = fat > kidney > liver = blood > fetus.

2.3.2.2 Oral Exposure

No studies were located regarding the distribution of PAHs in humans following oral exposure.

Tissue levels of benzo[a]pyrene in Sprague-Dawley rats were highest 2-8 days after initial exposure to multiple doses of 0.0005 mg [^{3}H]-benzo[a]pyrene (Yamazaki and Kakiuchi 1989). The highest radioactivities were found in the kidney and testis. [^{3}H]-Benzo[a]pyrene distributed to the protein fractions of the liver, lung, and kidney (Yamazaki et al. 1987). The radioactivity in the protein fractions of these tissues increased gradually over time. In contrast, the radioactivity in the lipid fractions of these tissues accounted for 70% of the administered dose at 3 hours but decreased rapidly with time. The nucleic acid fraction maintained approximately 10% of the total radioactivity throughout the experiment. The increase in protein binding of radioactivity associated with benzo[a]pyrene and its metabolites, and the persistence of the radioactivity associated with the protein fractions, suggests that protein binding may allow benzo[a]pyrene and its metabolites to accumulate in certain tissues, thus increasing the likelihood of cytotoxicity, mutagenicity, or carcinogenicity of benzo[a]pyrene and its metabolites in these organs. In addition, these organs have low metabolic activity while the liver has a high detoxification potential and can facilitate the excretion of these toxic products (Yamazaki et al. 1987).

Single oral doses of 12 mg/kg [^{14}C]-benzo[a]pyrene were administered by gavage to pregnant NMRI:Han mice on gestational days 11, 12, 13, or 18 (Neubert and Tapken 1988). Distribution of radioactivity was measured at 6, 24, and 48 hours after exposure. Maternal and embryo levels were highest with exposure on gestational day 11. The difference in radioactivity between maternal and embryo liver tissues increased when exposure occurred at later gestation. In another experiment, mice were exposed to 24 mg/kg benzo[a]pyrene for 3 consecutive days during early (gestational days 9-l1) or late gestation (days 15-17) (Neubert and Tapken 1988). Maternal tissue levels were not much different from those observed following the administration of single doses. After multiple dose administration, elimination appeared to be faster in maternal tissues, but slower in embryonic tissues. Placental levels were always higher than those in embryonic tissue. Results suggest that benzo[a]pyrene does not cross the placental barrier readily and, therefore, that levels in embryonic tissues of mice never reach levels found in maternal tissues.

In general, orally absorbed benz[a]anthracene, chrysene, and pyrene were rapidly and widely distributed in the rat (Bartosek et al. 1984; Withey et al. 1991). Maximum concentrations of benz[a]anthracene and chrysene in perfused tissues, like the liver, blood, and brain, were achieved within l-2 hours after administration of high doses (76 and 152 mg/kg) (Bartosek et al. 1984). Maximum levels in lesser perfused tissues, like adipose and mammary tissue, were reached in

3-4 hours. In male Wistar rats receiving a gavage dose of 2-15 mg/kg of [^{14}C]-pyrene, the fat had the highest tissue levels of radioactivity, followed by kidney, liver, and lungs (Withey et al. 1991).

Orally absorbed dibenz[a,h]anthracene in rats was also widely distributed to several tissues (Daniel et al. 1967). However, maximum tissue concentrations were not reached until 10 hours after administration. Highest tissue concentrations were in the liver and kidneys, followed by adrenal glands, ovaries, blood, and fat. Soon after administration, large quantities of dibenz[a,h]anthracene were found in the liver and kidneys. The elimination rate from these organs was rapid. At 3-4 days after administration, dibenz[a,h]anthracene was distributed only in the adrenal glands, ovaries, and fat.

The permeability of the placenta to dimethylbenz[a]anthracene, benzo[a]pyrene, and 3-methylcholanthrene (MC) was compared by Shendrikova and Aleksandrov (1974). Pregnant rats received the PAH orally in sunflower oil at a dose of 200 mg/kg on the 21st day of pregnancy. Within 30 minutes after administration of dimethylbenz[a]anthracene, trace amount of the compound could be detected in the fetus. Maximum levels (1.53-1.6 μg/g) were reached 2-3 hours after administration. Only trace amounts were detected in the fetus at 5 hours after administration. Concentration profiles in the liver and placenta were similar to those seen in the fetus. Benzo[a]pyrene was detected in the fetus at 2.77 μg/g. MC was only present in trace amounts. Concentration differences in the fetus among the various PAHs appeared to be highly dependent on the gastrointestinal absorption of the compound. The difference in fetal concentration of the PAHs did not reflect their ability to permeate the placenta.

2.3.2.3 Dermal Exposure

No studies were located regarding the distribution of PAHs in humans following dermal exposure. Evidence regarding the distribution of PAHs in animals following dermal exposure is limited. Although PAHs can readily penetrate the skin, there are few data on distribution to tissues. In one published study on this subject, only 1.3% of an applied dose of [^{14}C]-anthracene (9.3 μg/cm^2) was detected in tissues, primarily liver and kidneys, of rats 6 days after administration (Yang et al. 1986). Groups of 12 male Wistar rats were dosed with 2, 6, or 15 mg/kg of [^{14}C]-pyrene applied to 4 cm^2 of a shaved area of the mid back (Withey et al. 1993b). Three animals in each dose group were killed at

1, 2, 4, and 6 days postdosing, and the brain, lungs, heart, liver, spleen, kidneys, testes, muscle, and perirenal fat were removed and analyzed for pyrene and [^{14}C]-pyrene equivalents. Blood, urine, feces, as well as the skin from the application site were also analyzed. The rate of uptake from the skin was rapid (t1/2 = 0.5-0.8 d) relative to rate processes for the other organs, and about 50% of the applied dose was excreted over the 6 days of the study. Levels of pyrene were highest in the liver, kidneys, and fat. Levels of metabolites were also high in the lung.

2.3.3 Metabolism

The lipophilicity of PAHs enables them to readily penetrate cellular membranes and remain in the body indefinitely. However, the metabolism of PAHs renders them more water-soluble and more excretable. Metabolism of PAHs occurs in all tissues. The metabolic process involves several possible pathways with varying degrees of enzyme activities. The activities and affinities of the enzymes in a given tissue determine which metabolic route will prevail.

The metabolism of PAHs has been studied extensively *in vitro* and *in vivo.* The most commonly used system is the rat liver microsomal fraction, although other species are also used. Cells and cultured tissues from human and other animals have also significantly contributed to the elucidation of the PAH metabolic scheme.

The structural similarity of PAHs contributes to the similarities that exist in their biotransformation. Benzo[a]pyrene metabolism has been extensively reviewed and will be used as a model for PAH metabolism. In the many microsomal, cell, and cultured tissue preparations that have been examined, the metabolic profiles are qualitatively similar. However, there are differences in the relative levels and rates of formation of specific metabolites among tissues and cell preparations used from various animal species and strains. These differences are susceptible to change as a result of pretreatment of the animals with either inducers or inhibitors of particular enzymes. Furthermore, it is known that the metabolism of alternant PAHs (such as benzo[a]pyrene, benz[a]anthracene, chrysene, and dibenz[a,h]anthracene) differs from nonalternant PAHs (such as benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[j]fluoranthene, and indeno[1,2,3-c,d]pyrene) (see Section 2.2). Therefore, the metabolism of benzo[b]fluoranthene will also be discussed as a model for nonalternant PAH metabolism.

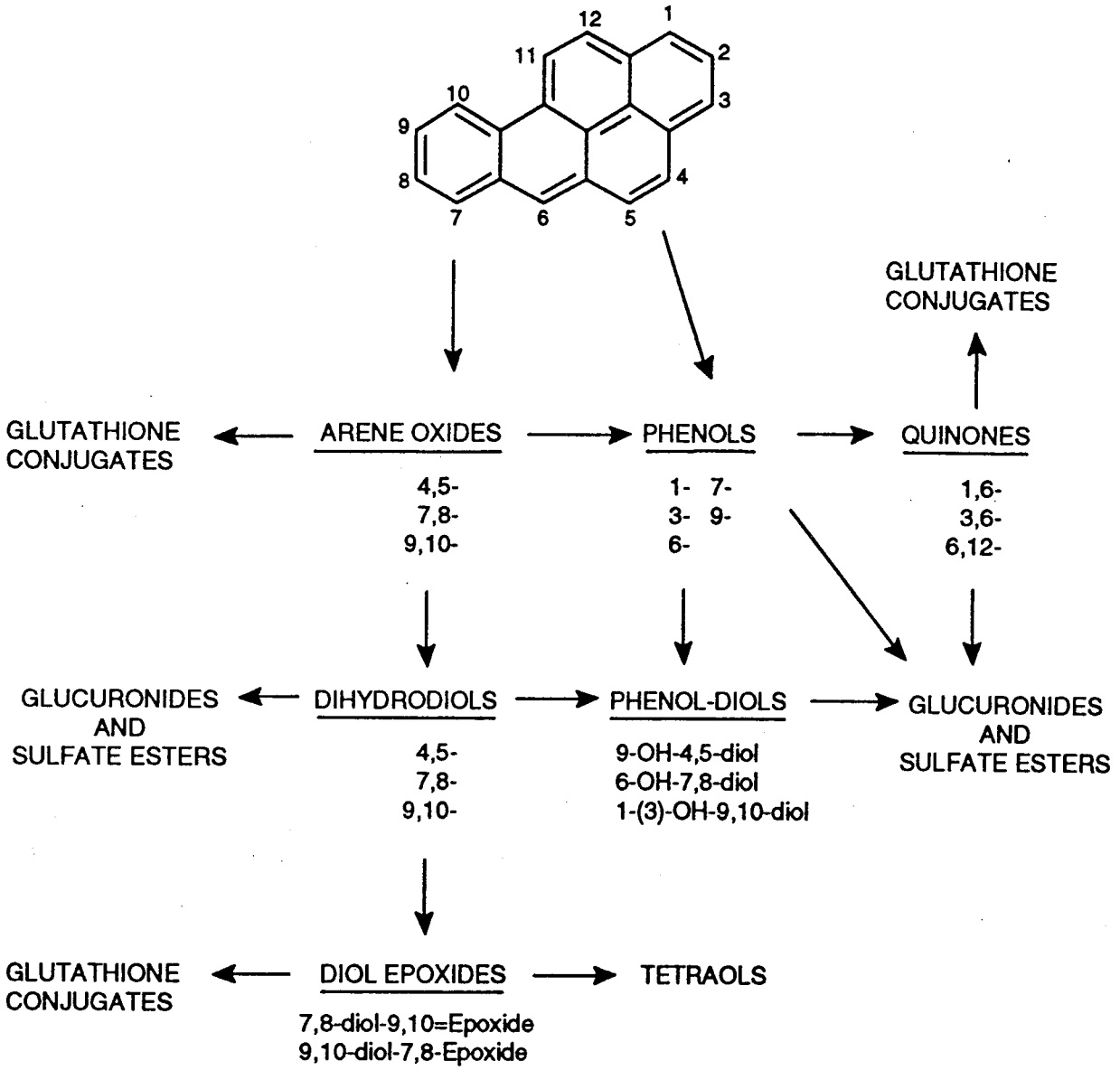
The metabolism of benzo[a]pyrene is summarized in Figure 2-3. Benzo[a]pyrene is metabolized initially by the microsomal cytochrome P-450 systems to several arene oxides. Once formed, these arene oxides may rearrange spontaneously to phenols, undergo hydration to the corresponding trans-dihydrodiols in a reaction catalyzed by microsomal epoxide hydrolase, or react covalently with glutathione, either spontaneously or in a reaction catalyzed by cytosolic glutathione-S-transferases (IARC 1983). Phenols may also be formed by the P-450 system by direct oxygen insertion, although unequivocal proof for this mechanism is lacking. 6-Hydroxybenzo[a]pyrene is further oxidized either spontaneously or metabolically to the 1,6-, 3,6-, or 6,12-quinones. This phenol is also a presumed intermediate in the oxidation of benzo[a]pyrene to the three quinones catalyzed by prostaglandin endoperoxide synthetase (Panthanickal and Marnett 1981). Evidence exists for the further oxidative metabolism to two additional phenols. 3-Hydroxybenzopyrene is metabolized to the 3,6-quinone and 9-hydroxy-benzo[a]pyrene is further oxidized to the K-region 4,5-oxide, which is hydrated to the corresponding 4,5-dihydrodiol (4,5,9-triol). The phenols, quinones, and dihydrodiols can all be conjugated to glucuronides and sulfate esters; the quinones also form glutathione conjugates (Agarwal et al. 1991; IARC 1983).

In addition to being conjugated, the dihydrodiols undergo further oxidative metabolism. The cytochrome P-450 system metabolizes benzo[a]pyrene-4,5-dihydrodiol to a number of uncharacterized metabolites, while the 9,10-dihydrodiol is metabolized predominantly to its l- and/or 3-phenol derivative with only minor quantities of a 9,10-diol-7,8-epoxide being formed. In contrast to the 9,10-diol, benzopyrene-7,8-diol is metabolized to a 7,8-dihydrodiol-9,10-epoxide, and phenol-diol formation is a relatively minor pathway. The diol epoxides can be conjugated with glutathione either spontaneously or by a glutathione-S-transferase catalyzed reaction. They may also hydrolyze spontaneously to tetrols (Hall and Grover 1988).

The route by which PAHs and other xenobiotics enter the body may determine their fate and organ specificity. For example, an inhaled compound may bypass the first-pass effect of the liver and reach peripheral tissues in concentrations higher than one would see after oral exposures. Enzyme activities among tissues are variable.

Benzo[a]pyrene was metabolized *in vitro* by human bronchial epithelial and lung tissue to the 9,10-dihydrodiol, 7,8-dihydrodiol, and small quantities of the 4,5-dihydrodiol and 3-hydroxybenzo[a]pyrene, all of which are extractable into ethyl acetate (Autrup et al. 1978; Cohen et

FIGURE 2-3. Proposed Metabolic Scheme for Benzo(a)pyrene.



al. 1976; Kiefer et al. 1988). These metabolites also conjugated with glutathione and sulfates, but none conjugated with glucuronide. The rate of formation of the dihydrodiols was greater in the bronchial epithelium than in the lung (Autrup et al. 1978; Cohen et al. 1976). This may render some areas of the respiratory tract more sensitive to the effects of carcinogens. One principal difference seen in human lung was the generation of a major ethyl acetate-soluble metabolite that was identified as the sulfate conjugate of 3-hydroxybenzo[a]pyrene, benzo[a]pyrene-3-yl-hydrogen sulfate. This sulfate is very lipid soluble and, thus, would not be readily excreted in the urine (Cohen et al. 1976). Activation of benzo[a]pyrene has also been detected in human fetal esophageal cell culture (Chakradeo et al. 1993).

Intratracheal instillation of benzo[a]pyrene to rats resulted in quinones constituting the highest concentration of metabolites in the lung and the liver within 5 minutes after instillation (Weyand and Bevan 1986, 1988). An *in vitro* study with rat lung demonstrated that the lung tissue has a high capacity to form quinones originating from oxidation at the six position of benzo[a]pyrene to form quinones and subsequently to water-soluble products. Ozone exposure resulted in an increase in the metabolism of benzo[a]pyrene metabolites with the greatest increase observed in the formation of metabolites generated by oxidation at the six position. The proposed retention of quinones following ozone exposure might lead to cytotoxicity associated with superoxide-anion generation by quinone-quinol redox-cycling. However, the high levels of benzo[a]pyrene used in this *in vitro* study may not relate to what occurs *in vivo*. Metabolism of benzo[a]pyrene at carbon six was higher at a lower dose than at the higher dose. Therefore, quinone production and detoxification may represent a major pathway of lung PAH detoxification *in vivo* (Basett et al. 1988).

Approximately 50% of the benzo[a]pyrene that was intratracheally instilled in hamsters was metabolized in the nose (Dahl et al. 1985). The metabolite produced in the hamster nose included tetrols, the 4,5-, 7,8-, and 9,10-dihydrodiol, quinones, and 3-and 9-hydroxybenzo[a]pyrene. Similar metabolites were detected in nasal and lung tissues of rats inhaling benzo[a]pyrene (Wolff et al. 1989b). The prevalence of quinone production was not seen in hamsters as it was in rats (Dahl et al. 1985; Weyand and Bevan 1987a, 1988). In monkeys and dogs, dihydrodiols, phenols, quinones, and tetrols were identified in the nasal mucus following nasal instillation of benzo[a]pyrene (Petridou-Fischer et al. 1988). *In vitro* metabolism of benzo[a]pyrene in the ethmoid turbinates of dogs resulted in a prevalence of phenols (Bond et al. 1988). However, small quantities of .quinones and dihydrodiols were also identified.

Rat lung microsomes facilitated the dissociation of small amounts of benzo[a]pyrene from diesel particles, but only a small fraction of the amount dissociated was metabolized (Leung et al. 1988). The ability to dissociate benzo[a]pyrene was related to the lipid content of the microsomal fraction. Microsomes are able to enhance the slow dissociation of a small amount of benzo[a]pyrene from diesel particles in a form that can be metabolized. Free benzo[a]pyrene was principally and extensively metabolized to the 9,10-dihydrodiol.

A human hepatoma cell line (HepG2) has high benzo[a]pyrene-metabolizing activity and converts benzo[a]pyrene to metabolites (Diamond et al. 1980). When [^{3}H]-benzo[a]pyrene was added to the incubate, a large fraction of the radioactivity was not extractable into chloroform. The extractable fraction contained 9,10-dihydrodiols, 7,8-dihydrodiols, quinones, 3-hydroxybenzo[a]pyrene, and the unchanged parent compound. The cell lysate also consisted of the same metabolites, but the proportions of 3-hydroxybenzo[a]pyrene and the parent compound were much higher than in the medium. Conversely, the proportion of water-soluble metabolites in the cell lysate was lower than in the medium. Treatment of the medium and cell lysate with β-glucuronidase converted only 5-7% of the water-soluble metabolites to chloroform-extractable material. Aryl sulfatase had no effect on radioactivity. These results suggested that this human liver tumor cell line does not extensively utilize the phenol detoxification pathway (Diamond et al. 1980).

Metabolism of benzo[a]pyrene in the primary culture of human hepatocytes primarily resulted in the formation of 3-hydroxybenzo[a]pyrene, 4,5-dihydrodiol, 9,10-dihydrodiol, and 7,8-dihydrodiol (Monteith et al. 1987). As the dose of benzo[a]pyrene increased, the amount of metabolites increased linearly. Binding to DNA was associated with the amount of unconjugated 7,8-dihydrodiol. DNA binding was linear up to a benzo[a]pyrene concentration of 100 μmol. At this concentration, binding increased 64-844 times over the extent of binding at 10 umol. As the concentration of benzo[a]pyrene increased, the ratio of dihydrodiol/phenolic metabolites also increased. Although the capacity to form dihydrodiols was not saturated at 100 umol benzo[a]pyrene, there was a change in the relative proportion of the dihydrodiol metabolites formed as the dose of benzo[a]pyrene increased. As benzo[a]pyrene concentration increased, the 9,10-dihydrodiol was the more prevalent metabolite, but levels of 7,8-dihydrodiol also increased (Monteith et al. 1987).

Epoxide hydrolase is a microsomal enzyme that converts alkene and arene oxides to dihydrodiols. Appreciable enzyme activity was observed in human livers. Comparison of epoxide hydrolase

activities with various substrates revealed that the human liver has a single epoxide hydrolase with broad substrate specificity (Kapitulnik et al. 1977). Epoxide hydrolase activity is also present in other tissues and increases the likelihood for carcinogenic effects in these organs. Ethyl acetate extracts of human and rat bladder cultures contained 9,10-dihydrodiol, 7,8-dihydrodiol, and 3-hydroxybenzo[a]pyrene. Covalent binding of [^{3}H]-benzo[a]pyrene with DNA occurring in both human and rat bladder cultures suggested that benzo[a]pyrene-7,8-diol-9, 10-epoxide is generated. The urothelium of the bladder clearly has the ability to generate the ultimate carcinogen (Moore et al. 1982).

Hepatic microsomes from rats induced with 3-methylcholanthrene convert benzo[a]pyrene to benzo[a]pyrene-7,8-diol-9,10-epoxide (BPDE) 10 times faster than untreated microsomes. The rate-limiting step in BPDE formation is the competition for P-450 between benzo[a]pyrene and the 7,8-dihydrodiol. Formation of BPDE is directly correlated with the 3-methylcholanthrene inducible form(s) of P-450 (Keller et al. 1987). Formation of the proximate carcinogen, 7,8-dihydrodiol, is stereoselective. Rabbit hepatic microsomes generated more of the 7R,8R enantiomer with an optical purity of >90% (Hall and Grover 1987). The major stereoisomer formed by rat liver microsomes is (+)-diol-epoxide-2 (R,S,S,R absolute conformation) (Jerina et al. 1976, 1980). This metabolite is highly tumorigenic (Levin et al. 1982) and gives rise to the major adduct formed upon reaction with DNA. The adduct is a diol epoxide-deoxyguanosine formed by alkylation at the exocyclic nitrogen (N-2) of deoxyguanosine. This diol epoxide-deoxyguanosine has been isolated from several animal species (Autrup and Seremet 1986; Horton et al. 1985) and human tissue preparations (Harris et al. 1979).

Studies using rat liver microsomes have shown that hydroxy metabolites of benzo[a]pyrene undergo glucuronidation (Mackenzie et al. 1993). Assays with three different DNA-expressed glucuronidases from human liver indicate preferential glucuronidation for the 2- and 5-hydroxy, 4- and 11-hydroxy, or l-, 2-, and 8-hydroxy derivatives of benzo[a]pyrene. There are differences in preferential activities for the glucuronidation of various benzo[a]pyrene metaboiites among the various DNA-expressed glucuronidases from human liver, with some glucuronidases being relatively or totally inactive toward this class of compounds (Jin et al. 1993). The results of this study suggest that the relative content of particular types of glucuronidases in a cell or tissue may be important for determining the extent to which a particular carcinogen is deactivated.

Several xenobiotics can induce enzymes to influence the rat liver microsomal metabolite profiles of various PAHs. For example, AHH, the cytochrome P-450 isoenzyme believed to be primarily responsible for the metabolism of benzo[a]pyrene and other PAHs, is subject to induction by PAHs. Treatment of pregnant and lactating rats with a single intraperitoneal dose of Aroclor 1245 increased the metabolism of benzo[a]pyrene by liver microsomes from pregnant and fetal rats 9-fold and 2-fold, respectively, and 2-fold in lactating rats (Borlakoglu et al. 1993). The pretreatment enhanced the formation of all metabolites, but the ratio of the 7,8-diol (the proximate carcinogen) was increased 3-fold in lactating rats and 5-fold in pregnant rats. Similar results were observed in rabbit lung microsomes (Ueng and Alvares 1993). Cigarette smoke exposure has been shown to increase PAH metabolism in human placental tissue (Sanyal et al. 1993), and in rat liver microsomes (Kawamoto et al. 1993). In studying benz[a]anthracene metabolism, some xenobiotics were found to be weak or moderate inducers, but even less efficient ones altered the benz[a]anthracene profile significantly. Thiophenes equally enhanced oxidation at the 5,6- and the 8,9-positions. Benzacridines favored K-region oxidation (5,6-oxidation) (Jacob et al. 1983b). Indeno[1,2,3-c,d]pyrene stimulated the bay region oxidation (3,4-oxidation) of benz[a]anthracene (Jacob et al. 1985). Similar xenobiotic effects were observed with chrysene as a substrate (Jacob et al. 1987). While some enzyme activities are being enhanced, alternate enzymatic pathways may be suppressed (Jacob et al. 1983a).

Rat liver microsomes also catalyzed benzo[a]pyrene metabolism in cumene hydroperoxide (CHP)-dependent reactions which ultimately produced 3-hydroxybenzo[a]pyrene and benzo[a]pyrene-quinones (Cavalieri et al. 1987). At low CHP concentrations, 3-hydroxybenzo[a]pyrene was the major metabolite. As CHP concentrations increased, levels of quinones increased and levels of 3-hydroxybenzo[a]pyrene decreased. This effect of varying CHP levels was reversed by preincubating with pyrene. Pyrene inhibited quinone production and increased 3-hydroxybenzo[a]pyrene production. Pretreatment with other PAHs like naphthalene, phenanthrene, and benz[a]anthracene nonspecifically inhibited the overall metabolism. The binding of benzo[a]pyrene to microsomal proteins correlated with quinone formation. This suggested that a reactive intermediate was a common precursor. The effects of pyrene on benzo[a]pyrene metabolism indicated that two distinct microsomal binding sites were responsible for the formation of 3-hydroxybenzo[a]pyrene and benzo[a]pyrene-quinone (Cavalieri et al. 1987).

Rat mammary epithelial cells (RMEC) have been shown to activate PAHs (Christou et al. 1987). Cytochrome-P-450 in RMEC is responsible for the monooxygenation of DMBA. Prior exposure’of

cultured cells to benz[a]anthracene induced DMBA metabolism. The metabolite profile following benz[a]anthracene-induction was significantly different from the profile obtained with purified P-450c, the predominant PAH-inducible enzyme in rat liver. The bay region 3,4-dihydrodiol, which was not formed with P-450c, was clearly detectable in RMEC. Low epoxide hydrolase activity in the benz[a]anthracene-induced RMEC limited the formation of all other DMBA dihydrodiols. The DMBA monooxygenase activity of benz[a]anfhracene-induced RMEC was inhibited by a-naphthaflavone. The study concluded that DMBA metabolism by RMEC depended on the induction of P-450c and at least one additional form of P-450 that is sensitive to α-naphthaflavone (Christou et al. 1987).

As expected from results of other studies, the perfused rat lung can release high quantities of benzo[a]pyrene metabolites and conjugates into the perfusate (Molliere et al. 1987). Addition of a liver to this perfusion system up gradient from the lungs reduces the concentration of parent compound and free metabolites to less than 20% of that seen in the liver's absence. The liver provides a protective effect on the lung to inhibit covalent binding of benzo[a]pyrene metabolites to pulmonary macromolecules.

The effects of various factors that can modify the hepatic clearance of PAHs, specifically benz[a]anthracene and chrysene, were studied by Fiume et al. (1983). The hepatic clearance and rate constants of these PAHs were significantly reduced in the perfused livers of fasted rats relative to those of fed rats. This reduction was attributed to a decrease in aryl hydrocarbon hydroxylase activity. Fasting also accelerated the depletion of cytochrome P-450 and other microsomal enzymes. In contrast, pretreatment of the rats with these PAHs resulted in increased clearance of both hydrocarbons from the perfusion medium when compared to control rats.

It was also noted by Fiume et al. (1983) that the livers of male rats demonstrated a significantly higher hepatic clearance of benz[a]anthracene than female rats, perhaps suggesting a sexual difference with aryl hydrocarbon hydroxylase activity. Similar findings regarding sexual differences in the metabolism of chrysene by rat livers were also reported by Jacob et al. (1985, 1987). Furthermore, Fiume et al. (1983) demonstrated that age can play a role in PAH metabolism. The hepatic clearance of PAHs in older rats (2 years) was significantly less than the hepatic clearance in younger rats (8 weeks). However, activation of benzo[a]pyrene to mutagenic derivatives, as measured by the *Salmonella typhimurium* test, with hepatic microsomes from male rats from 3 weeks to 18 months of age showed no age-dependent changes (Hilali et al. 1993).

A proposed metabolic scheme for the metabolism of the nonaltemant PAH, benzo[b]fluoranthene is presented in Figure 2-4. Nonalternant PAHs, in contrast to several alternant PAHs, do not appear to exert their genotoxic effect primarily through the metabolic formation of simple dihydrodiol epoxides. In the case of benzo[b]fluoranthene, there is evidence to suggest that metabolism to the dihydrodiol precursor to its bay-region dihydrodiol does occur. Rather than this metabolite being converted to its dihydrodiol epoxide; however, it appears to be extensively converted to its 5-hydroxy derivative. It is the further metabolism of this phenolic dihydrodiol to 5, 9, 10-trihydroxy- 11,12-epoxy-9,10,11,12-tetra-hydrobenzo[b]fluoranthene that has been linked to the genotoxic activity of benzo[b]fluoranthene in mouse skin (Weyand et al. 1993b). In the case of benzo[j]fluoranthene, two potentially genotoxic metabolites have been identified. These are the trans-4,5- and 9,10-dihydrodiols of benzo[j]fluoranthene. It is the conversion of trans-4,5-dihydro-4,5-dihydroxybenzo[j]fluoranthene to anti-4,5-dihydroxy-5,6a-epoxy-4,5,6,6a-tetrahydrobenzo[j]fluoranthene that is principally associated with DNA adduct formation in mouse skin (LaVoie et al. 1993b; Weyand et al. 1993a). Benzo[k]fluoranthene in rat microsomes was shown to result in the formation of 8,9-dihydrodiol. This dihydrodiol can form a dihydrodiol epoxide that is not within a bay region. This may represent an activation pathway of benzo[k]fluoranthene that may be associated, in part, with its genotoxic activity. In the case of nonalternant PAHs, reactive metabolites, that deviate from classical bay region dihydrodiol epoxides, have been linked to their tumorigenic activity.

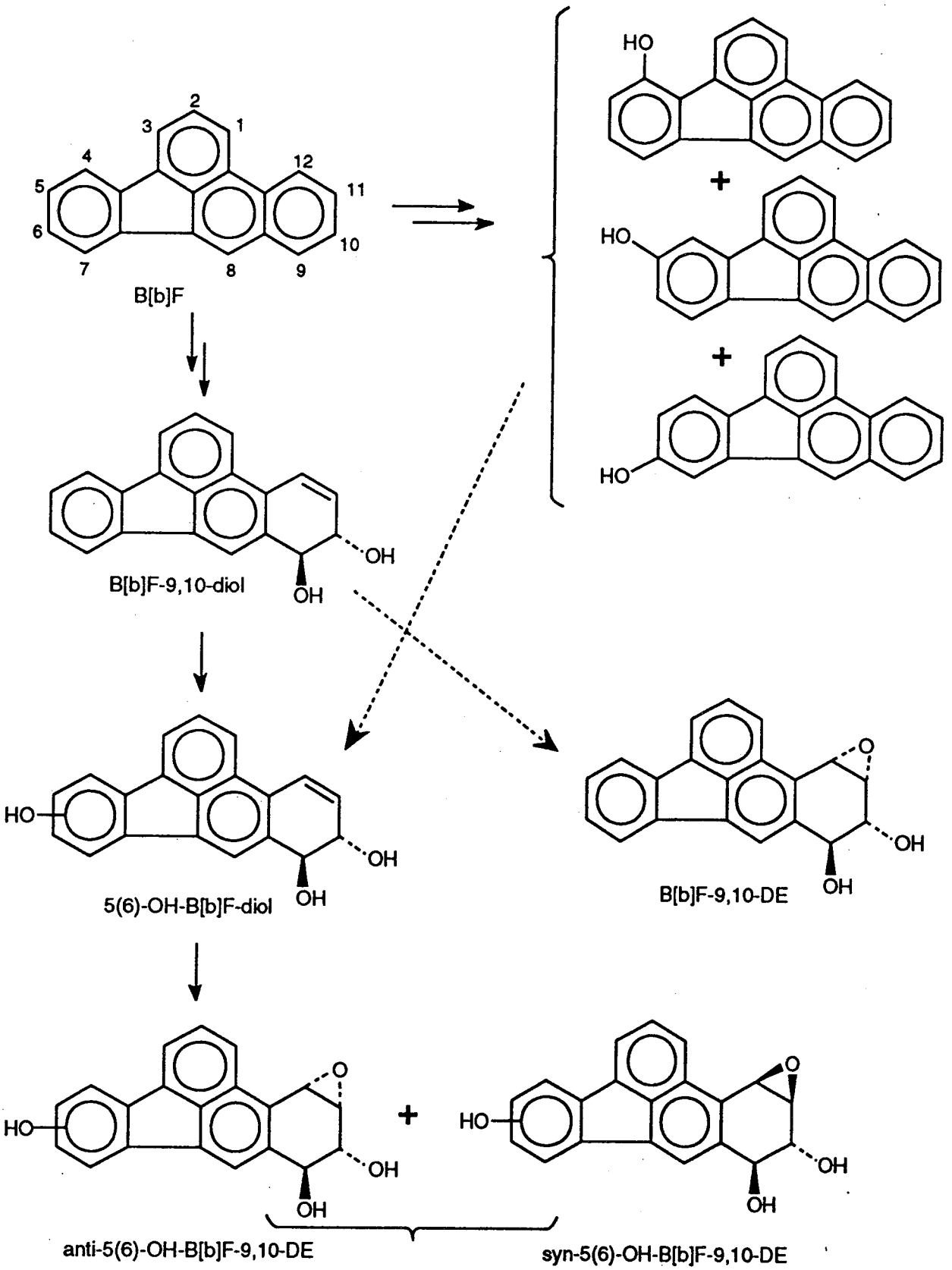
2.3.4 Excretion

2.3.4.1 Inhalation Exposure

Urinary metabolites of PAHs were detected in workers exposed to these compounds in an aluminum plant (Becher and Bjorseth 1983). The ambient levels of PAHs in the workplace (indicated by the authors to exceed 95 mg/m^3, although these data were not presented) did not correspond to the amount of PAHs deposited, metabolized, and excreted in the urine in this study. No quantitative inhalation data were available in humans regarding the excretion of PAHs.

Thirty-four workers in an electrode paste plant were monitored for response to exposure (Ovrebo et al. 1994). Exposure to benzo[a]pyrene was 0.9 µg/m^3; exposure to pyrene was 3.5 µg/m^3. 1-Hydroxypyrene was measured in the urine. Results from these workers were compared to two reference control groups, research and development workers and nickel refinery workers.

FIGURE 2-4. Proposed Metabolic Scheme for Benzo(b)fluoranthene.



Measurements of PAH levels were collected by personal sampling and at two stationary sites. PAH aerosols were collected on filters during the mixing of hot coal tar with carbon. The value of PAHs on the filters varied from 4.3 to 84.6 μg/m^3, with a mean of 14.4 μg/m^3. The PAH particulates were assayed for 8 of 11 PAHs classified as carcinogenic, including benz[a]anthracene, benz[g,h,i]perylene, benzo[a]pyrene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[j]fluoranthene, chrysene, fluoranthene, and indeno[1,2,3-c,d]pyrene, and presented relative to the marker compound, pyrene. Content of these compounds ranged from 30 to 150% of the pyrene content on the filters, which was 1.6 μg/m^3. For example, the benzo[a]pyrene level was 0.8 μg/m^3. Urine analysis indicated a mean urinary value of 1-hydroxypyrene among electrode paste plant workers of 6.98 umol/mol creatinine, compared to 0.08 μmol/mol creatinine for the R&D workers, and 0.14 μmol/mol creatinine for the industrial worker group. Smokers had higher levels of 1-hydroxypyrene compared to non-smokers in all groups. The urinary 1-hydroxypyrene level in the electrode plant workers correlated inversely with age. No correlation was found between frequency of use of a protective mask and the urinary 1-hydroxypyrene concentration.

In an ongoing comprehensive evaluation of biological markers, workers in or near an iron foundry with varying exposures to PAHs were analyzed for response to exposure (Santella et al. 1993). Exposure to benzo[a]pyrene, determined by personal monitors, was 2-60 ng/m^3. 1-Hydroxypyrene was measured in the urine. Cigarette smoking, but not age or charbroiled food, influenced the level of 1-hydroxypyrene. When workers were classified into three categories (low, <.0005 mg/m^3; medium, 0.0005-0.0012 mg/m^3; high, >0.0012 mg/m^3), mean 1-hydroxypyrene levels were 2.7, 1.8, and 3.6 μmol/mol creatinine, respectively. There was a significant difference between the groups after controlling for smoking exposure, but there was no consistent trend. The authors indicate that this study evaluates biological markers of exposure at PAH levels that are very low, compared to other studies.

Workers employed in a graphite electrode producing plant (n=16) and a coke oven (n=33) were compared to a control population of maintenance workers in a blast furnace (n=54) (Van Hummelen et al. 1993). The concentration of PAHs in the environment was measured by personal air samplers, the concentration of hydroxypyrene in urine was measured, and smoking habits were evaluated. The mean age of the workers was 40, and did not differ significantly between the three plants. The proportion of smokers was not different among the three groups. The mean exposure for workers in the graphite electrode producing plant was 11.33 μg/m^3 (0.011 mg/m^3) and was correlated with a urinary

hydroxypyrene concentration of 3.18 µg/g creatinine prior to the shift and 6.25 µg/g creatinine after the shift. For the coke oven workers, airborne PAHs were measured at 23.7 µg/m^3 but this was not illustrative of true exposure, since there were a few very high exposures in the sample: 90.10 µg/m^3 for 7 workers compared to 5.57 µg/m^3 for 26 workers. In accordance with the predominantly low exposure, the urinary hydroxypyrene levels were 0.51 µg/g creatinine before the shift and 0.75 µg/g creatinine after the shift.

The excretion of benzo[a]pyrene following low-level inhalation exposure is rapid and high in rats (Bevan and Weyand 1988; Weyand and Bevan 1986; Wolff et al. 1989c); however, elimination is low in dogs and monkeys (Petridou-Fischer et al. 1988). After nose-only inhalation of 4.8 mg/m^3 [^{14}C]-benzo[a]pyrene for a single exposure or daily for 4 weeks, excretion of radioactivity in the feces of Fischer-344 rats was approximately 96% of the administered concentration (Wolff et al. 1989c). The excretion half-lives in feces and urine were 22 and 28 hours, respectively.

2.3.4.2 Oral Exposure

Five volunteers (21-41 years of age) ingested specially prepared diets high in PAHs, specifically benzo[a]pyrene (from grilled beef), for 2-3 days for an intake of approximately 0.007-0.02 mg/day (Buckley and Lioy 1992). A 100-250-fold increase in ingested benzo[a]pyrene in the high-PAH diet corresponded to a 6-12-fold increase in the elimination of 1-hydroxypyrene. However, benzo[a]pyrene and its other metabolites (not specified) were not measured in excreta, which prevented determination of the total excretion (and an estimate of oral absorption).

Male Sprague-Dawley rats received a low dose of [^{3}H]-benzo[a]pyrene (suspended in 10% ethanolsoybean oil) daily for 3, 5, or 7 days (Yamazaki and Kakiuchi 1989). Highest radioactivity was excreted 2-8 days after first exposure. Polar and phenol metabolites represented approximately 60% and 20% of the radioactivity detected in urine, respectively. The conjugated form accounted for 80% of these urinary metabolites. Only small amounts of unmetabolized benzo[a]pyrene were detected in the urine. Excretion into the feces was not studied.

Male Wistar rats eliminated a large amount of a single gavage dose of 0.22 mg/kg chrysene by 2 days postexposure (Grimmer et al. 1988). The unchanged parent compound represented 0.17% and 13.09% in the urine and feces, respectively. The recovery of the dose in excreta was 74% of dose after 4 days

of which about 61% was represented by hydroxychrysene compounds. The metabolite pattern was similar for urine and feces. The major metabolites identified were 1- and 3-hydroxychrysene, with about 100 times higher amounts in the feces (33.1% and 17.87%, respectively, of administered dose) than urine (0.79% and 0.35%, respectively). Approximately 79% of a large chrysene dose (1,217-2,717 mg/kg in the diet) was eliminated in the feces of rats; however, levels in the urine were not measured (Chang 1943). As the dose of chrysene in the diet increased, the percentage of excreted hydrocarbon also increased.

Male Wistar rats were given single oral doses of 2, 4, 6, 9, or 1.5 mg/kg of [^{14}C]-pyrene (Withey et al. 1991). Recovery of the dose in excreta was 82% for the two low-dose groups and 50-63% for the other groups 2 days postexposure. The urine and feces contained 34-45% and 21-50% of the dose, respectively, at 4 days postexposure. Recovery of radioactivity in the bile was approximately 10% of the dose after 6 hours.

2.3.4.3 Dermal Exposure

No studies were located regarding the excretion of PAHs in humans following dermal exposure to single PAHs. Excretion patterns of 1-hydroxypyrene in urine were studied in two psoriatic patients, each treated daily with coal tar pitch covering over 50% of their skin for 3 weeks (Hansen et al. 1993). The coal tar contained 1.43 mg/g pyrene. After 1 week of treatment, the urinary concentration of 1-hydroxypyrene increased approximately 100 times. However, the concentration after 3 weeks of treatment was decreased to that observed before treatment was initiated. The authors speculate that the healing of the psoriatic lesions may have rendered the skin less permeable to the PAHs after 3 weeks of treatment and healing.

The urinary excretion of 1-hydroxypyrene was evaluated in 65 automotive repair workers (automobile or diesel truck repair) whose skin was exposed to used mineral oils, and compared to values from non-professionally exposed control males on control diets (Granella and Clonfero 1993). Smoking exposure was equivalent in both groups. Pyrene concentrations were determined in the oily material taken from cloths used to clean various types of engines. Values of urinary 1-hydroxypyrene were determined on Friday at the end of the working week, and again on Monday morning prior to work. Smoking and PAH-rich diets were considered confounding factors. At both the beginning and the end of the working week, the values of urinary 1-hydroxypyrene were slightly higher in exposed subjects

(0.178 + 0.150 and 0.194 + 0.135 µmol creatinine on Monday and Friday, respectively) than in controls ((0.124 + 0.090 µmol/mol creatinine on Monday and Friday, respectively). The urinary 1-hydroxypyrene values were higher in both smoking and non-smoking subjects than controls. The highest values were found in urinary samples of smokers exposed to used mineral oils (0.259 + 0.090 µmol/mol creatinine). In non-smoking workers, post-shift 1-hydroxypyrene values were 0.154 + 0.105 µmol/mol creatinine, compared to 0.083 + 0.042 µmol/mol creatinine for the non-smoking controls. In automobile repair workers, there was no significant difference in the levels of 1-hydroxypyrene at the beginning and end of the work week. Tobacco smoking had more influence on the levels of 1-hydroxypyrene than did occupational exposure in this group. The influence of PAHs in the diet was only detectable when the subjects returned to work after the weekend. No explanation was given for this finding. This data suggests that exposure to PAHs through dermal contact with used engine oil is low.

The elimination of benzo[a]pyrene was rapid and high in mice and guinea pigs following low- and high-level dermal exposure (Ng et al. 1992; Sanders et al. 1986). The percentages of recovered radioactivity in urine and feces were 24.5%, 46.9%, and 25% for Swiss Webster mice dermally exposed to benzo[a]pyrene at 1.25, 12.5, and 125 µg/cm^2, respectively, for 7 days (Sanders et al. 1986). The feces in the high-dose animals had 35%, 58%, and 80% of the total recovered radioactivity after 24 hours, 48 hours, and 7 days, respectively. The amount of radioactivity excreted in urine was about 10% of amount excreted in feces. A elimination half-life of about 30 hours was estimated for benzo[a]pyrene. The data are limited because the exposed area of skin was not reportedly covered or collars were not employed to prevent ingestion of test compound by the animal. In guinea pigs, 73% of the dose was excreted 7 days after low-level (0.28 mg) exposure to benzo[a]pyrene (Ng et al. 1992).

The excretion of dermally absorbed phenanthrene and pyrene was rapid in guinea pigs (Ng et al. 1991, 1992). The presence of [^{14}C]-activity in the urine and feces of rats that received [^{14}C]-anthracene applied to the skin provides evidence of its absorption (Yang et al. 1986). Six days after administration of 9.3 µg/cm^2, the amounts detected in the urine and feces were 29.1% and 21.9% of the dose, respectively.

2.3.4.4 Other Routes of Exposure

No studies were located regarding excretion of PAHs in humans following other routes of exposure.

Three female Beagle dogs were given a bolus of aerosolized crystals of 7.7 mg/kg benzo[a]pyrene or 2.8 mg/kg phenanthrene in a single breath by intratracheal instillation (Gerde et al. 1993a). The blood borne clearance of the PAHs was monitored by repeatedly sampling blood through catheters in the ascending aorta and the right atrium of the dog. Half of the benzo[a]pyrene cleared within 2.4 minutes. Half of the phenanthrene cleared in 1.0 minute. Compared to clearance of phenanthrene, a less lipophilic PAH, the data indicate that the clearance of benzo[a]pyrene was limited by diffusion through the alveolar septa, while clearance of the moderately lipophilic phenanthrene was limited mostly by the rate of perfusion of the blood. The results indicate that inhaled PAHs of sufficient lipophilicity to limit diffusion through cells have a greater potential for toxicity to the lung than less lipophilic PAHs. Because of the thicker epithelia, bronchi should be at greater risk than the alveoli for PAH-induced toxicity exerted at the port of entry. Clearance of PAHs from the respiratory tract follows a biphasic pattern, with a rapid clearance of most of the PAH followed by a slow clearance of a small fraction. Previously published models predict that the rapid phase represents clearance through the thin epithelial barriers in the alveoli, the slow clearance is through the thicker epithelium of the airways, and the rate of clearance from either region will be slowed if the PAH has a high degree of lipophilicity. This study sought to validate model predictions for rates of alveolar clearance of PAHs of different lipophilicities. In a companion study, 3 female Beagle dogs were given doses of 0.00091 g/kg benzo[a]pyrene instilled on the surface of the conducting airways (Gerde et al. 1993b). Sequential lavage of the mucous-retained materials followed the instillations. Benzo[a]pyrene was retained within the mucous lining layer sufficiently to be transported with the mucocilliary escalator. Fractions of benzo[a]pyrene penetrating to the bronchial epithelium had a clearance half-time in the range of 1.4 hours. This long retention indicates a diffusion-limited uptake of benzo[a]pyrene by the airways. Physiological models have predicted that the lipophilicity of solutes such as PAHs will delay clearance from the respiratory tract. This clearance consists of a delayed penetration of the mucous lining layer, allowing mucocilliary clearance, followed by a slow penetration of PAHs through walls of the conducting airways.

Excretion of radioactivity in the urine of rats following intratracheal instillation only accounted for 2.2% of the administered benzo[a]pyrene at 6 hours (Bevan and Weyand 1988; Weyand and Bevan

1986). Amounts of radiolabel in the blood were also very small. However, levels could still be determined in order to derive toxicokinetic parameters. The data obtained by Weyand and Bevan (1986) fit best to a three-compartment model whereby the half-lives for the three phases were 4.3, 31.5, and 277 minutes.

Results obtained by Weyand and Bevan (1986, 1988) revealed that a large fraction of the administered dose was excreted in the bile of rats, therefore suggesting that fecal elimination is the major excretion route. After 6 hours, 53% of the 0.001 mg/kg dose was excreted into the intestine and intestinal contents of rats that were without a bile duct cannula, while cannulated rats excreted 74% in the bile over the same period (Weyand and Bevan 1986). These results indicate the occurrence of enterohepatic recirculation. Metabolites excreted in the bile included thioether conjugates (62.5%), glucuronide conjugates (22.8%), sulfate conjugates (7.4%), and free benzo[a]pyrene (9.8%) (Weyand and Bevan 1988). Radioactivity detected in the gastrointestinal tract of rats following pulmonary exposure to benzo[a]pyrene also suggests that biliary excretion occurs (Weyand and Bevan 1987a; Wolff et al. 1989c). The percentage of benzo[a]pyrene excretion into bile declined as intratracheal doses increased from 0.00016 to 0.35 mg in rats and guinea pigs (Weyand and Bevan 1987b). However, the biliary excretion of benzo[a]pyrene in hamsters remained the same after administration of either dose.

Female Wistar rats received low doses of chrysene (0.002 and 0.004 mg/kg) intratracheally (Grimmer et al. 1988). The major metabolite in the excreta was 1-hydroxychrysene. Hydroxychrysene compounds represented 31.26-48.9% of dose in the feces and about 3% in the urine. The unmetabolized parent compound was 17-19% of the administered dose in feces and only l-2% in urine.

Less than 10% of instilled radioactivity was excreted in the urine and feces of dogs and monkeys 48 hours after intratracheal administration of [^{3}H]-benzo[a]pyrene into the nostril (Petridou-Fischer et al. 1988).

Nineteen outbred male rats were dosed intraperitoneally once with 200 mg/kg benzo[a]pyrene in sunflower oil (Likhachev et al. 1993). Concentrations of benzo[a]pyrene-7,8-diol, a marker metabolite of bioactivation of benzo[a]pyrene, and 3-hydroxy-benzo[a]pyrene, a marker metabolite of deactivation, were measured daily in the urine and feces for 15 days. Levels of these metabolites were

correlated with tumor latency. Another group of- 10 rats was dosed intraperitoneally once with 15 mg/kg benzo[a]pyrene in sunflower oil and urine was collected for 3 days. Five rats were killed on day 3 and the other 5 were killed on day 8. Liver DNA concentrations of benzo[a]pyrene-7,8,9,10-tetrols were determined in animals killed on day 8. Considerable individual variation was observed in the levels of daily and total excretion of benzo[a]pyrene-7,8-diol and 3-hydroxy-benzo[a]pyrene in rats receiving 200 mg/kg benzo[a]pyrene. Both metabolites were excreted primarily in the feces. More than half of the total metabolites excreted were detected during the first five days, and peak concentrations were observed on the second day after benzo[a]pyrene administration. Peritoneal malignant fibrous histiocytomas developed in 10 of the 16 survivors at 15 days. Levels of urinary benzo[a]pyrene-7,8-diol correlated positively with tumor latency. In the animals exposed to 15 mg/kg benzo[a]pyrene, a high correlation was found between excretion of benzo[a]pyrene-7,8-diol and benzo[a]pyrene-DNA adducts in the liver.

[^{14}C]-Benzo[a]pyrene was administered to male germfree rats (Yang et al. 1994). Urine was collected 24 hours before and every 24 hours for 7 days after administration. Urinary metabolites, consisting of 9% of the administered radioactivity, were fractionated by lipophilic ion exchange chromatography, and characterized by reversed-phase HPLC, ultraviolet spectrometry, and gas chromatography/mass spectrometry. About 90% of the administered dose was excreted within 7 days; 80% in the feces and 9% in the urine. About 90% of the radioactivity in the urine was recovered in the methanol eluate. In this eluate, more than 80% of the urinary metabolites were conjugated, while neutral metabolites constituted 13-18%. The neutral metabolites consisted of 7,8,9,10-tetrols (trace), trans-11,12-dihydrodiol (major), trans-7,8-dihydrodiol (trace), three isomer trihydroxy-benzo[a]pyrenes (major), carboxylic methyl ester derivatives of benzo[a]pyrene quinones, and trioxo-benzo[a]pyrenes (major). Most of the urinary radioactivity was excreted within 72 hours of dosing, with a peak excretion of 24-48 hours. A similar time course was observed for excretion in feces (data not shown).

Six hours after intravenous administration of 0.08 mg/kg [^{14}C]-benzo[a]pyrene to rabbits, 30% and 12% of the dose was excreted in the bile and urine, respectively (Chipman et al. 1982). Excretion of activity into the bile was biphasic over a period of 30 hours with apparent half-lives of 0.27 and 4.623 hours for the rapid and slow phases, respectively. Treatment of the bile and urine with β-glucuronidase and aryl sulfatase increased the amount of activity in the bile and urine that was extractable into ethyl acetate indicating the presence of glucuronide and sulfate conjugates.

Intraduodenal administration of the bile resulted in 21% and 14% of the intraduodenal dose being excreted into the bile and urine, respectively. Since biliary metabolites undergo enterohepatic recirculation, the half-life for ^{14}C-activity is expected to be longer in animals without biliary fistulae (Chipman et al. 1982).

The overall elimination of [^{3}H]-benzo[a]pyrene following intravenous administration (0.001 mg/kg) best fits a triexponential model, as after inhalation exposure (Weyand and Bevan 1986). The half-lives for the three phases were 1.5, 22.4, and 178 minutes. These parameters were very similar to those derived from intratracheal instillation.

2.3.5 Mechanisms of Action

PAHs are absorbed through the lungs by transport across the mucus layer lining the bronchi (Bevan and Ulman 1991). In general, PAHs are lipophilic compounds that can cross the lungs through passive diffusion and partitioning into lipids and water of cells (Gerde et al. 1991, 1993a, 1993b). The rapid, blood-bound redistribution of hydrocarbons at low blood concentrations from lungs to other organs indicates that diffusion is the rate-determining step (Gerde et al. 1991). The absorption rates vary among the PAHs, probably depending on the octanol/water partition coefficient. Essentially all of gastrically instilled benzo[a]pyrene is absorbed via uptake of fat-soluble compounds (Busbee et al. 1990). Oral absorption of benzo[a]pyrene is enhanced by some oils (such as corn oil) in the gastrointestinal tract (Kawamura et al. 1988). The mechanism of dermal absorption of PAHs is most likely passive diffusion through the stratum comeum (Yang et al. 1986).

PAHs and their metabolites are distributed to tissues by transport through the blood. Therefore, PAHs reach more-perfused tissues rapidly following exposure and are eliminated more slowly from less-perfused tissues (Bartosek et al. 1984). A large fraction of orally absorbed benzo[a]pyrene is believedto be transported by lipoproteins from the gastrointestinal tract to the blood via the thoracic duct lymph flow (Busbee et al. 1990).

The carcinogenic mechanism of action of altemant PAHs is fairly well elucidated, but it is not as well described for nonaltemant PAHs. Furthermore, it is not known exactly how PAHs affect rapidly proliferating tissues. PAHs express their carcinogenic activity through biotransformation to chemically reactive intermediates that then covalently bind to cellular macromolecules (i.e., DNA) leading to

mutation and tumor initiation. The products of PAH metabolism include epoxide intermediates, dihydrodiols, phenols, quinones, and their various combinations. The bay region (e.g., the sterically hindered, cup-shaped area between carbons 10 and 11 of benzo[a]pyrene or 1 and 12 of benz[a]anthracene) diol epoxide intermediates of PAHs are considered to be the ultimate carcinogen for alternant PAHs (Jerina et al. 1980). These diol epoxides are easily converted into carbonium ions (carbocations) which are alkylating agents and thus mutagens and initiators of carcinogenesis. Therefore, the carcinogenic and toxic potential of PAHs relies on their metabolites. However, several of the tumorigenic PAHs (i.e., the nonaltemant PAHs) discussed in this profile do not have a bay region, or have been shown not to be similarly activated via a simple bay region epoxide (e.g., Amin et al. 1985a, 1985b). This observation has important implications regarding the expression of carcinogenicity for the nonalternant PAHs. If these chemicals are activated to carcinogens via a mechanism that differs from alternant PAHs, then they may also differ with respect to tumor site and species specificity.

A prerequisite for conversion of PAHs into these active bay region diol epoxides is the presence of cytochrome P-450 and associated enzymes.responsible for this conversion. These enzymes can be found primarily in the liver, but they are also present in the lung, intestinal mucosa, and other tissues. Thus, factors such as distribution to the target tissue(s), solubility, and intracellular localization proximate to these enzymes figure prominently in the expression of a PAH's carcinogenicity. In fact, in order to assess whether there was any correlation between carcinogenic potency and the ability to induce P-450 isoenzymes, several indices of P-450 isoenzyme activity (*O*-demethylation of ethoxyresorufin, metabolic activation of 2-amino-6-methyldipyrido [1,2-α:3',2'd]imadazol [Glu-P-I] to mutagens, and immunological detection of polyclonal antibodies against purified rat P-450 I) were measured in microsomal preparations incubated with benzo[a]pyrene and benzo[e]pyrene (Ayrton et al. 1990). While both PAHs increased several parameters of P-450-I activity, benzo[a]pyrene was markedly more potent than benzo[e]pyrene. Based on these results, the authors concluded that the carcinogenic potency of the PAHs tested could be predicted by the degree to which they induced these enzymes.

Changes in the cytochrome P-450 system can affect the carcinogenicity of the PAHs. This system is susceptible to induction by the PAHs themselves as well as other chemicals commonly found in the environment. The degree and specificity (i.e., which enzymes are affected) of induction depend on the tissue and species and strain. The induction of one enzyme particularly important to the metabolism

of PAHs, AHH, is also known to be under genetic control (see discussions in Section 2.2.2 on responsive versus nonresponsive mouse strains). Given the heterogeneity of human genotypes, it is likely that certain human subpopulations exist that are more susceptible to AHH induction and thus more susceptible to the induction of cancer (see Section 2.7).

Once the reactive bay region epoxide is formed, it may covalently bind to DNA and other cellular macromolecules and presumably initiate mutagenesis and carcinogenesis. Indeed, the level of DNA-adduct formation has been found to correlate with tumor induction activity for a number of PAHs in newborn rat liver and lung (Weyand and LaVoie 1988) and in mouse skin (Albert et al. 1991b; Alexandrov and Rojas-Moreno 1990). Furthermore, no benzo[a]pyrene-DNA-adducts were found in rat skin, which is known to be resistant to PAH-induced skin tumor formation (Alexandrov and Rojas-Moreno 1990). The types of adducts formed in various tissues may dictate target organ susceptibility to PAH-induced carcinogenicity. Various metabolites of benzo[a]pyrene were administered to rats intraperitoneally and DNA adducts from lung, liver, and lymphocytes were measured (Ross et al. 1991). The only metabolites that led to DNA binding were 2-, 9-, and 12-hydroxybenzo[a]pyrene and the truns-7,8-dihydrodiol of benzo[a]pyrene. The authors suggested that different DNA adducts resulting from the *in vivo* metabolism of benzo[a]pyrene in different tissues may be related to tissue specificity of benzo[a]pyrene-induced carcinogenicity.

Although the bulk of this work on PAH-induced carcinogenicity has been done in animal models and animal *in vitro* systems, work in human *in vitro* systems indicates that these same mechanisms of activation may be involved in humans. For example, induction of AHH and formation of the reactive intermediate, benzo[a]pyrene 7,8-dihydrodiol, has been observed in the epithelial tissue from human hair follicles (Merk et al. 1987). All the steps necessary for cellular transformation and cancer induction were demonstrated in cultured human skin fibroblasts: inducible AHH activity, altered cellular proliferation kinetics, and DNA damage (Milo et al. 1978). Thus, humans are likely to be susceptible to tumor induction by PAHs by these mechanisms.

Carcinogenic PAHs have been suggested to have an effect on immune function (Luster and Rosenthal 1993; Saboori and Newcombe 1992), thereby allowing the induction of carcinogenesis, while noncarcinogenic PAHs do not affect immune function (see Section 2.4). The effects of dermally applied benzo[a]pyrene alone or following dermal pretreatment with the prostaglandin synthetase inhibitor, indomethacin, on contact hypersensitivity (cell-mediated immunity), production of antibodies

to DNP (humoral immunity), and the induction of skin tumors was studied in male BALBc mice treated for 6 weeks to 6 months (Andrews et al. 1991b). A group of mice treated with acetone served as controls. Skin tumors were observed in the mice treated with benzo[a]pyrene beginning at week 18 of treatment. Pretreatment with indomethacin significantly increased (by 21%) the latency of tumor induction by benzo[a]pyrene and significantly reduced (by 46%) the weight of benzo[a]pyrene-induced skin tumors. Based on these findings, the authors suggested that benzo[a]pyrene-induced skin carcinogenesis may be mediated by a mechanism that involves prostaglandin suppression of cellular immunity. Undoubtedly, several other factors yet to be determined are involved in the ultimate expression of PAH-induced toxicity and carcinogenicity.

2.4 RELEVANCE TO PUBLIC HEALTH

PAHs occur ubiquitously in the environment from both synthetic and natural sources. PAHs occur in the atmosphere most commonly in the products of incomplete combustion. These products include fossil fuels; cigarette smoke; industrial processes (such as coke production and refinement of crude oil); and exhaust emissions from gasoline engines, oil-fired heating, and burnt coals. PAHs are present in groundwater, surface water, drinking water, waste water, and sludge. They are found in foods, particularly charbroiled, broiled, or pickled food items, and refined fats and oils. Individuals living in the vicinity of hazardous waste sites where PAHs have been detected at levels above background may experience exposure to these chemicals via inhalation of contaminated air or ingestion of contaminated food, soil, or water.

Evidence exists to indicate that certain PAHs are carcinogenic in humans and animals. The evidence in humans comes primarily from occupational studies of workers who were exposed to mixtures containing PAHs as a result of their involvement in such processes as coke production, roofing, oil refining, or coal gasification (e.g., coal tar, coke oven emissions, soot, shale, and crude oil). Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lungs and skin following inhalation and dermal exposure, respectively. Some ingestion of PAHs is probably due to swallowing of particulates containing PAHs subsequent to mucocilliary clearance from the lung. Certain PAHs have also been shown to induce cancer in animals. The site of tumor induction is influenced by route of administration: stomach tumors are observed following ingestion, lung tumors following inhalation, and skin tumors following dermal exposure, although tumors can form at other locations (e.g., lung tumors after dermal exposure).

Noncancer adverse health effects associated with PAH exposure have been observed in animals but generally not in humans (with the exception of adverse hematological and dermal effects). Animal studies demonstrate that PAHs tend to affect proliferating tissues such as bone marrow, lymphoid organs, gonads, and intestinal epithelium.

Minimal Risk Levels (MRLs) for Polycyclic Aromatic Hydrocarbons

Inhalation MRLS

No inhalation MRLs have been derived for PAHs because no adequate dose-response data that identify threshold levels for noncancer health effects are available in humans or animals for any duration of exposure.

Oral MRL.s

No acute, or chronic oral MRLs were derived for PAHs because there are no adequate human or animal dose-response data available that identify threshold levels for appropriate noncancer health effects. Serious reproductive and developmental effects in animals associated with acute oral exposure to PAHs have been reported. These are not appropriate end points for the derivation of an MRL. Noncancer effects noted in longer term oral toxicity studies in animals include increased liver weight (generally not considered to be adverse) and aplastic anemia (a serious effect), neither of which is an appropriate end point for the derivation of an MRL. Intermediate-duration oral MRLs were derived for acenaphthene, anthracene, fluoranthene, and fluorene.

Acenaphthene

- An MRL of 0.6 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to acenaphthene.

The MRL was based on a minimal LOAEL of 175 mg/kg/day for liver weight (EPA 1989c). Four groups of CD-l mice (20/sex/group) were gavaged daily with 0, 175, 350, or 700 mg/kg/day acenaphthene for 90 days. The toxicological evaluations of this study included body weight changes, food consumption, mortality, clinical pathological evaluations (including hematology and clinical

chemistry), organ weights and histopathological evaluations of target organs. The results of this study indicated no treatment-related effects on survival, clinical signs, body weight changes, total food intake, and ophthalmological alterations. Liver weight changes accompanied by microscopic alterations (cellular hypertrophy) were noted in both the mid- and high-dose groups, and seemed to be dose-dependent. Additionally, high-dose males and mid- and high-dose females showed significant increases in cholesterol levels. Increased relative liver weights in males, and increased absolute and relative liver weight in females, without accompanying microscopic alterations or increased cholesterol levels were also observed at the low dose; in light of the effects seen at higher doses, this change was considered to be a minimum LOAEL. There was no NOAEL. The MRL was obtained by dividing the LOAEL value by 300 (3 for a minimum LOAEL, 10 for extrapolation from animals to humans, and 10 for human variability) and rounding to one significant figure.

MRLs for acute-duration and chronic-duration have not been derived because suitable NOAEL and LOAEL values have not been identified in the available literature.

Fluoranthene.

- An MRL of 0.4 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to fluoranthene.

The MRL was based on a minimal LOAEL of 125 mg/kg/day for increased relative liver weight in male mice (EPA 1988e). Four groups of CD-1 mice (20/sex/group) were gavaged daily with 0, 125, 250, or 500 mg/kg/day fluoranthene for 90 days. The toxicological evaluations of this study included body weight changes, food consumption, mortality, clinical pathological evaluations (including hematology and clinical chemistry), organ weights, and histopathological evaluations of target organs. The results of this study indicated no treatment-related effects on survival, clinical signs, body weight changes, total food intake, or ophthalmological alterations. All treated mice exhibited nephropathy, increased salivation, and increased liver enzyme levels in a dose-dependent manner. However, these effects were either not significant, not dose-related, or not considered adverse at 125 mg/kg/day. Mice exposed to 500 mg/kg/day had increased food consumption throughout the study. Mice exposed to 250 mg/kg/day had statistically increased SGPT values and increased liver weight. Compound-related microscopic liver lesions (indicated by pigmentation) were observed in 65 and 87% of the mid- and high-dose mice, respectively. Male mice exposed to 125 mg/kg/day had increased relative liver

weight. The LOAEL is 125 mg/kg/day, based on-relative liver weight in males. There was no NOAEL. The MRL was obtained by dividing the LOAEL value by 300 (3 for a minimal LOAEL, 10 for extrapolation from animals to humans, and 10 for human variability) and rounding to one significant figure.

Fluorene.

- An MRL of 0.4 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to fluorene.

The MRL was based on a minimal LOAEL of 125 mg/kg/day for relative liver weight (EPA 1989e). Four groups of CD-l mice (20/sex/group) were gavaged daily with 0, 125, 250, or 500 mg/kg/day fluorene for 90 days. The toxicological evaluations of this study included body weight changes, food consumption, mortality, clinical pathological evaluations (including hematology and clinical chemistry), organ weights and histopathological evaluations of target organs. The results of this study indicated no treatment-related effects on survival, body weight changes, total food intake, or ophthalmological alterations. All treated male mice exhibited increased salivation, hypoactivity, and urine-wet abdomens. A significant decrease in red blood cell count and packed cell volume was observed in females treated with 250 mg/kg/day and in males and females at 500 me/kg/day. Decreased hemoglobin concentration was also observed in the high-dose group. A dose-related increase in relative liver weight was observed in all treated mice, and in absolute liver weight at >250 mg/kg/day. A significant increase in absolute and relative spleen and kidney weight was observed at 250 mg/kg/day.. Increases in absolute and relative liver and spleen weights at the high dose were accompanied by histopathological increases in hemosiderin in the spleen and in the Kupffer cells of the liver. The LOAEL is 125 mg/kg/day based on increased relative liver weight. There was no NOAEL. The MRL was obtained by dividing the LOAEL value by 300 (3 for a minimal LOAEL, 10 for extrapolation from animals to humans, and 10 for human variability) and rounding to one significant figure.

Anthracene.

- An MRL of 10 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to anthracene.

The MRL was based on a NOAEL of 1,000 mg/kg/day for liver effects (EPA 1989d). The objective of this study was to evaluate the toxicity of anthracene in a subchronic toxicity study. Four groups of male and female CD-1 mice (20/sex/group) were placed on study, and were dosed with 0, 250, 500, and 1,000 mg/kg/day fluorene in corn oil by gavage for 13 weeks. The mice were observed twice daily for clinical signs. Body weights and food consumption were reported weekly. Hematologic and serum chemistry evaluations were completed at final sacrifice. At final sacrifice, gross post-mortem examinations were completed, organ weights were taken, and histological examinations were subsequently done on the tissues collected from all organ systems. No treatment-related finding were noted in survival, clinical signs, mean body weights, food consumption, and ophthalmological examinations, hematology, clinical chemistry, organ weights , gross pathology, and histopathology. In summary, anthracene produced no discemable effects. This study was conducted under the same laboratory conditions as the 90-day study of acenaphthene (EPA 1989c), and under similar laboratory conditions as the 90-day studies of fluoranthene (EPA 1988e) and fluorene (EPA 1989e), from which intermediate-duration MRLs were derived, based on liver effects. In these studies (EPA 1988e, 1989c, 1989e), many other treatment-related and dose-related effects were observed, including renal, hematological, and splenic, that lent support to the derivation of the MRL for each compound. Thus, although no toxic effects were noted even at the highest dose tested in the study cited for anthracene (EPA 1989d), this free-standing NOAEL has considerable credibility, based on the assumption that toxic effects would have been observed if present, as was seen for the other compounds using the same study design. The NOAEL is 1,000 mg/kg/day based on the absence of liver effects, and any other effects in the organ systems studied. The NOAEL was the highest dose used in the study. The MRL was obtained by dividing the NOAEL value by 100 (10 for extrapolation from animals to humans, and 10 for human variability).

Dermal MRLs

No acute-, intermediate-, or chronic-duration MRLs were derived for the 17 PAHs because of the lack of appropriate methodology for the development of dermal MRLs.

Death. There have been no reports of death in humans following exposure to any of the PAHs. However, benzo[a]pyrene is fatal to mice following ingestion, and aeath in animals has been reported following parenteral exposure to a number of PAHs. The intraperitoneal LD_{50} values in mice for pyrene, anthracene, and benzo[a]pyrene are 514, >430, and 232 mg/kg, respectively (Salamone 1981).

Reduced survival time in "Ah-responsive" mice (those capable of producing increased levels of cytochrome P-450 enzymes) was observed following a single intraperitoneal dose of 500 mg/kg benzo[a]pyrene (Robinson et al. 1975). In contrast, oral exposure to 120 mg/kg/day benzo[a]pyrene results in reduced survival of "Ah-nonresponsive" mice (those whose P-450 enzymes are not induced by PAHs).

While the results in animal studies indicate that exposure to high doses of PAHs is lethal, the majority of the data are from parenteral exposure. This route is not applicable to exposure routes humans may expect to encounter, so the relevance of these findings to public health is not known. Parenteral administration bypasses the first-pass effect in the liver that occurs following oral exposure (PAHs may be expected to be ultimately biotransformed to inactive metabolites more quickly in the liver than in other tissues). However, because death has been observed in animals following oral exposure as well, it can be assumed that acute exposure to high enough doses of the PAHs can be lethal.

Systemic Effects.

Respiratory Effects. Adverse noncancer respiratory effects, including bloody vomit, breathing problems, chest pains, chest and throat irritation, and abnormalities in chest X-rays have been reported in humans exposed to PAHs and respirable particles in a rubber factory (Gupta et al. 1993). Inhalation is a significant route of exposure to PAHs in humans. *In vitro* studies using human lung tumor cells demonstrate that the benzo[a]pyrene-induced cytotoxicity (as measured by protein incorporation or cloning efficiency) observed was most likely due to formation of such reactive products as the 7,8-diol 9,10-epoxide metabolite of benzo[a]pyrene (Kiefer et al. 1988). Thus, human lung cells are capable of metabolizing PAHs to reactive intermediates. This implies that inhalation exposure to PAHs could result in toxicity in the respiratory tract.

Adverse effects on the respiratory tissue of laboratory animals have also been observed. The effects of benzo[e]pyrene, pyrene, anthracene, benz[a]anthracene, and benzo[a]pyrene on respiratory mucosa were studied in tracheal explants in rats (Topping et al. 1978). The PAHs were incorporated into beeswax pellets that were placed into tracheal grafts that had been transplanted subcutaneously into the subscapular region of isogenic host rats and the pellets remained in place for 4 weeks. Approximately 50-60% of the test substance was delivered to the tracheal tissue by the end of 4 weeks, in most instances. Benzo[e]pyrene induced only mild changes that included slight hyperplasia of the tracheal

epithelium. A more long-lasting epithelial hyperplasia was observed with pyrene, anthracene, and benz[a]anthracene, and tracheas implanted with pyrene also exhibited a more severe mucocilliary hyperplasia. In addition, undifferentiated epithelium and small areas of squamous metaplasia were also seen with these PAHs, effects that persisted at least 8 weeks after exposure. Severe and long-lasting hyperplasia and transitional hyperplasia as well as metaplasia were seen in tracheas exposed to benzo[a]pyrene, and after 8 weeks, 75% of the epithelium was still abnormal. Acute inflammation (edema and/or granulocyte infiltration), subacute inflammation (mononuclear infiltration and an increase in fibroblasts), and fibrosis and hyalinization in the second half of the experiment were seen with all PAHs. The authors concluded that all of the PAHs tested induced pathological changes in the respiratory mucosa of the transplanted tracheas. The effects were different for the noncarcinogenic PAHs (benzo[e]pyrene, pyrene, anthracene, benz[a]anthracene), as compared to the carcinogenic PAH (benzo[a]pyrene); the former induced changes that were short-lived while the latter produced more severe, long-lasting (metaplastic) changes.

Cultured fetal hamster tracheal explants were exposed to two concentrations each of benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[e]pyrene, and pyrene *in vitro* for 4 days, and the effects of these PAHs on the respiratory epithelium were evaluated by scanning electron microscopy (Richter-Reichhelm and Althoff 1986). Exposure to benzo[e]pyrene and pyrene, as well as the lower concentrations of benz[a]anthracene and benzo[b]fluoranthene, resulted in effects similar to those seen in the DMSO controls: up to a 10% incidence of focally slight inhibition of epithelial differentiation and/or metaplasia. When the concentrations of all of the PAHs except benzo[e]pyrene and pyrene were doubled, the frequency of these lesions increased to 50-l00%, and the incidence of dysplasia (including hyperplasia) 1 was also observed to occur in a dose-related manner in explants exposed to benz[a]anthracene, benzo[b]fluoranthene, and benzo[k]fluoranthene. These lesions were not seen in the cultures exposed to benzo[e]pyrene, pyrene, or DMSO. The authors note that these effects on respiratory epithelium seen *in vitro* are similar to the preneoplastic changes seen *in vivo* following exposure to PAHs, and thus, this system may serve as a good screen for assessing risk to the respiratory tract.

These observations, coupled with the fact that the respiratory system appears to be a target for PAH-induced cancer in humans, suggest that the respiratory system may be a target organ for PAH-induced noncancer adverse effects in humans as well.

Cardiovascular Effects. PAHs are contained in cigarette smoke, and smoking is a well-established risk factor in the development of atherosclerosis. Arterial smooth muscle cell proliferation, collagen synthesis, lipid accumulation, and cellular necrosis are all involved in the pathogenesis of the atherosclerotic plaque. *In vitro* studies conducted using bovine, rabbit, and human smooth muscle cells from arteries demonstrated that benzopyrene affects some of the aforementioned processes. Cell proliferation was not affected by benzo[a]pyrene, but a decrease in collagen secretion and an increase in cellular toxicity were noted in both the animal and human cell cultures (Stavenow and Pessah-Rasmussen 1988).

Male White Leghorn chickens (six/group) were given weekly intramuscular injections of benzo[a]pyrene, benzo[e]pyrene, anthracene, and dibenz[a,h]anthracene for 16 weeks prior to removal of the abdominal aorta to investigate the effects of benzo[a]pyrene on the development of arteriosclerotic plaques (Penn and Snyder 1988). Animals injected with DMSO (the vehicle) served as controls. Microscopic plaques were found in the aortas of all treated and control animals. However, the plaque volume index (PVI), which is a measure of both plaque cross-sectional area and plaque length, was nine times larger in the benzo[a]pyrene animals than the controls. Benzo[e]pyrene and dibenz[a,h]anthracene also caused an increase in plaque volume as compared to controls. However, the plaque sizes in the animals treated with anthracene were no different than controls. Therefore, the authors concluded that benzo[a]pyrene, benzo[e]pyrene, and dibenz[a,h]anthracene “promoted” the development of preexisting atherosclerotic plaques in male chickens as opposed to initiating the development of new plaques. The ability to promote plaque development was not correlated with the mutagenicity or carcinogenicity of the PAH tested. Similarly, administration of benzo[a]pyrene or benzo[e]pyrene into atherosclerosis-susceptible or atherosclerosis-resistant pigeons for 3-5 months of treatment indicated that benzo[a]pyrene, but not benzo[e]pyrene, enhanced the formation of arterial lesions in female, but not male, birds (Hough et al. 1993). Female pigeons were also infertile, and showed ovarian abnormalities.

These results, therefore, suggest that PAHs may contribute to the pathogenesis of atherosclerosis in humans. This is a particularly relevant health risk for those individuals who are exposed to high levels of PAHs in the environment and who also smoke cigarettes.

Gastrointestinal Effects. Anthracene has been associated with gastrointestinal toxicity in humans. Humans that consumed laxatives that contained anthracene (anthracene concentration not specified) for

prolonged periods were found to have an increased incidence (73.4%) of melanosis of the colon and rectum as compared to those who did not consume anthracene-containing laxatives (26.6%) (Badiali et al. 1985). The authors suggested that the melanosis observed may be attributed to the consumption of anthracene laxatives and not to intestinal stasis. This study is severely limited because of confounding factors such as the existence of other predisposing factors for melanosis and lack of follow-up.

Several PAHs discussed in this profile have been shown to alter enzyme activity in the intestinal mucosa of animals following oral administration, which could conceivably lead to increased production of reactive intermediates and tissue injury. Given the selectivity of PAHs for rapidly proliferating tissues such as gastrointestinal mucosa and the results discussed above, exposure to PAHs (particularly oral) by humans could lead to adverse gastrointestinal effects.

Hematological Effects. Adverse hematological effects have been observed in animals following exposure to PAHs. For example, administration of a single intraperitoneal dose of benzo[a]pyrene to mice resulted in a small spleen, marked cellular depletion, prominent hemosiderosis, and follicles with large lymphocytes. These pathological lesions were associated with death (Shubik and Porta 1957). Death due to adverse hematological effects (e.g., aplastic anemia and pancytopenia resulting in hemorrhage) has also been observed in mice following intermediate-duration oral exposure to benzo[a]pyrene (Robinson et al. 1975). Fluoranthene and fluorene administered by gavage to male and female mice for 13 weeks caused hematological effects including decreased packed cell volume and decreased hemoglobin content (EPA 1988e, 1989e). In addition, it has been shown that benzo[a]pyrene is toxic to cultured bone marrow cells when applied directly (Legraverend et al. 1983)

PAHs appear to affect other blood elements, as well. The influence of several PAHs on calcium ionophore-induced activation of isolated rabbit platelets was studied (Yamazaki et al. 1990). The activation of the platelets was assessed by measuring thromboxane B_2 synthesis in response to stimulation by the calcium ionophore, A-23 187. The authors reported that thromboxane B_2 synthesis was inhibited by incubation of the stimulated platelets with benz[a]anthracene, chrysene, benzo[a]pyrene, and benzo[g,h,i]perylene, and stimulated by incubation with anthracene and pyrene. However, no statistical analysis was performed on these data, and the changes reported are generally within ±10% of control values. In addition, the effects of the PAHs on thromboxane B_2 synthesis are bidirectional, and in many instances, the same compound induced both inhibition and stimulation at different concentrations.

As discussed above, PAHs tend to exert their adverse effects on rapidly proliferating tissues, such as the bone marrow blood forming elements. It is likely that PAH-induced toxicity in this tissue is due to a specific attack on DNA of cells in the S or synthetic phase of mitosis (EPA 1988a).

Although the human data available on PAH-induced hematological toxicity are flawed by confounding factors, they, together with the animal data and the propensity for PAHs to attack rapidly proliferating tissues, indicate that humans exposed to PAHs may be at risk for developing hematological toxicity.

Hepatic Effects. No adverse hepatic effects have been reported in humans following exposure to PAHs. However, hepatic effects have been observed in animals following acute oral, intraperitoneal, or subcutaneous administration of various PAHs. These effects include the induction of preneoplastic hepatocytes, known as y-glutamyl transpeptidase foci, induction of carboxylesterase and aldehyde dehydrogenase activity, an increase in liver weight, and stimulation of hepatic regeneration (an indication of a proliferative effect) (Danz et al. 1991; Gershbein 1975; Kemena et al. 1988; Robinson et al. 1975; Shubik and Porta 1957; Torronen et al. 1981; Tsuda and Farber 1980). These hepatic changes are not considered serious adverse effects, but their incidence and severity have been shown to correlate with the carcinogenic potency of particular PAHs. Thus, monitoring of liver function and tissue integrity may prove useful in the evaluation of PAH exposure.

More serious effects indicative of hepatic injury have been observed in animals. For example, an acute intraperitoneal injection of phenanthrene to rats resulted in liver congestion with a distinct lobular pattern, and an increase in serum aspartate aminotransferase, gamma-GT, and creatinine (Yoshikawa et al. 1987). Similarly, a single intraperitoneal injection of pyrene resulted in minimal swelling of the liver but no significant alterations in serum chemistry. Longer-term administration of PAHs has also been reported to result in adverse hepatic effects in animals. For example, increased absolute and relative liver weight correlated with hepatocellular hypertrophy was seen in male and female mice given 350 mg/kg/day acenaphthene by gavage for 13 weeks (EPA 1989c). Increased liver weight and dose-related centrilobular pigmentation accompanied by an increase in liver enzymes was observed in both male and female mice receiving 250 mg/kg/day fluoranthene by gavage for 13 weeks (EPA 1988e).

Renal Effects. Adverse renal effects associated with PAHs have not been reported in humans. A single injection of anthracene or fluorene had no adverse effect on the kidneys of mice (Shubik and

Porta 1957). Dilated tubules were observed in the kidneys of mice administered pyrene in the diet for 25 days (Rigdon and Giannukos 1964); the toxicological significance of this effect is not known. Renal tubular regeneration, and interstitial lymphocytic infiltrates and/or fibrosis were observed after 13-week oral administration of fluoranthene to female mice at 250 mg/kg/day, and to male mice at 500 mg/kg/day (EPA 1988e). Given the lack of renal toxicity in humans and the limited value of the observations made in animals, the risk to humans for renal toxicity following exposure to PAHs is not known.

Endocrine Effects. There is suggestive evidence that PAHs may adversely affect endocrine function as well. The number of thymic glucocorticoid receptors in 6-week-old rats treated once with 2 mg/kg benzo[a]pyrene was measured (Csaba et al. 1991). It is assumed that the route of exposure was by oral gavage, but this was never explicitly stated. The number of these receptors was decreased by 40% in females and was unaffected in males relative to the vehicle control animals. The statistical significance of these effects was not indicated, nor was the adversity of a decrease in receptor number assessed by examination of functional parameters.

Dermal Effects. The skin is susceptible to PAH-induced toxicity in both humans and animals. Regressive verrucae were reported following intermediate-duration application of benzo[a]pyrene to human skin (Cottini and Mazzone 1939). Although reversible and apparently benign, these changes were thought to represent neoplastic proliferation. Benzo[a]pyrene application also apparently exacerbated skin lesions in patients with pre-existing skin conditions (pemphigus vulgaris and xeroderma pigmentosum) (Cottini and Mazzone 1939). Workers exposed to substances that contain PAHs (e.g., coal tar) experienced chronic dermatitis and hyperkeratosis (EPA 1988a). Coal tar preparations containing PAHs are used in the therapeutic treatment of some skin disorders. Adverse reactions have been noted in these patients, also.

Adverse dermatological effects have also been noted in animals in conjunction with acute and intermediate-duration dermal exposure to PAHs. These effects include destruction of sebaceous glands, skin ulcerations, hyperplasia, and hyperkeratosis (Bock and Mund 1958), and alterations in epidermal cell growth (Albert et al. 1991b; Elgjo 1968).

The observation that PAHs adversely affected the skin in both humans and animals is not surprising. The skin undergoes rapid cell turnover and is thus a likely target for PAH attack on DNA synthesis.

Given the information discussed above, the ubiquitous nature of PAHs in the environment, and the susceptibility of the skin to PAH-induced toxicity, adverse skin effects may occur in individuals exposed to these chemicals by the dermal route.

Immunological and Lymphoreticular Effects. Humoral immunity was depressed in male iron foundry workers exposed to benzo[a]pyrene (Szczeklik et al. 1994). IgG, and IgA were depressed in those workers exposed to high levels. There are reports in the literature concerning the immunotoxicity of PAHs following dermal and parenteral exposure in animals. The carcinogenic PAHs as a group have an immunosuppressive effect. There are limited data that suggest that the degree of immunosuppression correlates with the carcinogenic potency. For example, using spleen cell cultures from C3H/Anf mice, suppression of humoral immunity (as measured by the plaque-forming cell [PFC] response to sheep red blood cells) and cell-mediated immunity (as measured by the one-way mixed lymphocyte response) were observed following incubation with 10^{-5}-10^{-7} mol benzo[a]pyrene (Urso et al. 1986). There was no loss in cell viability at these concentrations. These immunological responses were unaffected by treatment with equivalent concentrations of benzo[e]pyrene. These findings led the authors to speculate that carcinogenic PAHs alter immune function, thereby allowing the induction of carcinogenesis while noncarcinogenic PAHs do not affect immune function. In addition, benzo[a]pyrene, but not benzo[e]pyrene, in the presence of S9 metabolic activation mix, has been shown to inhibit interferon induction by viruses by 60-70% in cultured LLC-MK_2 cells (Hahon and Booth 1986).

Benzo[a]pyrene has been shown to markedly inhibit the immune system, especially T-cell dependent antibody production by lymphocytes exposed either *in vivo* or *in vitro* (Blanton et al. 1986; Lyte and Bick 1985; White and Holsapple 1984). These effects are generally seen at high dose relative to those that can induce cancer in animals.

The effects of benzo[a]pyrene on several parameters of cell-mediated immune function in isolated and T-cell enriched mononuclear cell populations from three strains of mice (C57, C3H, and DBA) given a single intraperitoneal injection of 10-50 mg/kg benzo[a]pyrene or benzo[e]pyrene following stimulation with phytohemagglutinin (PHA) were studied (Wojdani and Alfred 1984). Neither benzo[a]pyrene nor benzo[e]pyrene had an inhibitory effect on lymphocyte blastogenesis induced by PHA; blastogenesis was slightly stimulated at 2.5 and 10 mg/kg of either PAH. Dose-related suppression of cell-mediated cytotoxicity of allosensitized lymphocytes was observed in all strains of

mice treated with benzo[a]pyrene, but no effect on this parameter was observed following treatment with benzo[e]pyrene. The percentage and adherence of macrophages from benzo[a]pyrene-treated mice were increased. The authors suggest that benzo[a]pyrene, but not benzo[e]pyrene, causes alterations in cell-mediated immune function that could compromise the animal's immune function allowing the development of PAH-induced tumors. A major limitation of this study was the lack of statistical analysis, thereby making it difficult to determine the validity of the changes seen. As mentioned previously, relatively high doses of benzo[a]pyrene were employed in these studies.

Benzo[a]pyrene-induced immune suppression was reported in male $B6C3F_1$ mice (Lyte and Bick 1985) and in the offspring of C3H/Anf mice treated intraperitoneally with benzo[a]pyrene (Urso and Gengozian 1980). Cell-mediated and humoral immune function of the liver, thymus, and spleen were evaluated in both maternal animals and the offspring of C3H mice administered one intraperitoneal dose of benzo[a]pyrene (150 mg/kg) during "mid-pregnancy" (Urso et al. 1992). The offspring were evaluated at 1 week and 18 months of age. Suppression of these various aspects of the immune system was observed in both the mothers and the offspring at these relatively high doses. However, the study lacked sufficient detail to adequately assess either the protocol or the results.

Groups of four $B6C3F_1$ female mice were administered single injections of 0, 50, or 200 mg/kg benzo[a]pyrene in corn oil to study the correlation between DNA adduct formation (as measured by ^{32}P-postlabelling analysis) and the suppression of polyclonal immune responses (^{3}H-TdR incorporation following stimulation by *Escherichia coli* lipopolysaccharide [LPS] and concanavalin A [Con A] and IgM secretion) and decreased cell viability in splenic lymphocytes harvested from the treated mice (Ginsberg et al. 1989). Spleen weight was significantly decreased (18%, $p<0.05$) at 50 mg/kg. The polyclonal response to LPS and Con A was suppressed by 30-45%, and this suppression was statistically significant at 200 mg/kg. IgM secretion was also significantly depressed (42%) at 200 mg/kg. These immunosuppressive effects were accompanied by high levels of benzo[a]pyrene/DNA adducts. The authors speculated that the immunosuppressive effects of benzo[a]pyrene were due to a cytotoxic mechanism (as supported by *in vitro* experiments) that in turn resulted partially from the genotoxic effects of benzo[a]pyrene (i.e., the formation of benzo[a]pyrene/DNA adducts).

Benzo[a]pyrene exerts its inhibitory effects on antibody production through alterations on the normal functioning of macrophages, T cells, and B cells (Blanton et al. 1988; Zhao et al. 1990). In contrast,

benzo[a]pyrene has no effect on most cellular immune responses before the appearance of tumors (Dean et al. 1983b), although benzo[a]pyrene exposure does inhibit IL-2-dependent proliferation (Myers et al. 1988).

Benzo[a]pyrene may also induce autoimmune responses. Groups of eight female Sprague-Dawley rats were administered a single subcutaneous injection of 2 mg benzo[a]pyrene or benzo[e]pyrene (11.1 mg/kg) in sesame oil in the right thigh (Faiderbe et al. 1992). The animals were observed for up to 150 days and blood samples were taken at regular intervals to measure anti-phosphatidylinositol (PtdIns) antibodies. Serum levels of anti-PtdIns in animals treated with benzo[a]pyrene exceeded those of the oil-injected controls after day 10, and the difference became statistically significant ($p<0.05$) after day 40. The levels reached a peak at day 60 after which time they reached a plateau. The anti-PtdIns were of the IgG type and specific to phosphatidylinositol. Malignant sarcomas developed at the injection site in the animals treated with benzo[a]pyrene within 100-120 days. Serum levels of anti-PtdIns in animals treated with benzo[e]pyrene did not differ from those of the oil-injected controls. No malignant sarcomas developed at the injection site in 100% of the animals administered benzo[e]pyrene within 100-120 days. The authors speculated that constant stimulation of lymphocytes reactive for PtdIns by an endogenous antigen, of which PtdIns could be a part, was responsible for the increased serum levels of anti-PtdIns. The authors suggested that PtdIns metabolism is altered in rapidly proliferating malignant cells (the neoplasia being stimulated by benzo[a]pyrene), resulting in the synthesis of the PtdIns-containing antigen. The lack of an autoimmune response to benzo[e]pyrene was due to the fact that benzo[e]pyrene was not carcinogenic; there was no neoplastic transformation occurring that could result in the production of PtdIns-containing antigens such as was seen with benzo[a]pyrene. Therefore, this study provides evidence that benzo[a]pyrene-induced neoplasia may cause an alteration in the metabolism of endogenous substances, resulting in the production of autoimmune antibodies to those substances.

The immunotoxic effects of benzo[a]pyrene have been noted *in vitro* as well (e.g., Ladies et al. 1991), and these studies provide some insight into the mechanism of action of benzo[a]pyrene-induced immunological effects. Splenic lymphocytes from $B6C3F_1$ mice were incubated with various concentrations of benzo[a]pyrene for either 2 hours or the entire culture period (Ginsberg et al. 1989). A dose- and duration-related decrease in splenic lymphocyte viability (as measured by ^{3}H-TdR incorporation) and immune response (as measured by IgM secretion) was observed in the absence of S9 activation. Addition of S9 enhanced this effect after acute-duration exposure. However, there was

very little formation of benzo[a]pyrene/DNA adducts at benzo[a]pyrene concentrations of l-200 µmol in the splenic lymphocytes; this lack of effect was accompanied by a very low level of benzo[a]pyrene metabolism to DNA-adducting metabolites. Benzo[a]pyrene/DNA adducts were measured in liver and lung; however, in the *in vivo* experiment. This led the authors to suggest that benzo[a]pyrene-induced immunotoxicity as expressed by splenic lymphocytes was the result of a cytotoxic effect that was mediated, in part, by a genotoxic mechanism involving the formation of benzo[a]pyrene/DNA adducts remote from the spleen and a direct cytotoxic effect not requiring activation of benzo[a]pyrene to the reactive intermediate.

Incubation of human lymphocytes with 0.1-01.0 µg/mL benzo[a]pyrene resulted in a suppression of lymphokine-activated killer cell (LAK) activity against tumor targets after 3 and 7 days (Lindemann and Park 1989). LAK DNA synthesis was also inhibited after 3 or 7 days of incubation with benzo[a]pyrene. However, benzo[a]pyrene had no effect on LAK binding with tumor targets, and benzo[a]pyrene did not interfere with the cytotoxic effect of natural killer cells added to the incubation medium. Based on these results, the authors concluded that benzo[a]pyrene interferes with the development of the immunological defense killer cells.

Benzo[a]pyrene has also been shown to affect immune responses to viral infection. Benzo[a]pyrene can reversibly inhibit the induction of viral interferon in 32 different mammalian cell lines but only in the presence of S9 metabolic activation (Hahon and Booth 1988). This inhibition must occur at an early level and not affect viral interferon interactions because the activity of exogenous interferon was unaffected. In addition, influenza virus multiplication was also inhibited by activated benzo[a]pyrene. Benzo[e]pyrene had no effect on interferon induction. The authors suggest that benzo[a]pyrene's inhibition of interferon induction may be an early step in compromising the host's immune function, thereby allowing the induction of carcinogenesis.

There is evidence to suggest that PAHs may alter the levels of brain neurotransmitters, which in turn affects the function of the immune system. The levels of two catecholamines, dopamine and norepinephrine, were determined in discrete brain areas in mice in which fibrosarcomas had been induced following a single subcutaneous injection of benzo[a]pyrene (Dasgupta and Lahiri 1992). Both dopamine and norepinephrine levels were significantly decreased in some brain regions (e.g., the corpus striatum and the hypothalamus), and these decreases were evident in both early and late tumor development. The authors state that since immunological function is compromised during

carcinogenesis and certain alterations in brain catecholamines impair immune function, the mechanism by which carcinogens such as benzo[a]pyrene cause immunosuppression and subsequent carcinogenesis may be via depression of brain catecholamines.

Very little information is available on the immunological effects of other PAHs. Mice treated with high doses of dibenz[a,h]anthracene exhibited a reduced serum antibody level in response to antigenic challenge by comparison to controls (Malmgren et al. 1952). The immunosuppressive effects of dibenz[a,h]anthracene were studied in AHH-inducible mice (C57BL/6) and AHH-noninducible mice (DBA/2N) by intraperitoneal and oral administration (Lubet et al. 1984). Immunosuppression occurred in both strains and was more pronounced in the C57BL/6 mice than in the DBA/2N mice, following intraperitoneal administration. However, the DBA/2N mice were more susceptible to immunosuppression following oral administration. These results suggest that PAHs are rapidly metabolized and excreted following oral administration in AHH-inducible mice, whereas in AHH-noninducible mice, the PAHs are absorbed and distributed to target organs. Based on these results, the authors concluded that AHH inducibility plays an important role in the immunosuppressive activity of PAHs.

B-cell lymphopoiesis in mouse bone marrow has been shown to be inhibited by incubation with fluoranthene *in vitro* at concentrations of ≥5 µg/mL (25 µmol). This effect on B-cell precursors may be mediated in part by a stimulation of programmed cell death; as demonstrated by the increase in DNA fragmentation induced by fluoranthene 15-17 hours after addition to the incubation medium. Furthermore, fluoranthene-induced DNA fragmentation always preceded fluoranthene-induced B-cell precursor death. Another mechanism for fluoranthene-induced inhibition of B-cell lymphopoiesis may be alterations in cell growth rates (fluoranthene was shown to slow the rate of B-cell precursor growth at concentrations <5 µg/mL) and/or altered cell survival (Hinoshita et al. 1992).

The lymphoid system, because of its rapidly proliferating tissues, is susceptible to PAH-induced toxicity. The mechanism of action for this effect is most likely inhibition of DNA synthesis. No adverse effects on this system associated with PAH exposure have been reported in humans, but several accounts of lymphoid toxicity in animals are available. A single intraperitoneal injection of benzo[a]pyrene to mice resulted in a small spleen with marked cellular depletion, prominent and edematous trabeculae, and large lymphocytes. These lesions resulted in death (Shubik and Porta 1957). The Shubik and Porta (1957) study was severely limited by the following: the benzo[a]pyrene

was only partly in solution, only one dose was employed, there was a small sample size, the purity of benzo[a]pyrene was not specified, only one sex was tested, and the presence of benzo[a]pyrene in the peritoneal cavity indicates inadequate absorption. No other similar studies were found in the literature.

Even though these effects have not been noted in humans, and the data in animals are contained in only one study, the rapidly proliferating nature of this tissue suggest that humans exposed to PAHs may be a risk for the development of adverse effects on the lymphoid system.

Given the high potential for exposure to PAHs in the vicinity of hazardous waste sites, the evidence from animal studies, and the heterogeneity of human genotypes with regard to enzyme induction capabilities, it would be prudent to consider that PAHs may pose an immunotoxic risk to humans living in areas surrounding hazardous waste sites.

Neurological Effects. No information is available on the short- or long-term neurotoxic effects of exposure to PAHs in humans and animals. Acute-, intermediate-, or chronic-duration studies conducted in animals do not indicate that any of the PAHs tested showed evidence of neurotoxicity, although these tests were not designed to detect subtle neurological changes.

However, there is evidence to suggest that PAHs may alter the levels of brain neurotransmitters. The levels of two catecholamines, dopamine and norepinephrine, were determined in discreet brain areas in mice in which fibrosarcomas had been induced following a single subcutaneous injection of benzo[a]pyrene (Dasgupta and Lahiri 1992). The mice were divided into two groups: early tumor development and late tumor development 3-4 months after administration of the benzo[a]pyrene. Both dopamine and norepinephrine levels were significantly decreased in some brain regions (e.g., the corpus striatum and the hypothalamus), and these decreases were evident in both early and late tumor development. The authors state that because immunological function is compromised during carcinogenesis and because certain alterations in brain catecholamines impair immune function, the mechanism by which carcinogens such as benzo[a]pyrene cause immunosuppression and subsequent carcinogenesis may be via depression of brain catecholamines.

Reproductive Effects. In both prospective and retrospective studies, a decrease in fecundity was observed in women who were exposed prenatally to cigarette smoke (i.e., their mothers smoked when pregnant) (Weinberg et al. 1989; Wilcox et al. 1989). This association was apparent even after

adjustment for age, frequency of intercourse, current smoking status, age at menarche, childhood exposure to cigarette smoking, educational level, reproductive history, body weight, and consumption of alcohol and caffeine. On the other hand, an increase in fecundity was observed in a retrospective study of women who were exposed to cigarette smoke in early childhood. These apparently opposite effects may be partially explained by the fact that when a woman smokes during pregnancy, her fetus is exposed to the components of the cigarette smoke that cross the placenta as well as changes in fetal and placental oxygenation and metabolism that are secondary to changes in maternal metabolism resulting from smoking. However, childhood exposure involves direct inhalation of cigarette smoke. The authors could offer no explanation as to why fecundity should be *increased* as a result of childhood exposure to cigarette smoke (Weinberg et al. 1989; Wilcox et al. 1989).

The testes and ovaries contain rapidly proliferating cells and therefore should be considered susceptible to damage by PAHs. The reproductive toxicity data in animals for the PAHs are limited. The available animal studies exclusively discuss the reproductive effects of benzo[a]pyrene. Adverse effects such as decreased fertility and total sterility in F_1 progeny of CD-1 mice (Mackenzie and Angevine 1981) and decreased incidence of pregnant female rats at parturition (Rigdon and Rennels 1964) were reported following oral exposure to benzo[a]pyrene. However, no adverse reproductive effects were observed in Swiss mice fed benzo[a]pyrene in their diet (Rigdon and Neal 1965). The metabolic differences and method of benzo[a]pyrene administration could account for the differential response to benzo[a]pyrene induced toxicity in these studies. A single intraperitoneal injection of benzo[a]pyrene to female C57BL/6N mice decreased the number of corpora lutea (Swartz and Mattison 1985). The, antiestrogenic effects causing decreased uterine weights in pseudopregnant Sprague-Dawley rats were reported following daily subcutaneous injections of benzo[a]pyrene during days 6-11 of pseudopregnancy (Bui et al. 1986). Similar treatment to pregnant rats during gestation caused resorptions, reduced percentage of viable litters, and decreased uterine weights (Bui et al. 1986; Cervello et al. 1992). Female mice exhibited decreased ovary weights after 13 weeks oral exposure to 700 mg/kg/day acenaphthene (EPA 1989c). The studies conducted on the reproductive effects of benzo[a]pyrene via parenteral routes are briefly discussed below.

Single intraperitoneal injection of benzo[a]pyrene to female C57BL/6N mice at doses as high as 500 mg/kg body weight produced a dose- and time-dependent decrease in the number of corpora lutea (Swartz and Mattison 1985). The NOAEL in this study was 1 mg/kg/day. Groups of 20 C57BL/6N mice were given single intraperitoneal injections of 0-500 mg/kg benzo[a]pyrene (Miller et al. 1992)

and were killed at various intervals after injection. Total ovarian volume, total corpora lutea volume, and total number of corpora lutea per ovary were significantly reduced by doses of benzo[a]pyrene >5 mg/kg in a dose-related manner. These effects resolved in a dose- and time-dependent fashion, so that after 4 weeks, most changes were only evident in the animals treated with the 100 or 500 mg/kg benzo[a]pyrene. Individual corpora lutea volume actually increased in the treated animals, indicating that compensatory hypertrophy was probably occurring. The authors concluded that based on these findings and previous findings, benzo[a]pyrene impairs corpora lutea formation by destroying follicles. In another study, DBA/2N (D2), C57BL/6N (B6), and (DBA/2N x C57BL/6N)F_1 (F_1) mice (7-8/group) were injected with 10 µg of either benzo[a]pyrene or one of three different metabolites of benzo[a]pyrene ([+]7,8-oxide, [-]7,8-dihydrodiol, or [+]-diol-epoxide-2) into the right ovary (Mattison et al. 1989). The left ovary served as a control, and an additional control group injected with the vehicle (DMSO) also served as controls. Ovarian volume, wet weight, and small, growing, and large follicle number were measured in both the treated and contralateral control ovaries. Benzo[a]pyrene and one or more of its'metabolites caused decreases in the treated ovarian weight, the ovarian volume, and the small, growing, and large follicles in one or more strains. In most instances, the contralateral untreated ovary exhibited a compensatory response; ovarian weight and volume increased as compared to the DMSO controls. This study shows that benzo[a]pyrene and some of its metabolites are toxic to the ovaries of mice, and that the ovary is capable of metabolizing benzo[a]pyrene into reactive metabolites. Similarly, administration of benzo[a]pyrene or benzo[e]pyrene into atherosclerosis-susceptible or atherosclerosis-resistant pigeons for 3-5 months of treatment indicated that benzo[a]pyrene, but not benzo[e]pyrene, rendered female pigeons infertile, with ovarian abnormalities (Hough et al. 1993). Cumulatively, these results demonstrate the sensitivity of integrated hypothalamic-pituitary-ovarian function to adverse effects of benzo[a]pyrene.

Daily subcutaneous injection of benzo[a]pyrene beginning on day 6 of gestation for 6 days as opposed to 3 days significantly increased the number of resorptions, and decreased the fetal survival and uterine weights in Sprague-Dawley rats (Bui et al. 1986). In pseudopregnant (i.e., condition occurring following sterile matings in which anatomical and physiological changes occur similar to those of pregnancy) rats, similar benzo[a]pyrene treatment during days 6-l1 of pseudopregnancy significantly decreased the cyclic nucleotide levels and uterine weights suggesting an antiestrogenic effect (Bui et al. 1986). Use of a single dosage level precluded the assessment of dose response in these studies.

Pregnant Sprague-Dawley rats were administered subcutaneous injections of benzo[a]pyrene (in DMSO and corn oil) or the vehicle alone on gestation days 7, 9, 11, 13, and 15 (Cervello et al. 1992). The animals were sacrificed on gestation day 16. There were no maternal deaths or signs of maternal toxicity. However, the number of fetuses per litter and number of live fetuses per litter were significantly decreased in the animals treated with benzo[a]pyrene, and the number of resorptions was significantly increased. In addition, uterine weight, and whole uterine gravid weight were significantly decreased and increased, respectively. These results demonstrate the reproductive toxicity of benzo[a]pyrene, but a dose-response relationship could not be established because only one dose was tested.

These results suggest that the potential for adverse reproductive effects may be increased in humans exposed to benzo[a]pyrene in the workplace or at hazardous waste sites.

Developmental Effects. The developmental toxicity data for PAHs are mostly limited to *in utero* exposure of pregnant animals to benzo[a]pyrene via various routes of exposure. The placental transfer of benzo[a]pyrene has been shown in mice following oral and intravenous exposure of dams (Shendrikova and Aleksandrov 1974) and in rats after intratracheal administration (Srivastava et al. 1986). The available data from oral studies in animals indicate that exposure of pregnant dams to benzo[a]pyrene produced resorptions and malformations in fetuses (Legraverend et al. 1984) and sterility in F_1 mouse progeny (Mackenzie and Angevine 1981). Investigations by Legraverend et al. (1984) suggest that benzo[a]pyrene metabolites generated in the fetus rather than in the maternal tissues are responsible for these adverse effects. Also, the genetic differences observed in this study using the oral route were contrary to those induced by intraperitoneal administration of benzo[a]pyrene (Hoshino et al. 1981; Shum et al. 1979), thus emphasizing the importance of route of administration in benzo[a]pyrene metabolism and resulting toxicity.

The developmental effects of benzo[a]pyrene have also been investigated in animals using the parenteral route of administration. Intraperitoneal injection of benzo[a]pyrene to pregnant mice produced stillbirths, resorptions and malformations at a greater incidence in Ah-responsive mice than in Ah-nonresponsive mice (Shum et al. 1979); testicular changes including atrophy of seminiferous tubules with lack of spermatids and spermatozoa; interstitial cell tumors (Payne 1958); immunosuppression (Urso and Gengozian 1980); and tumor induction (Bulay and Wattenberg 1971; Soyka 1980). Adverse effects observed following subcutaneous injection of benzo[a]pyrene include

increased fetal resorptio'ns in rats (Wolfe and Bryan 1939) and lung tumor induction in mice (Nikonova 1977). Decreased fetal survival (Wolfe and Bryan 1939) and lung tumor development (Rossi et al. 1983) were reported in Swiss mice following direct intra-embryonal injection of benzo[a]pyrene.

Results of *in vitro* studies suggest that benzo[a]pyrene may affect a number of enzyme and hormone activities in the human placenta. The effects of benzo[a]pyrene on the binding of epidermal growth factor (EGF) and receptor autophosphorylation were studied in human placental cell cultures from early and late gestation placentas (Guyda et al. 1990). In a subsequent study, the effects of benzo[a]pyrene on the uptake of aminoisobutyric acid (AIB) by early and late gestational human placental cells was also studied (Guyda 1991). Benzo[a]pyrene decreased binding of EGF (37-60%) to the early gestation placental cells, but not the late gestation placental cells. The decrease in binding was due to a decrease in the number of high-affinity EGF binding sites. This effect was specific for EGF receptor sites and not due to a nonspecific effect of benzo[a]pyrene on the membranes because benzo[a]pyrene had no effect on the binding of ^{125}I-labeled insulin and insulin-like growth factors. The authors concluded that the effects of benzo[a]pyrene on EGF binding were specific and related to gestational age. Benzo[a]pyrene stimulated AIB uptake by both early and late gestational cells and enhanced EGF-stimulated AIB uptake in spite of a decrease in the number of EGF receptors. The implications of these finding are that benzo[a]pyrene could alter EGF-induced secretion of human chorionic gonadotrophin and human placental lactogen secretion as well as metabolic functions, thereby affecting the regulation of cell growth and differentiation in human placentas.

The activity of quinone reductase, a major protective enzyme, was increased 2-3-fold in first trimester human placental extracts *in vitro* when incubated for 6 hours with benz[a]anthracene, dibenz[a,h]anthracene, and chrysene at a concentration of 50 µmol (Avigdor et al. 1992). Based on these results, it can be postulated that the early placenta is capable of metabolizing certain toxic xenobiotics such as PAH quinone metabolites to inactive intermediates thereby protecting the developing embryo.

Benzo[a]pyrene (50 µmol) has been shown to stimulate human gonadotropin release by first trimester human placental explants *in vitro* (Bamea and Shurtz-Swirski 1992). This stimulation was evident following static exposure for 24 hours and also in cultures that were superfused, meaning the benzo[a]pyrene had a delayed effect and did not need to be present for this effect to be expressed.

The implication of these findings is that benzo[a]pyrene can alter human placental endocrine function early in pregnancy.

Results of animal and *in vitro* studies suggest that benzo[a]pyrene may produce adverse effects in the offspring of women exposed during pregnancy. Furthermore, the results of genetic studies conducted via oral and intraperitoneal routes emphasize the importance of route of administration in benzo[a]pyrene metabolism and resulting toxicity and the severity of the effect may vary depending upon the genotype of the individual exposed (see Section 2.7, Populations That Are Unusually Susceptible). Based on these observations, it is therefore prudent to consider that the genetically heterogeneous human population may show variation in response to *in utero* exposure to benzo[a]pyrene.

Other PAHs such as anthracene, benzanthracene, chrysene, and dibenz[a,h]anthracene have also been tested for developmental effects via parenteral routes. Of these compounds, dibenz[a,h]anthracene produced fetolethal effects in rats (Wolfe and Bryan 1939), while chrysene produced liver tumors in the mouse progeny (Buening et al. 1979a; Grover et al. 1975)

Genotoxic Effects. As the results presented in Tables 2-4 and 2-5 indicate, benzo[a]pyrene has been thoroughly studied in genetic toxicology test systems. It induces genetic damage in prokaryotes, eukaryotes, and mammalian cells *in vitro* and produces a wide range of genotoxic effects (gene mutations in somatic cells, chromosome damage in germinal and somatic cells, DNA adduct formation, UDS, sister chromatid exchange, and neoplastic cell transformation). In cultured human cells, benzo[a]pyrene binds to DNA and causes gene mutations, chromosome aberrations, sister chromatid exchange, and UDS.

The results of *in vivo* studies indicate that many of the same types of adverse effects observed *in vitro* were seen in mice, rats, and hamsters exposed to benzo[a]pyrene via the oral, dermal, or intraperitoneal routes. The available data also indicate that benzo[a]pyrene is genotoxic in both somatic and germinal cells of intact animals (Table 2-4). The only study that was found regarding genotoxic effects in humans following exposure to benzo[a]pyrene reported no correlation between aluminum plant workers' exposure to PAHs, including benzo[a]pyrene, and sister chromatid exchange frequency (Becher et al. 1984). The findings from assays using human cells as the target, in

TABLE 2-4. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo*

Species (test system)	End point		Results	Reference
	ANTHRACENE			
Mammalian systems:				
Chinese hamster/bone marrow	Chromosome aberrations	–		Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Sister chromatid exchange		–	Roszinsky-Kocher et al. 1979
Mouse/bone marrow	Micronuclei		–	Salamone et al. 1981
Mouse	Sperm abnormalities	–		Topham 1980
Host-mediated systems:				
Salmonella typhimurium/mouse host-mediated	Gene mutation		(+)[a]	Simmon et al. 1979
Saccharomyces cerevisiae/mouse host-mediated	Gene mutation	–		Simmon et al. 1979
Chinese hamster V79 cells/mouse host-mediated	Sister chromatid exchange	–		Sirianni and Huang 1978
	BENZ(*a*)ANTHRACENE			
Mammalian systems:				
Chinese hamster/bone marrow	Chromosome aberrations	–		Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Sister chromatid exchange		+	Roszinsky-Kocher et al. 1979
Insect systems:				
Drosophila melanogaster/sex-linked recessives	Gene mutation		–	Zijlstra and Vogel 1984
D. melanogaster/somatic mutation	Gene mutation	–		Fahmy and Fahmy 1980
Host-mediated systems:				
S. typhimurium/mouse host-mediated	Gene mutation		+	Simmon et al. 1979
S. cerevisiae/mouse host-mediated	Gene mutation	–		Simmon et al. 1979
	BENZO(*b*)FLUORANTHENE			
Mammalian systems:				
Chinese hamster/bone marrow	Chromosome aberrations	–		Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Sister chromatid exchange		–	Roszinsky-Kocher et al. 1979
Mouse skin	DNA binding		+	Weyand et al. 1987, 1992a

TABLE 2-4. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo* (continued)

Species (test system)	End point	Results	Reference
Rat/lung, liver, peripheral blood lymphocytes	DNA binding	+	Ross et al. 1992
Rat peripheral blood lymphocytes	Sister chromatid exchange	+	Ross et al. 1992
New born mice/lung, liver	DNA binding	+	Weyand et al. 1993b
	BENZO(*j*)FLUORANTHENE		
Mammalian systems:			
Mouse skin	DNA binding	+	La Voie et al. 1991a; Weyand et al. 1987, 1993a
	BENZO(*k*)FLUORANTHENE		
Mammalian systems:			
Mouse skin	DNA binding	+	Weyand et al. 1987
	BENZO(*g,h,i*)PERYLENE		
Host-mediated systems:			
Hamster embryos/transplacental exposure	Transformation	–	Quarles et al. 1979
	BENZO(*a*)PYRENE		
Mammalian systems:			
Mouse/dominant lethals	Gene mutation	+	Epstein 1968; Generoso et al. 1982; Russell 1977
Mouse/spot test	Gene mutation	+	Davidson and Dawson 1976, 1977
Rat hepatocytes/unscheduled DNA synthesis	DNA damage	–	Miralis et al. 1982
Rat hepatocytes/unscheduled DNA synthesis	DNA damage	–	Mullaart et al. 1989
Mouse germ cells/unscheduled DNA synthesis	DNA damage	–	Sega 1979
Mouse skin/lung	DNA binding	+	Mukhtar et al. 1986
Mouse skin	DNA binding	+	Morse et al. 1985; Rice et al. 1984; Weyand and Bevan 1987a

TABLE 2-4. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo* (continued)

Species (test system)	End point	Results	Reference
Mouse/bone marrow	DNA binding	+	Wielgosz et al. 1991
Mouse/spleen cells	DNA binding	+	Wielgosz et al.1991
Rat liver parenchymal cells	DNA single strand breaks	+	Mullaart et al. 1989
Rat liver nonparenchymal cells	DNA single strand breaks	–	Mullaart et al. 1989
Rat intestinal cells	DNA single strand breaks	+	Mullaart et al. 1989
Mouse/bone marrow	Chromosome aberrations	+	Adler and Ingwersen 1989
Mouse/bone marrow	Chromosome aberrations	+	Adler et al. 1989
Mouse/embryos	Chromosome aberrations	+	Adler et al. 1989
Chinese hamster/bone marrow	Chromosome aberrations	+	Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Chromosome aberrations	(+)	Bayer 1978
Mouse/heritable translocation	Chromosome aberrations	–	Generoso et al. 1982
Mouse/bone marrow	Chromosome aberrations	+	Wielgosz et al. 1991
Mouse/spleen cells	Chromosome aberrations	+	Wielgosz et al. 1991
Chinese hamster/bone marrow	Sister chromatid exchange	+	Bayer 1978; Roszinsky-Kocher et al. 1979
Mouse/bone marrow	Micronuclei	+	Salamone et al. 1981
Mouse/bone marrow	Micronuclei	–	Bruce and Heddle 1979
Mouse/fetal liver	Micronuclei	+	Harper et al. 1989
Mouse/bone marrow	Micronuclei	+	Harper et al. 1989
Mouse/bone marrow	Micronuclei	+	Awogi and Sato 1989
Mouse/keratinocytes	Micronuclei	+	He and Baker 1991
Mouse/bone marrow	Micronuclei	+	Shimada et al. 1990

TABLE 2-4. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo* (continued)

Species (test system)	End point	Results	Reference
Mouse/peripheral blood reticulocytes	Micronuclei	+	Shimada et al. 1992
Rat/peripheral blood reticulocytes	Micronuclei	+	Shimada et al. 1992
Chinese hamster/bone marrow	Micronuclei	–	Bayer 1978
Mouse	Sperm abnormalities	+	Bruce and Heddle 1979; Topham 1980
Mouse	Sperm abnormalities	(+)	Salamone et al. 1988
Mouse	Sperm abnormalities	+	Salamone and Logan 1988
Mouse/bone marrow	Micronuclei	+	Balansky et al. 1994
Mouse/bone marrow	Micronuclei	+	Koratkar et al. 1993
Mouse papilloma cells	Gene mutation	+	Colapietro et al. 1993
Human lung	DNA damage	+	Weston et al. 1993a
Mouse papilloma cells	Gene mutation	+	DiGiovanni et al. 1993
Insect systems:			
D. melanogaster/sex-linked recessive	Gene mutation	(+)	Vogel et al. 1983
D. melanogaster/sex-linked recessive	Gene mutation	–	Valencia and Houtchens 1981; Zijlstra and Vogel 1984
D. melanogaster/somatic mutation	Gene mutation	+	Fahmy and Fahmy 1980
D. melanogaster	Chromosome aberration	(+)	Vogel et al. 1983
Host-mediated systems:			
S. typhimurium/mouse host-mediated	Gene mutation	–	Glatt et al. 1985; Simmon et al. 1979
S. cerevisiae/mouse host-mediated	Gene mutation	–	Simmon et al. 1979
Chinese hamster V79/mouse host-mediated	Sister chromatid exchange	+	Sirianni and Huang 1978
Hamster embryos/transplacental exposure	Transformation	+	Quarles et al. 1979

TABLE 2-4. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo* (continued)

Species (test system)	End point	Results	Reference
	BENZO(*e*)PYRENE		
Mammalian systems:			
Chinese hamster/bone marrow	Sister chromatid exchange	(+)	Roszinsky-Kocher et al. 1979
	CHRYSENE		
Mammalian systems:			
Chinese hamster/bone marrow	Chromosome aberrations	–	Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Sister chromatid exchange	+	Roszinsky-Kocher et al. 1979
Host-mediated systems:			
S. typhimurium/mouse host-mediated	Gene mutation	–	Simmon et al. 1979
S. cerevisiae/mouse host-mediated	Gene mutation	–	Simmon et al. 1979
	DIBENZ(*a,h*)ANTHRACENE		
Mammalian systems:			
Chinese hamster/bone marrow	Chromosome aberrations	–	Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Sister chromatid exchange	+	Roszinsky-Kocher et al. 1979
	FLUORANTHENE		
Mammalian systems:			
Mouse/bone marrow	Sister chromatid exchange	–	Palitti et al. 1986
	INDENO(1,2,3-*c,d*)PYRENE		
Mammalian systems:			
Mouse skin	DNA binding	+	Weyand et al. 1987
	PHENANTHRENE		
Mammalian systems:			
Chinese hamster/bone marrow	Chromosome aberrations	–	Bayer 1978; Roszinsky-Kocher et al. 1979

TABLE 2-4. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vivo* (continued)

Species (test system)	End point	Results	Reference
Chinese hamster/bone marrow	Sister chromatid exchange	(+)	Bayer 1978; Roszinsky-Kocher et al. 1979
Chinese hamster/bone marrow	Micronuclei	–	Bayer 1978
Host-mediated systems: *S. typhimurium*/mouse host-mediated	Gene mutation	–	Simmon et al. 1979
S. cerevisiae/mouse host-mediated	Gene mutation	–	Simmon et al. 1979
Hamster embryos/transplacental exposure	Transformation	–	Quarles et al. 1979
	PYRENE		
Mammalian systems: Mouse/bone marrow	Micronuclei	–	Salamone et al. 1981
Mouse	Sperm abnormalities	–	Salamone et al. 1988
Mouse	Sperm abnormalities	–	Salamone and Logan 1988
Insect systems: *D. melanogaster*/sex-linked recessive	Gene mutation	–	Valencia and Houtchens 1981
Host-mediated systems Chinese hamster V79/mouse host-mediated	Sister chromatid exchange	–	Sirianni and Huang 1978

[a]A positive result was obtained in one experiment; this result was not reproduced in the same laboratory or in a second laboratory.

DNA = deoxyribonucleic acid; – = negative result; + = positive result; (+) = weakly positive result

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
		ACENAPHTHENE		
Prokaryotic organisms:				
Salmonella typhimurium	Gene mutation	–	No data	Pahlman and Pelkonen 1987
Escherichia coli SOS chromotest	Gene mutation	–	No data	Mersch-Sundermann et al. 1992b
		ACENAPHTHYLENE		
Prokaryotic organisms:				
S. typhimurium	Gene mutation	–	No data	Bos et al. 1988
		ANTHRACENE		
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Sakai et al. 1985
S. typhimurium	Gene mutation	+	No data	Carver et al. 1986
S. typhimurium	Gene mutation	–	–	LaVoie et al. 1983b; 1985; Rosenkranz and Poirier 1979; Simmon 1979a
S. typhimurium	Gene mutation	–	No data	Bos et al. 1988; LaVoie et al. 1979; Pahlman and Pelkonen 1987
Escherichia coli/Pol A	DNA damage	–	–	Rosenkranz and Poirier 1979
E. coli WP2-WP100/rec-assay	DNA damage	–	No data	Mamber et al. 1983
E. coli/differential killing	DNA damage	–	–	Tweats 1981
E. coli SOS chromotest	DNA damage	–	No data	Mersch-Sundermann et al. 1992b
E. coli SOS chromotest	DNA damage	–	–	Mersch-Sundermann et al. 1992a
Eukaryotic organisms:				
Fungi: *Saccharomyces cerevisiae D3*	Miotic recombination	–	–	Simmon 1979b
S. cerevisiae D4-RDII	Gene conversion	No data	–	Siebert et al. 1981

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Mammalian cells:				
Fischer rat embryo cells	Gene mutation	No data	–	Mishra et al. 1978
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	(+)	No data	Amacher and Turner 1980
Mouse lymphoma L5178/TK$^{+/-}$	Gene mutation	–	No data	Amacher et al. 1980
Human lymphoblasts TK6	Gene mutation	–	No data	Barfknecht et al. 1982
Human epithelial cells EUE	Gene mutation	No data	–	Rochhi et al. 1980
HeLa cells/unscheduled DNA synthesis	DNA damage	–	–	Martin et al. 1978
Human skin fibroblasts	DNA damage	No data	–	Milo et al. 1978
Rat liver cells RL1	Chromosome aberrations	No data	–	Dean 1981
Rat liver cells ARL18	Sister chromatid exchange	No data	–	Tong et al. 1981
Hamster BHK21 clone 13	Transformation	–	No data	Greb et al. 1980
Syrian hamster embryo cells	Transformation	No data	–	Dunkel et al. 1981
Mouse C3H/10T1/2 clone 8	Transformation	No data	–	Dunkel et al. 1981
Mouse Balb/3T3 cells	Transformation	No data	–	Lubet et al. 1983b; Peterson et al. 1981
Fischer rat embryo cells	Transformation	No data	–	Mishra et al. 1978
Fischer rat embryo cells/leukemia virus transformation	Transformation	No data	–	Dunkel et al. 1981
	BENZ[a]ANTHRACENE			
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Norpoth et al. 1984; Simmon 1979a

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
S. typhimurium	Gene mutation	+	No data	Bos et al. 1988; Carver et al. 1986; Coombs et al. 1976; Hermann 1981; Pahlman and Pelkonen 1987
S. typhimurium	Gene mutation	+[a]	No data	Phillipson and Ioannides 1989
S. typhimurium	Gene mutation	–[b]	No data	Phillipson and Ioannides 1989
S. typhimurium	Gene mutation	–	–	Rosenkranz and Poirier 1979
E. coli/Pol A	DNA damage	–	–	Rosenkranz and Poirier 1979
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann 1992a
Eukaryotic organisms: Fungi: *S. cerevisiae* D3	Mitotic recombination	–	–	Simon 1979b
Mammalian cells:				
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	+	No data	Amacher et al. 1980
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	+	–	Amacher and Turner 1980; Amacher and Paillet 1982
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	–	–	Amacher and Paillet 1983
Chinese hamster V79	Gene mutation	–	–	Huberman 1975
Chinese hamster V79	Gene mutation	–	No data	Huberman 1975
Human lymphoblasts TK6	Gene mutation	+	No data	Barfknecht et al. 1982
Human epithelial cells EUE	Gene mutation	No data	–	Rochhi et al. 1980
Human keratinocytes	Gene mutation	No data	–	Allen-Hoffmann and Rheinwald 1984
HeLa cells/unshceduled DNA synthesis	DNA damage	+	No data	Martin et al. 1978

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Rat liver cells ARL18	Sister chromatid exchange	No data	(+)	Tong et al. 1981
Hamster BHK21 clone 13	Transformation	+	No data	Greb et al. 1980
Hamster embryo cells	Transformation	No data	(+)	DiPaolo et al. 1969, 1971
Hamster embryo cells	Transformation	–	No data	Grover et al. 1971
Syrian hamster embryo cells	Transformation	No data	+	Dunkel et al. 1981
Syrian hamster lung cells FSHL	Transformation	No data	+	Emura et al. 1980
Mouse ventral prostate C3H clone G23	Transformation	No data	–	Grover et al. 1971; Marquardt et al. 1972
Mouse Balb/3T3 cells	Transformation	No data	(+)	Dunkel et al. 1981
Fischer rat embryo cells/leukemia virus transformation	Transformation	No data	+	Dunkel et al. 1981
	BENZO[b]FLUORANTHENE			
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	No data	Amin et al. 1984; Hermann 1981; LaVoie et al. 1979
S. typhimurium	Gene mutation	–	No data	Mossanda et al. 1979
S. typhimurium/fluctuation test	Gene mutation	–	No data	Mossanda et al. 1979
E. coli PQ37 SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992b
Mammalian cells:				
Chinese hamster V79	Gene mutation	–	–	Huberman 1975
Hamster BHK21 clone 13	Transformation	+	No data	Greb et al. 1980
Syrian hamster lung cells FSHL	Transformation	No data	+	Emura et al. 1980

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
BENZO[j]FLUORANTHENE				
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	No data	LaVoie et al. 1979
S. typhimurium/fluctuation test	DNA binding	+	No data	Marshall et al. 1992; Weyand et al. 1992
S. typhimurium/fluctuation test	Gene mutation	+	+	Marshall et al. 1993
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b
BENZO[k]FLUORANTHENE				
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	No data	Amin et al. 1985b; LaVoie et al. 1979; LaVoie et al. 1980; Weyand et al. 1988
Mammalian cells:				
Syrian hamster lung cells FSHL	Transformation	No data	–	Emura et al. 1980
BENZO[g,h,i]PERYLENE				
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Andrews et al. 1978; Sakai et al. 1985
S. typhimurium	Gene mutation	+	No data	Carver et al. 1986; LaVoie et al. 1979; Mossanda et al. 1979
S. typhimurium/fluctuation test	Gene mutation	(+)	No data	Mossanda et al. 1979
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b
BENZO[a]PYRENE				

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Glatt et al. 1987; Grolier et al. 1989; Prasanna et al. 1987; Rosenkranz and Poirier 1979; Sakai et al. 1985; Simmon 1979a
S. typhimurium	Gene mutation	+	No data	Alfheim and Randahl 1984; Alzieu et al. 1987; Ampy et al. 1988; Andrews et al. 1989; Antignac et al. 1990; Bos et al. 1988; Bruce and Heddle 1979; Carver et al. 1986; Hermann 1981; LaVoie et al. 1979; Lee and Lin 1988; Marino 1987; Norpoth et al. 1984; Pahlman and Pelkonen 1987
S. typhimurium	Gene mutation	+	No data	Phillipson and Ioannides 1989a
S. typhimurium	Gene mutation	–	No data	Gao et al. 1991
S. typhimurium	Gene mutation	–	No data	Phillipson and Ioannides 1989b
S. typhimurium TM677	Gene mutation	+	–	Rastetter et al. 1982
S. typhimurium TM677	Gene mutation	+	No data	Babson et al. 1986
S. typhimurium	Gene mutation	+	No data	Balansky et al. 1994
E. coli WP2-WP100/rec-assay	DNA damage	+	No data	Mamber et al. 1983
E. coli/PoLA		+	–	Rosenkranz and Poirier 1979
E. coli/differential killing	DNA damage	+	–	Tweats 1981
E. coli/SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992b
Eukaryotic organisms:				
Fungi: *S. cerevisiae* D3	Mitotic recombination	–	–	Simmon 1979b
S. cerevisiae D4-RDII	Mitotic recombination	No data	–	Siebert et al. 1981

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Animal systems:				
Chinese hamster V79	Gene mutation	+	No data	Arce et al. 1987; Diamond et al. 1980; Huberman 1975
Chinese hamster V79	Gene mutation	+	–	Huberman 1975
Chinese hamster CHO	Gene mutation	+	(+)	Gupta and Singh 1982
Fischer rat embryo cells/OUA®	Gene mutation	No data	+	Mishra et al. 1978
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	+	–	Amacher and Paillet 1983; Clive et al. 1979
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	+	No data	Amacher et al. 1980; Amacher and Turner 1980; Arce et al. 1987
Mouse lymphoma L5178Y/HGPRT	Gene mutation	(+)	No data	Clive et al. 1979
Human lymphoblasts AHH	Gene mutation	No data	+	Crespi et al. 1985
Human lymphoblasts TK6	Gene mutation	(+)	No data	Crespi et al. 1985
Human lymphoblasts	Gene mutation	+	No data	Danheiser 1989
Human epithelial cells EUE	Gene mutation	No data	+	Barfknecht et al. 1982; Rocchi et al. 1980
Human fibroblasts HSC172	Gene mutation	+	–	Gupta and Goldstein 1981
Human keratinocytes	Gene mutation	No data	+	Allen-Hoffmann and Rheinwald 1984
Rat hepatocytes/DNA repair	DNA damage	No data	+	Williams et al. 1982
Rat tracheal epithelial cells	DNA damage	No data	+	Cosma and Marchock 1988; Cosma et al. 1988
Mouse C3H/10T1/2 clone 8	DNA damage	No data	(+)	Lubet et al. 1983b
HeLa cells/unscheduled DNA synthesis	DNA damage	+	NR	Martin et al. 1978
Human skin fibroblasts	DNA damage	No data	+	Milo et al. 1978
Human mammary cells	DNA damage	No data	+	Leadon et al. 1988

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Human fibroblasts/unscheduled DNA synthesis	DNA damage	+	No data	Agrelo and Amos 1981
Human fibroblasts WI-38/unscheduled DNA synthesis	DNA damage	+	–	Robinson and Mitchell 1981
Human lymphocyte	DNA damage	No data	+	Wienke et al. 1990
Calf thymus DNA	DNA binding	+	No data	Cavalieri et al. 1988a
Chick embryo fibroblasts	DNA binding	No data	+	Liotti et al. 1988
Chick embryo hepatocytes	DNA binding	No data	+	Liotti et al. 1988
Chinese hamster V79	DNA binding	No data	No data	Arce et al. 1987
Mouse lymphoma L5178Y/TK$^{+/-}$	DNA binding	+	No data	Arce et al. 1987
Mouse C3H/10T1/2	DNA binding	+	No data	Arce et al. 1987
Syrian hamster embryo SHE	DNA binding	No data	+	Arce et al. 1987
Rat bladder epithelial cells	DNA binding	No data	+	Moore et al. 1982
Rat mammary epithelial cells	DNA binding	No data	+	Moore et al. 1987
Human liver HepG2 cells	DNA binding	No data	+	Diamond et al. 1980
Human mammary cells	DNA binding	No data	+	Leadon et al. 1988; Moore et al. 1987
Human bladder cells	DNA binding	No data	+	Moore et al. 1982
Human endometrial cells	DNA binding	No data	+	Dorman et al. 1981
Human bronchus cells	DNA binding	No data	+	Harris et al. 1984
Human colon cells	DNA binding	No data	+	Harris et al. 1984
Human lymphocytes	DNA binding	No data	+	Pavanello and Levis 1992

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Chinese hamster V79-4	Chromosome aberrations	–	–	Popescu et al. 1977
Chinese hamster CHL	Chromosome aberrations	+	–	Matsuoka et al. 1979
Mouse lymphoma L5178Y/TK$^{+/-}$	Chromosome aberrations	+	No data	Arce et al. 1987
Rat liver cells RL1	Chromosome aberrations	No data	+	Dean 1981
Human fibroblasts WI-38	Chromosome aberrations	+	–	Weinstein et al. 1977
Chinese hamster V79	Sister chromatid exchange	+	No data	Arce et al. 1987; Mane et al. 1990
Chinese hamster V79	Sister chromatid exchange	+	–	Popescu et al. 1977; Wojciechowski et al. 1981
Chinese hamster bone marrow	Sister chromatid exchange	No data	+	Roszinsky-Kocher et al. 1979
Chinese hamster Don-6	Sister chromatid exchange	No data	+	Abe et al. 1983b
Chinese hamster CHO	Sister chromatid exchange	+	–	Husgafvel-Pursiainen et al. 1986
Rat pleural mesothelial cells	Sister chromatid exchange	No data	+	Achard et al. 1987
Rat liver cells ARL18	Sister chromatid exchange	No data	+	Tong et al. 1981
Rat hepatoma Reuber H4-II-E	Sister chromatid exchange	No data	+	Dean et al. 1983a
Rat esophageal tumor R1	Sister chromatid exchange	No data	+	Abe et al. 1983b
Rat ascites hepatoma AH66-B	Sister chromatid exchange	No data	+	Abe et al. 1983b
Human fibroblasts TIG-II	Sister chromatid exchange	+	(+)	Huh et al. 1982
Human hepatoma C-HC-4	Sister chromatid exchange	No data	+	Abe et al. 1983a, 1983b
Human hepatoma C-HC-20	Sister chromatid exchange	No data	+	Abe et al. 1983a, 1983b
Human lymphocyte	Sister chromatid exchange	+	–	Lo Jacono et al. 1992
Human lymphocyte	Sister chromatid exchange	No data	+	Wienke et al. 1990

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Golden hamster embryo cells	Transformation	+	No data	Mager et al. 1977
Hamster BHK21 clone 13	Transformation	+	–	Greb et al. 1980
Hamster embryo cells/SA7 virus transformation	Transformation	No data	+	Casto et al. 1977
Syrian hamster embryo cells	Transformation	No data	+	DiPaolo et al. 1969, 1971; Dunkel et al. 1981
Syrian hamster embryo cells/focus assay	Transformation	No data	+	Casto et al. 1977
Syrian hamster lung FSHL	Transformation	No data	+	Emura et al. 1980, 1987
Syrian hamster SHE/SA7 virus transformation	Transformation	No data	+	Arce et al. 1987
Mouse C3H/10T1/2	Transformation	No data	+	Arce et al. 1987; Lubet et al. 1983b; Peterson et al. 1981
Mouse Balb/3T3	Transformation	No data	+	Dunkel et al. 1981
Mouse Balb/3T3 clone A31-1-1	Transformation	No data	+	Little and Vetroys 1988
Fischer rat embryo cells	Transformation	No data	+	Mishra et al. 1978
Rat embryo cells/SA7 virus transformation	Transformation	No data	+	DiPaolo and Casto 1976
Fischer rat embryo cells/leukemia virus transformation	Transformation	No data	+	Dunkel et al. 1981
Human breast cancer cells	Gene expression	+	No data	Moore et al. 1994
Human breast epithelial cells	Transformation	No data	+	Calaf et al. 1993
Rat heptocyte	Sister chromatid exchange	+	No data	Kulka et al. 1993
Chinese hamster cells	Sister chromatid exchange	No data	+	Kulka et al. 1993

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Mouse Balb/c-3T3 cells	Transformation	No data	+	Matthews 1994
Hamster tracheal cells	DNA damage	No data	+	Roggeband et al. 1994
Rat tracheal cells	DNA damage	No data	+	Roggeband et all. 1994
	BENZO[e]PYRENE			
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	No data	Andrews et al. 1978
S. typhimurium	Gene mutation	(+)	No data	Wood et al. 1979b
S. typhimurium	Gene mutation	+[c]	No data	Wood et al. 1979b
S. typhimurium	Gene mutation	+	No data	LaVoie et al. 1979b
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b
E. coli SOS chromotest	DNA damage	(+)	–	Mersch-Sundermann et al. 1992a
Mammalian cells:				
Chinese hamster V79 ovary cells	Sister chromatid exchange	–	No data	Mane et al. 1990
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Sakai et al. 1985
S. typhimurium	Gene mutation	+	No data	Bos et al. 1988; Carver et al. 1986; Hermann 1981; LaVoie et al. 1979; Pahlman and Pelkonen 1987
S. typhimurium	Gene mutation	(+)	No data	Wood et al. 1977
S. typhimurium	Gene mutation	–	–	Rosenkranz and Poirier 1979; Simmon 1979a
E. coli/PolA	DNA damage	–	–	Rosenkranz and Poirier 1979
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Eukaryotic organisms:				
Fungi:				
S. cerevisiae D3	Mitotic recombination	–	–	Simmon 1979b
S. cerevisiae D4-RDII	Mitotic recombination	No data	–	Siebert et al. 1981
Mammalian cells:				
Chinese hamster V79	Gene mutation	–	No data	Huberman 1975
Human lymphoblasts TK6	Gene mutation	+	No data	Barfknecht et al. 1982
Human ephithelial cells EUE	Gene mutation	No data	–	Rocchi et al. 1980
Hamster BHK21 clone 13	Tranformation	+	No data	Greb et al. 1980
Mouse ventral prostrate C3H clone G23	Transformation	No data	–	Marquardt et al. 1972
	DIBENZ[a,h]ANTHRACENE			
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	No data	Andrews et al. 1978; Carver et al. 1986; Hermann 1981; Lecoq et al. 1991b; Pahlman and Pelkonen 1987; Wood et al. 1978
S. typhimurium	Gene mutation	–[a,b]	No data	Phillipson and Ioannides 1989
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b
Eukaryotic organisms:				
Fungi:				
Neurospora crassa	Gene mutation	No data	+	Barrat and Tatam 1958
S. cerevisiae D4-RDII	Mitotic recombination	No data	–	Siebert et al. 1981
Mammalian cells:				
Chinese hamster V79	Gene mutation	(+)	No data	Huberman 1975
Human epithelial cells EUE	Gene mutation	No data	(+)	Rocchi et al. 1980

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
HeLa cells/unscheduled DNA synthesis	DNA damage	+	NR	Martin et al. 1978
Human bronchus cells	DNA binding	No data	+	Harris et al. 1984
Hamster embryo cells	Transformation	–	No data	Grover et al. 1971
Hamster embryo cells/SA7 virus transformation	Transformation	No data	+	Casto 1973; Casto et al. 1977
Syrian hamster embryo cells	Transformation	No data	+	DiPaolo et al. 1969
Syrian hamster embryo cells/focus assay	Transformation	No data	+	Casto et al. 1977
Hamster BHK21 clone 13	Transformation	+	–	Greb et al. 1980
Mouse ventral prostate C3H clone G23	Transformation	No data	–	Marquardt et al. 1972
Mouse C3H/10T$^{1/2}$ clone 8	Transformation	No data	(+)	Lubet et al. 1983b
Rat embryo cells/SA7 virus transformation	Transformation	No data	+	DiPaolo and Casto 1976
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	No data	Bos et al. 1988; Carver et al. 1986; Hermann 1981; LaVoie et al. 1979
S. typhimurium	Gene mutation	(+)	No data	Bos et al. 1987
S. typhimurium	Gene mutation	–	No data	Mossanda et al. 1979
S. typhimurium/fluctuation test	Gene mutation	+	No data	Mossanda et al. 1979
S. typhimurium/fluctuation test	Gene mutation	+	–	Bhatia et al. 1987
S. typhimurium/taped plate assay	Gene mutation	+	–	Bos et al. 1987
S. typhimurium TM 677	Gene mutation	+	–	Rastetter et al. 1982

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
S. typhimurium TM 677	Gene mutation	+	No data	Babson et al. 1986
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b
Mammalian cells:				
Human lymphoblasts AHH1	Gene mutation	No data	–	Crespi et al. 1985
Human lymphoblasts TK6	Gene mutation	+	No data	Barfknecht et al. 1982
Chinese hamster CHO-1	Sister chromatid exchange	+	–	Palitti et al. 1986
Prokaryotic organisms:				
S. typhimurium	Gene mutation	–	–	Sakai et al. 1985
S. typhimurium	Gene mutation	–	No data	Bos et al. 1988; Hermann 1981; LaVoie et al. 1979; Pahlman and Pelkonen 1987
E. coli WP2-WP100/rec-assay	DNA damage	–	No data	Mamber et al. 1983
E. coli SOS chromotest	DNA damage	–	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	–	No data	Mersch-Sundermann et al. 1992b
Mammalian cells:				
Chinese hamster lung cell	Chromosome abberrations	+	–	Matsuoka et al. 1991
IDENO[1,2,3-c,d]PYRENE				
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Rice et al. 1985b
S. typhimurium	Gene mutation	+	No data	LaVoie et al. 1979
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Mammalian cells:				
Syrian hamster lung cells FSHL	Transformation	No data	+	Emura et al. 1980
		PHENANTHRENE		
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Sakai et al. 1985
S. typhimurium	Gene mutation	+	No data	Carver et al. 1986; Oesch et al. 1981
S. typhimurium	Gene mutation	(+)	No data	Bos et al. 1988
S. typhimurium	Gene mutation	–	–	LaVoie et al. 1981b; Rosenkranz and Poirier 1979; Simmon 1979a
S. typhimurium	Gene mutation	–	No data	Hermann 1981; LaVoie et al. 1979; Pahlman and Pelkonen 1987
E. coli/PolA	DNA damage	–	–	Rosenkranz and Poirier 1979
E. coli SOS chromotest	DNA damage	+	–	Mersch-Sundermann et al. 1992a
E. coli SOS chromotest	DNA damage	+	No data	Mersch-Sundermann et al. 1992b
Eukaryotic organisms:				
Fungi: *S. cerevisiae* D3	Mitotic recombination	–	–	Simmon 1979b
S. cerevisiae D4-RDII	Mitotic recombination	No data	–	Siebert et al. 1981
Mammalian cells:				
Fischer rat embryo cells	Gene mutation	No data	–	Mishra et al. 1978
Chinese hamster V79	Gene mutation	–	No data	Huberman 1975
Human lymphoblasts TK6	Gene mutation	(+)	No data	Barfknecht et al. 1982
Human skin fibroblasts	DNA damage	No data	–	Milo et al. 1978
Chinese hamster V79-4	Chromosome aberrations	–	–	Popescu et al. 1977

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Chinese hamster Don	Chromosome aberrations	No data	–	Abe and Sasaki 1977
Chinese hamster CHL	Chromosome aberrations	No data	–	Ishidate and Odashima 1977
Chinese hamster CHL	Chromosome aberrations	–	–	Matsuoka et al. 1979
Chinese hamster V79-4	Sister chromatid exchange	–	–	Popescu et al. 1977
Chinese hamster Don	Sister chromatid exchange	No data	–	Abe and Sasaki 1977
Syrian hamster embryo cells	Transformation	No data	–	DiPaolo et al. 1969; Dunkel et al. 1981
Hamster BHK21 clone 13	Transformation	–	No data	Greb et al. 1980
Hamster embryo cells/SA7 virus transformation	Transformation	No data	–	Casto et al. 1977
Mouse ventral prostate C3H clone G23	Transformation	No data	–	Marquardt et al. 1972
Mouse C3H/10T$^{1/2}$	Transformation	No data	–	Lubet et al. 1983b; Peterson et al. 1981
Mouse Balb/3T3 cells	Transformation	No data	–	Dunkel et al. 1981
Fischer rat embryo cells	Transformation	No data	–	Mishra et al. 1978
Fischer rat embryo cells/leukemia virus transformation	Transformation	No data	–	Dunkel et al. 1981
Prokaryotic organisms:				
S. typhimurium	Gene mutation	+	–	Sakai et al. 1985
S. typhimurium	Gene mutation	+	No data	Bos et al. 1988
S. typhimurium	Gene mutation	–	No data	Carver et al. 1986; Hermann 1981; LaVoie et al. 1979
S. typhimurium/fluctuation test	Gene mutation	+	+	Bhatia et al. 1987
S. typhimurium/taped plate	Gene mutation	+	No data	Bos et al. 1988
E. coli WP2-WP100/rec-assay	DNA damage	–	No data	Mamber et al. 1983

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
E. coli/differential killing	DNA damage	–	–	Tweats 1981
E. coli/SOS chromotest	DNA damage	–	–	Mersch-Sundermann et al. 1992a
E. coli/SOS chromotest	DNA damage	–	No data	Mersch-Sundermann et al. 1992b
Mammalian cells:				
Fisher rat embryo cells	Gene mutation	No data	+	Mishra et al. 1978
Chinese hamster V79	Gene mutation	–	–	Huberman 1975
Chinese hamster V79	Gene mutation	–	No data	Huberman 1975
Mouse lymphoma L5178Y/TK$^{+/-}$	Gene mutation	–	No data	Amacher et al. 1980
Human lymphoblasts TK6	Gene mutation	–	No data	Barfknecht et al. 1982
HeLa cells/unscheduled DNA synthesis	DNA damage	–	–	Martin et al. 1978
Rat hepatocytes/DNA repair	DNA damage	No data	–	Williams et al. 1982
Human skin fibroblasts	DNA damage	No data	–	Milo et al. 1978
Human skin fibroblasts	DNA damage	–	No data	Agrelo and Amos 1981
Human fibroblasts WI-38 unscheduled DNA synthesis	DNA damage	+	–	Robinson and Mitchell 1981
Chinese hamster V79-4	Chromosome aberrations	+	–	Popescu et al. 1977
Human fibroblasts WI-38	Chromosome aberrations	–	–	Weinstein et al. 1977
Rat liver cells RL1	Chromosome aberrations	No data	–	Dean 1981
Chinese hamster V79-4	Sister chromatid exchange	–	–	Popescu et al. 1977
Rat liver cells ARL18	Sister chromatid exchange	No data	–	Tong et al. 1981
Syrian hamster embryo cells	Transformation	No data	–	DiPaolo et al. 1969
Fischer rat embryo cells	Transformation	No data	–	Mishra et al. 1978

TABLE 2-5. Genotoxicity of Polycyclic Aromatic Hydrocarbons *In Vitro (continued)*

Species (test system)	End point	Result		Reference
		With activation	Without activation	
Hamster embryo cells/SA7 virus transformation	Transformation	No data	–	Casto et al. 1977
		Chrysene		
Prokaryotic organisms: *S. typhimurium*	Gene mutation	+	No data	Glatt et al. 1993
S. typhimurium	Gene mutation	+	No data	Cheung et al. 1993

[a]Noninduced hamster S9
[b]Noninduced mouse, rat, pig and human S9
[c]Synthetically prepared diol epoxide was strongly mutagenic

AHH = aromatic hydrocarbon hydroxylase; CHO = Chinese hamster ovary; DNA = deoxyribonucleic acid; FSHL = female sex hormone lutenizing; NR = Not reported; PAHs = polycyclic hydrocarbons; SOS = DNA repair assay; – = negative result; + = positive result; (+) = weakly positive result

conjunction with the data from whole animal experiments, suggest that benzo[a]pyrene would probably have similar deleterious effects on human genetic material.

Because the genotoxic activity of benzo[a]pyrene is well established, it is frequently used as a positive control to demonstrate the sensitivity of various test systems to detect the genotoxic action of unknown compounds. It also serves as the model compound for PAHs, and the available information on the formation of metabolites and structure of benzo[a]pyrene can theoretically be used to predict potential genotoxicity/carcinogenicity of other PAHs that have not been as extensively studied.

Benzo[a]pyrene is generally considered to be biologically inert but can be metabolized by enzyme systems into at least 27 identified metabolites; however, only a few of these metabolites are reactive species that can damage DNA (De Bruin 1976). Benzo[a]pyrene 7,8-diol-9,10-epoxide is thought to be the ultimate mutagenic/carcinogenic metabolite. The primary metabolic pathway leading to the formation of the genotoxic/carcinogenic diol epoxides is assumed to be cytochrome P-450-dependent mixed-function oxidases (MFO), which in the case of PAHs are called AHHs. AHH is an ubiquitous enzyme system and has been found in a variety of tissues including liver, lung, and gastrointestinal tract of rats, mice, hamsters, and monkeys. AHH has also been detected in human liver, lung, placenta, lymphocytes, monocytes, and alveolar macrophages (Singer and Grunberger 1983). The evidence indicating that a variety of human tissues including human lymphocytes (GAO 1991; Wiencke et al. 1990), human lymphoblasts (Danheiser et al. 1989), and human mammary epithelial cells (Mane et al. 1990) can serve as a source of exogenous metabolic activation tends to support the role of AHH systems in initiating the conversion of benzo[a]pyrene to genotoxic forms. However, human erythrocytes, which do not contain an effective cytochrome P-450 system, were more efficient than induced rat liver fractions in converting benzo[a]pyrene to a genotoxin as indicated by higher sister chromatid exchange and micronuclei frequencies observed in human lymphocytes co-cultivated with human erythrocytes (Lo Jacono et al. 1992). The findings, while unconfirmed, suggest that enzymatic systems other than AHH may yield reactive intermediates. Similar evidence that uninduced lung, kidney, or spleen from Sprague-Dawley rats or BALB/c mice did not convert benzo[a]pyrene to a mutagen in *S. typhimurium* was reported by Ampy et al. (1988) who concluded that these tissues may, therefore, not be at risk from exposure. Superficially, the data from the studies conducted by Phillipson and Ioannides (1989) (indicating that neither benzo[a]pyrene nor benz[a]anthracene were mutagenic in *S. typhimurium* TA100 in the presence of noninduced hepatic fractions from rats, mice, pigs, or humans) would tend to support the data reported by Lo Jacono et al. (1992) and Ampy et al.

(1988) (suggesting either that other enzyme systems are involved in the bioactivation of these compounds or that certain tissues are not at risk). However, it is important to note, as pointed out by Phillipson and Ioannides (1989), that the level of P-450 isoenzyme proteins in unexposed animals is relatively low. Support for this statement was provided by the data demonstrating that uninduced hamster liver fractions, which contain high cytochrome P-448 levels, converted both benzo[a]pyrene and benz[a]anthracene to mutagens. By inference, it can reasonably be assumed that repeated exposures are required to induce the requisite enzyme systems to metabolize these promutagens to ultimate mutagenic/carcinogenic forms. It can further be assumed that the tissues of any species, including humans, that contain the appropriate inducible enzyme system are at risk.

The function of other enzyme systems in the biotransformation of benzo[a]pyrene should not be ruled out. However, the evidence that cytochrome P-448 plays a major role in this process was further substantiated by the observation that rat liver enzymes induced by PAHs such as 3-MC or dibenz[a,h]anthracene were more efficient in metabolizing benzo[a]pyrene, dibenz[a,h]anthracene, and benz[a]anthracene to mutagenic metabolites for *S. typhimurium* than was phenobarbital (Teranishi et al. 1975). This finding is consistent with the well-documented observation that various inducing agents such as phenobarbital and 3-MC cause the preferential synthesis of specific forms of cytochrome P-450. In the case of 3-MC, cytochrome P-448 is the principal form of induced cytochrome (Singer and Grunberger 1983).

Epoxidation is thought to be the major pathway for benzo[a]pyrene metabolism pertinent to macromolecular interaction. The metabolic attack consists of the cytochrome P-450/P-448-dependent MFO system converting the benzo[a]pyrene molecule into an epoxide; the epoxide is acted upon by epoxide hydrolase to form a dihydrodiol, and a second cytochrome MFO reaction gives rise to the ultimate mutagenic/carcinogenic form, benzo[a]pyrene 7,8-diol-9,10-epoxide. One of the unique structural features of the diol epoxide is that it appears to form in the area of the PAH molecule referred to as the bay region (i.e., a deep-pocketed area formed when a single benzo ring is joined to the remainder of the multiple ring system to form a phenanthrene nucleus). The location of the bay region(s) for the various PAHs in this profile is depicted in Chapter 3 (Table 3-l).

An additional feature of bay region diol epoxides is the ease of carbonium ion formation, which renders the PAH molecule highly reactive and susceptible to attack by nucleophiles (Jerina 1980; Singer and Grunberger 1983). The carbonium ion is more likely to form in structures where the

epoxide is part of the bay region of a saturated terminal angular ring than in an area where the diol epoxide is not associated with a bay region. Further enhancement of bay region epoxides can occur by the formation of an intramolecular hydrogen bond between the oxygen molecule of the epoxide and an associated hydroxyl group. These metabolites are also more resistant to enzymatic detoxification by epoxide hydrolase and glutathione transferase. The increased reactivity conferred by intramolecular hydrogen bonding and the decreased rate of further metabolism favor the interaction with DNA.

Analysis of the bay region diol epoxides and their contribution to the DNA binding, genotoxicity, and carcinogenicity of various PAHs has provided the basis for the bay region hypothesis (Wood et al. 1979a). For example, DNA adducts formed with non-bay region diol epoxides of benzo[a]pyrene have low mutagenic potential (MacLeod et al. 1994). The hypothesis further predicts that structures with more reactive bay regions would probably be more genotoxic and more carcinogenic. The body of evidence on the mutagenic and tumorigenic activity of the PAHs that form bay region diol epoxides (benzo[a]pyrene, benz[a]anthracene, chrysene, dibenz[a,h]anthracene; benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene) supports this hypothesis.

Based on these considerations, the available genetic toxicology results from studies conducted with the other PAHs in this profile are discussed relative to the bay region hypothesis. It is cautioned, however, that while the use of structural relationships to predict potentially reactive compounds is a powerful tool, it is not infallible, nor does it replace *in vitro* or *in vivo* testing. The formation of bay region epoxides is not an absolute requirement for carcinogenic activity because several PAHs that cannot form bay region epoxides are known to be carcinogens. It can, nevertheless, serve as a warning system to alert regulatory agencies to a potential health hazard and to enable investigators to establish priority lists for testing PAHs.

There is no convincing evidence that the PAHs lacking a bay region structure (acenaphthene, acenaphthylene, and fluorene) are genotoxic; the results for acenaphthene and acenaphthylene are consistently negative. The induction of chromosome aberrations only, at a single dose in Chinese hamster lung cells exposed to fluorene (Matsuoka et al. 1991), is not sufficient to conclude that fluorene is a clastogen. However, none of these compounds have been extensively studied in *in vitro* assays, and they have not been tested *in vivo*.

The majority of the data for anthracene and pyrene were negative. Although isolated positive results were obtained, particularly in microbial systems, neither compound produced consistent genotoxic effects in mammalian cells *in vitro*, and both were negative in the limited *in vivo* studies that have been performed.

The results obtained with fluoranthene, the remaining PAH without a bay region configuration, illustrate the need to apply the bay region hypothesis judiciously. There is ample evidence indicating that fluoranthene induced gene mutations in bacteria and human lymphoblasts and sister chromatid exchange in Chinese hamster ovary cells. Based on the evidence of a powerful response in the *Escherichia coli* PQ37 SOS DNA repair assay (SOS chromotest), Mersch-Sundermann et al. (1992a) predicted that fluoranthene has a relatively high probability of being genotoxic (80%). However, fluoranthene did not induce sister chromatid exchanges in mouse bone marrow cells (Palitti et al. 1986). The work of Busby et al. (1984) in newborn mice, suggests that fluoranthene should be classified as a carcinogen.

The occurrence of a bay region structure on the phenanthrene molecule suggests that this compound is genotoxic. However, the overall findings from the genetic toxicology studies do not support such a prediction. Similarly, the reported observation that the intraperitoneal injection of phenanthrene resulted in sister chromatid exchange induction in Chinese hamster bone marrow cells was not convincing (Bayer 1979; Roszinsky-Kocher et al. 1979). In both studies, the sister chromatid exchange increase over background was less than 1.5 fold and comparable doses did not cause chromosome aberrations. As stated earlier, the occurrence of a bay region on the molecule in conjunction with the reactivity of the bay region appear to be the determinants of genotoxic/carcinogenic activity. It is, therefore, probable that the bay region on phenanthrene is not very reactive, which would account for the lack of genotoxicity and for the low carcinogenicity index (<2) assigned to this compound (Arcos et al. 1968). Similarly, quantum mechanical calculations indicate a low probability of carbonation formation for the bay region diol epoxide of phenanthrene (Jerina 1980).

The lack of genotoxicity for phenanthrene is thought to be related to the metabolism of this substance to its 9,10-dihydrodiol. However, specific methylated phenanthrenes, which direct the metabolic fate of this tricyclic hydrocarbon towards the formation of a classical bay region dihydrodiol epoxide, have exhibited significant genotoxicity (LaVoie et al. 1983a). It was demonstrated that the presence of a

methyl group at or adjacent to the K-region of phenanthrene can inhibit the formation of the 9,10-dihydrodiol and produce powerful mutagens in *Salmonella.* Additionally, the presence of a halogen at the K-region site produced similar results, which further support the association between inhibition of 9,10-dihydrodiol formation and mutagenic potency of substituted phenanthrenes. The study authors concluded that derivatives of phenanthrene that can inhibit metabolism at this site have a greater probability of exerting genotoxic effects. Additionally, methylated derivatives of phenanthrene may act as tumor initiators, as shown on mouse skin (LaVoie et al. 1981b).

The weight of evidence from the *in vitro* and *in vivo* studies conducted with benz[a]anthracene, dibenz[a,h]anthracene, and chrysene indicates that these three agents are genotoxic and that they exert their genotoxic effects through the binding of bay region diol epoxides to cellular DNA. Similarly, there is a substantive body of evidence that confirms the hypothesis implicating the formation of bay region diol epoxides as the major mechanism of action for both the genotoxicity and carcinogenicity induced by these PAHs (Cheung et al. 1993; Fuchs et al. 1993a, 1993b; Glatt et al. 1993; Lecoq et al. 1989, 1991a; Wood 1979). It is also of note that these three compounds, as well as benzo[a]pyrene, induced neoplastic cell transformation in at least one cell line (see Table 2-5).

Both benzo[b]fluoranthene and indeno[1,2,3-c,d]pyrene are known to exhibit mutagenic activity in *S. typhimurium* TA100 in the presence of rat liver homogenate (Amin et al. 1984; Hermann 1981; LaVoie et al. 1979; Rice et al. 1985b). Both of these agents were positive for *in vitro* cell transformation (Emura et al. 1980; Greb et al. 1980) and were shown to bind to mouse skin DNA *in vivo* (Hughes et al. 1993; Weyand 1989; Weyand et al. 1987). In addition, benzo[b]fluoranthene formed DNA adducts in the lungs and livers of adult rats (Ross et al. 1992) and newborn mice (Weyand et al. 1993b) and formed DNA adducts as well as induced sister chromatid exchange in peripheral blood lymphocytes of treated rats (Ross et al. 1992). These data are consistent with reports on the tumorigenic activity of these PAHs in rodents and their potential to act as carcinogens in humans.

Studies on the mutagenic activity of benzofilfluoranthene and benzo[k]fluoranthene have also indicated that these nonalternant PAHs are mutagenic in *S. typhimurium* TAl00 (Amin et al. 1985b; LaVoie et al. 1979, 1980a; Weyand et al. 1988, 1992). There is also evidence that application of either of these PAHs to mouse skin results in DNA adduct formation (Hughes et al. 1993; LaVoie et al. 1991a, 1991b; Weyand et al. 1987, 1993a). The relative extent of binding to mouse skin DNA (i.e.,

benzo[j]fluoranthene > benzo[k]fluoranthene) parallels the relative tumorigenic potency of these hydrocarbons on mouse skin (i.e., benzo[j]fluoranthene is more potent than benzo[k]fluoranthene as a tumor initiator) (LaVoie et al. 1982).

Benzo[g,h,i]perylene has been reported to be mutagenic in *S. typhimurium* and to cause DNA damage in *E. coli*. Benzo[g,h,i]perylene has been shown to be responsible for the formation of DNA adducts isolated after topical application of pharmaceutical grade coal tar to the skin of mice (Hughes et al. 1993). However, the few studies that were found were insufficient to draw meaningful conclusions.

The final compound in this group, benzo[e]pyrene, contains two equivalent bay regions. *In vivo,* benzo[e]pyrene induced a marginal increase in sister chromatid exchanges but did not cause structural chromosome aberrations in bone marrow cells harvested from Chinese hamsters receiving two daily intraperitoneal doses of 450 mg/kg (Roszinsky-Kocher et al. 1979). Similarly, sister chromatid exchange frequencies were not increased in V-79 cells co-cultivated with rat mammary epithelial cells as the source of exogenous metabolic activation (Mane et al. 1990). Benzo[e]pyrene was, however, reported to be weakly mutagenic in *S. typhimurium* (Andrews et al. 1978) and weakly genotoxic in the *E. coli* SOS chromotest (Mersch-Sundermann et al. 1992a, 1992b).

The weak genotoxicity and the very weak carcinogenicity of benzo[e]pyrene appear to contradict the bay region diol epoxide hypothesis. Quantum mechanical analysis of the ringed structure strongly suggests the likelihood of carbonium ion formation and an associated chemical reactivity equivalent to the bay region diol epoxide of dibenz[a,h]anthracene (Wood et al. 1979a). Similarly, synthetically prepared bay region tetrahydro-epoxides of benzo[e]pyrene were found to be highly mutagenic in bacteria and mammalian cells, suggesting that bay region diol epoxide(s), if formed, would also be mutagenic. However, the parent compound was not metabolized to a reactive state by Aroclor 1254 S9 or by purified cytochrome P-450 derived from rat livers induced with Aroclor 1254. From these results, Wood et al. (1979a) concluded that the lack of mutagenicity for benzo[e]pyrene may be associated with the failure of the cytochrome P-450-dependent monooxygenase system to catalyze the critical oxidations necessary to form the bay region diol. Specifically, there was very little formation of the bay region 9,10-dihydrodiol and low conversion of authentic 9,10-dihydrodiol to the bay region diol epoxide. Subsequent studies with authentic bay region diol epoxides of benzo[e]pyrene showed that they had relatively low mutagenic and tumorigenic activity as a result of the diaxial conformation of the diol. The diaxial conformation of the 9,10-dihydrodiol also provides an explanation for the low

formation of the bay region diol epoxide since metabolism is shifted away from the adjacent isolated double bond (Chang et al. 1981; Wood et al. 1980). Since structural-activity analysis suggests that the bay region diol epoxides would have biological activity, Wood et al. (1979a) caution that extrapolation of these findings to *in vivo* metabolic events in species other than rats should be approached with caution. It is conceivable that benzo[e]pyrene would be genotoxic in species capable of carrying out the appropriate enzymatic steps.

In summary, several general conclusions can be reached for the unsubstituted PAHs evaluated in this profile. The formation of diol epoxides that covalently bind to DNA appears to be the primary mechanism of action for both genotoxicity and carcinogenicity of several of the unsubstituted PAHs that are genotoxins (benzo[a]pyrene, benz[a]anthracene, dibenz[a,h]anthracene, chrysene, benzo[b]fluoranthene, benzo[j]fluoranthene). There was insufficient evidence to draw meaningful conclusions regarding the genotoxic potential of benzo[g,h,i]perylene, although some evidence does exist.

With regard to the unsubstituted PAHs that either lack a bay region configuration (acenaphthene, acenaphthylene, anthracene, fluorene, and pyrene) or appear to have a weakly reactive bay region (phenanthrene), there is no compelling evidence to suggest that they interact with or damage DNA. The five PAHs that appear to be exceptions to the bay region diol epoxide hypothesis are fluoranthene, benzo[k]fluoranthene, benzo[j]fluoranthene, and indeno[1,2,3-cd]pyrene (no bay region), and benzo[e]pyrene (two bay regions). The evidence does suggest, however, that fluoranthene possesses genotoxic properties while benzo[e]pyrene is either weakly mutagenic or nonmutagenic.

Cancer. Evidence exists to indicate that mixtures of PAHs are carcinogenic in humans. The evidence in humans comes primarily from occupational studies of workers exposed to mixtures containing PAHs as a result of their involvement in such processes as coke production, roofing, oil refining, or coal gasification (e.g., coal tar, roofing tar, soot, coke oven emissions, soot, crude oil) (Hammond et al. 1976; Lloyd 1971; Maclure and MacMahon 1980; Mazumdar et al. 1975; Redmond et al. 1976; Wynder and Hoffmann 1967). PAHs, however, have not been clearly identified as the causative agent. Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lung and skin following inhalation and dermal exposure, respectively. Some ingestion of PAHs is likely because of swallowing of particles containing PAHs subsequent to mucocilliary clearance of these particulates from the lung.

Certain PAHs are carcinogenic to animals by the oral route (e.g., benz[a]anthracene, benzo[a]pyrene, and dibenz[a,h]anthracene) (Berenblum and Haran 1955; Chu and Malmgren 1965; Klein 1963; McCormick et al. 1981; Neal and Rigdon 1967; Rigdon and Neal 1966; Snell and Stewart 1963; Spamins et al. 1986; Wattenberg and Leong 1970). The results of dermal studies indicate that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[l,2,3-c,d]pyrene are tumorigenic in mice following dermal exposure (Albert et al. 1991b; Cavalieri 1988b; Habs et al. 1984; Levin et al. 1984; Warshawsky and Barkley 1987; Wilson and Holland 1988; Wynder and Hoffmann 1959b). The sensitivity of mouse skin to PAH tumorigenesis forms the basis for the extensive studies performed using dermal administration. This tumorigenicity can be enhanced or modified with concomitant exposure to more than one PAH, long straight-chain hydrocarbons (i.e., dodecane), or similar organic compounds commonly found at hazardous waste sites. Thus, humans exposed to PAHs in combination with these substances could be at risk for developing skin cancer.

For many of the carcinogenic PAHs discussed in this profile, it appears that the site of tumor induction is influenced by the route of administration and site of absorption, i.e., forestomach tumors are observed following ingestion, lung tumors following inhalation, and skin tumors following dermal exposure. However, the observations (discussed below) that (1) mammary tumors are induced following intravenous injection in Sprague-Dawley rats, (2) the susceptibility to tumor development on the skin after dermal application is not similar in rats and mice, and (3) oral cavity tumors are not observed when benzo[a]pyrene is administered in the diet, suggest that the point of first contact may not always be the site of PAH-induced tumors. The results of carcinogenicity studies conducted with the 17 PAHs discussed in this profile by parenteral routes of exposure are summarized in Table 2-6.

TABLE 2-6. Summary of Carcinogenicity Studies with Polycyclic Aromatic Hydrocarbons Using Parenteral Routes of Exposure

Chemical	Species	Route	Duration	Result/Site	Reference
Anthracene	Rat	Lung implantation	1 dose, 55-week observation	–	Stanton et al. 1972
	Newborn mouse	Subcutaneous	Single dose	–/lung	Platt et al. 1990
	Rat	Intrapulmonary	Single dose	+/lung	Deutsch-Wenzel et al. 1983
Benz[a]anthracene	Mouse	Subcutaneous	10 weeks	+/injection site	Boyland and Sims 1967
		Intramuscular	No data	+/fibrosarcomas, hemangioendotheliomas	Klein 1952
	Newborn mouse	Intraperitoneal	3 days	+/lung	Levin et al. 1984
	Hamster	Intratracheal	30 weeks	–	Sellakumar and Shubik 1974
Benzo[a]pyrene	Mouse	Subcutaneous	Single dose	+/injection site sarcomas	Pfeiffer 1977
	Newborn mouse	Intraperitoneal	Single dose	+/liver	LeVoie et al. 1987
	Newborn mouse	Intraperitoneal	No data	+/lung	Busby et al. 1984
	Rat	Intramammary	Single dose	+/mammary gland	Cavalieri et al. 1988b, 1988c
	Mouse	Intravaginal	5 months	+/cervix	Naslund et al. 1987
	Rat	Intrapulmonary	Single dose	+/lung	Deutsch-Wenzel et al. 1983
	Hamster	Intratracheal	Chronic	–	Kunstler 1983
	Rat	Tracheal implant	Intermediate	+/tracheal	Nettesheim et al. 1977
	Rat	Intrapulmonary	Single dose	+/lung	Iwagawa et al. 1989
	Newborn mouse	Subcutaneous	15 days	+/lung	Busby et al. 1989
	Rat	Intramammary	Single dose	+/mammary gland	Cavalieri et al. 1991
	Mouse	*In utero*	2 days	+/lung	Turusov et al. 1990
	Rat	Tracheal explant	Single dose	+/lung	Topping et al. 1981
	Rat	Intrapulmonary	Single dose	+/lung	Wenzel-Hartung et al. 1990
	Mouse	Intraperitoneal	Single dose	+/lung	Mass et all. 1993
	Hamster	Silastic implant	170 d	+/lung	Hammond and Benfield 1993
	Hamster	Intratracheal	1 time, for 6 weeks	+/lung	Kimizuka et al. 1993
Benzo[b]fluoranthene	Newborn mouse	Intraperitoneal	Single dose	+/liver	LaVoie et al. 1987
	Rat	Intrapulmonary	Single dose	+/lung	Deutsch-Wenzel et al. 1983
	Hamster	Intratracheal	30 weeks	–	Sellakumar and Shubik 1974
Benzo[e]pyrene	Rat	Tracheal explant	Single dose	–/trachea	Topping et al. 1981
	Rat	Intrapulmonary	Single dose	–/lung	Deutsch-Wenzel et al. 1983
Benzo[j]fluoranthene	Rat	Intrapulmonary	Single dose	+/lung	Deutsch-Wenzel et al. 1983
Benzo[g,h,i]perylene	Mouse	Subcutaneous	Single dose	–	IARC 1983
	Rat	Intrapulmonary	Single dose	+	Deutsch-Wenzel et al. 1983
Benzo[k]fluoranthene	Newborn mouse	Intraperitoneal	Single dose	–	LaVoie et al. 1987
	Rat	Intrapulmonary	Single dose	+/lung	Deutsch-Wenzel et al. 1983

TABLE 2-6. Summary of Carcinogenicity Studies with Polycyclic Aromatic Hydrocarbons Using Parenteral Routes of Exposure (continued)

Chemical	Species	Route	Duration	Result/Site	Reference
Anthracene	Rat	Lung implantation	1 dose, 55-week observation	–	Stanton et al. 1972
Chrysene	Newborn mouse	Intraperitoneal	No data	–	Buening et al. 1979a
	Newborn mouse	Intraperitoneal	Single dose, 70-week, week observation	+/liver	Grover et al. 1975
	Mouse	Subcutaneous	10 weeks	+/injection site tumors	Boyland and Sims 1967
	Rat	Intrapulmonary	Single dose	+/lung	Wenzel-Hartung et al. 1990
Dibenz[a,h]anthracene	Newborn mouse	Intraperitoneal	No data	+/lung	Buening et al. 1979b
	Mouse	Subcutaneous	10 weeks	+/injection site tumors	Boyland and Sims 1967
	Hamster	Intratracheal	30 weeks	–	Sellakumar and Shubik 1974
	Newborn mouse	Subcutaneous	Single dose	+/lung	Platt et al. 1990
	Newborn mouse	Subcutaneous	Single dose	+/injection site sarcoma	O'Gara et al. 1965
	Rat	Intrapulmonary	Single dose	+/lung	Wenzel-Hartung et al. 1990
Fluoranthene	Mouse	Intraperitoneal	15 days	+/lung	Busby et al. 1984
	Mouse	Intraperitoneal	3 doses in 15 days, 9-month observation	+/lung	Wang and Busby 1993
Fluorene	Mouse	Subcutaneous	Single dose	–	Roe 1962; Shear and Luter 1941; Steiner 1955
Ideno[1,2,3-c,d]pyrene	Newborn mouse	Intraperitoneal	Single dose	–	LaVoie et al. 1987
	Rat	Intrapulmonary	Single dose	+/lung	Deutsch-Wenzel et al. 1983
Phenanthrene	Newborn mouse	Intraperitoneal	No data	–	Buening et al. 1979a
	Rat	Intrapulmonary	Single dose	–/lung	Wenzel-Hartung et al. 1990
Pyrene	Hamster	Intratracheal	30 weeks	–	Sellakumar and Shubik 1974
	Newborn mouse	Subcutaneous	Single dose	–/lung	Busby et al. 1989

+ = increased incidence of tumors; – = no increase in tumor incidence

EPA has performed weight-of-evidence evaluations of several of the PAHs discussed in this profile. The carcinogenicity classifications currently verified by EPA's Carcinogenicity Risk Assessment Verification Endeavor Work Group (EPA 1994) are listed below:

PAH	EPA Classification
Acenaphthylene	D (not classifiable as to human carcinogenicity)
Anthracene	D
Benz[a]anthracene	B2 (probable human carcinogen)
Benzo[b]fluoranthene	B2
Benzo[k]fluoranthene	B2
Benzo[g,h,i]perylene	D
Benzo[a]pyrene	B2
Chrysene	B2
Dibenz[a,h]anthracene	B2
Fluoranthene	D
Fluorene	D
Indeno[1,2,3-c,d]pyrene	B2
Phenanthrene	D
Pyrene	D

A quantitative cancer risk estimate (i.e., cancer potency factor) has thus far been developed for benzo[a]pyrene only (EPA 1992). This cancer potency factor (q_1^*) is 7.3 per (mg/kg)/day and is based on the geometric mean of risk estimates calculated from the Neal and Rigdon (1967) and Brune et al. (1981) studies.

EPA and others have developed a relative potency estimate approach for the PAHs (EPA 1993a; Nisbet and LaGoy 1992). By using this approach, the cancer potency of the other carcinogenic PAHs can be estimated based on their relative potency to benzo[a]pyrene. Following are the toxicity equivalence factors (based on carcinogenicity) calculated for PAHs discussed in this profile considered by the authors of one of these approaches to be of most concern at hazardous waste sites (Nisbet and LaGoy 1992):

Compound	Toxicity Equivalency Factor (TEF)
Dibenz[a,h]anthracene	5
Benzo[a]pyrene	1
Benz[a]anthracene	0.1
Benzo[b]fluoranthene	0.1
Benzo[k]fluoranthene	0.1
Indeno[1,2,3-c,d]pyrene	0.1
Anthracene	0.01
Benzo[g,h,i]perylene	0.01
Chrysene	0.01
Acenaphthene	0.001
Acenaphthylene	0.001
Fluoranthene	0.001
Fluorene	0.001
Phenanthrene	0.001
Pyrene	0.001

EPA (1993) has derived the following relative potency estimates based on mouse skin carcinogenesis:

Compound	Relative Potency[a]
Benzo[a]pyrene	1.0
Benz[a]anthracene	0.145
Benzo[b]fluoranthene	0.167
Benzo[k]fluoranthene	0.020
Chrysene	0.0044
Dibenz[a,h]anthracene	1.11
Indeno[1,2,3-c,d]pyrene	0.055[b]

[a]Model was $P(d)=1-\exp[-a(1+bd)^2]$ for all but indeno[1,2,3-c,d]pyrene

[b]Simple mean of relative potencies (0.021 and 0.089); the latter derived using the one-hit model

2.5 BIOMARKERS OF EXPOSURE AND EFFECT

Biomarkers are broadly defined as indicators signaling events in biologic systems or samples. They have been classified as markers of exposure, markers of effect, and markers of susceptibility (NAS/NRC 1989).

A biomarker of exposure is a xenobiotic substance or its metabolite(s), or the product of an interaction between a xenobiotic agent and some target molecule(s) or cell(s) that is measured within a compartment of an organism (NRC 1989). The preferred biomarkers of exposure are generally the substance itself or substance-specific metabolites in readily obtainable body fluid(s) or excreta. However, several factors can confound the use and interpretation of biomarkers of exposure. The body burden of a substance may be the result of exposures from more than one source. The substance being measured may be a metabolite of another xenobiotic substance (e.g., high urinary levels of phenol can result from exposure to several different aromatic compounds). Depending on the properties of the substance (e.g., biologic half-life) and environmental conditions (e.g., duration and route of exposure), the substance and all of its metabolites may have left the body by the time samples can be taken. It may be difficult to identify individuals exposed to hazardous substances that are commonly found in body tissues and fluids (e.g., essential mineral nutrients such as copper, zinc, and selenium). Biomarkers of exposure to PAHs are discussed in Section 2.5.1.

Biomarkers of effect are defined as any measurable biochemical, physiologic, or other alteration within an organism that, depending on magnitude, can be recognized as an established or potential health impairment or disease (NAS/NRC 1989). This definition encompasses biochemical or cellular signals of tissue dysfunction (e.g., increased liver enzyme activity or pathologic changes in female genital epithelial cells), as well as physiologic signs of dysfunction such as increased blood pressure or decreased lung capacity. Note that these markers are not often substance specific. They also may not be directly adverse, but can indicate potential health impairment (e.g., DNA adducts). Biomarkers of effects caused by PAHs are discussed in Section 2.5.2.

A biomarker of susceptibility is an indicator of an inherent or acquired limitation of an organism’s ability to respond to the challenge of exposure to a specific xenobiotic substance. It can be an intrinsic genetic or other characteristic or a preexisting disease that results in an increase in absorbed

dose, a decrease in the biologically effective dose;or a target tissue response. If biomarkers of susceptibility exist, they are discussed in Section 2.7, Populations That Are Unusually Susceptible.

2.5.1 Biomarkers Used to Identify or Quantify Exposure to Polycyclic Aromatic Hydrocarbons

PAHs and their metabolites can be measured in the urine of exposed individuals. In workers exposed to PAHs and dermatology patients treated with coal tar, the PAH metabolite 1-hydroxypyrene has been detected in the urine at concentrations of 0-40 µg/g creatinine or 290 ng/g creatinine, respectively (Jongeneelen et al. 1985). The amount of 1-hydroxypyrene detected in urine samples taken during the weekend was less than that detected during the weekdays, when the exposure was presumably higher than on the weekends. No correlation was found between occupational exposure levels and urine levels, so it is not known whether urinary metabolites could be detected following exposure to low levels of PAHs (as might be expected to occur in individuals living in the vicinity of hazardous waste sites). The presence of 1-hydroxypyrene in urine has also been demonstrated in workers exposed to PAHs in several different environments (creosote-impregnating plant, road workers laying asphalt, and workers exposed to diesel exhaust fumes) (Jongeneelen et al. 1988). In another study, the levels of urinary 1-hydroxypyrene significantly correlated with the environmental levels of pyrene and benzo[a]pyrene in coke plants, steel plants, and several Chinese cities where coal burning occurs (Zhao et al. 1990). The usefulness of monitoring urinary 1-hydroxypyrene concentration by liquid chromatography in occupationally exposed individuals as a biomarker for exposure to environmental PAHs was assessed. Postshift 1-hydroxypyrene urinary levels were significantly increased over preshift 1-hydroxypyrene levels in exposed workers as compared to nonexposed controls (the net mean change was 17-fold higher in the exposed workers as opposed to the nonexposed controls), and smoking status did not affect this result. In addition, in this work setting (an aluminum production plant), environmental levels of pyrene were strongly correlated with the environmental levels of total PAHs, indicating that pyrene is an appropriate environmental PAH marker in this situation. Thus, 1-Hydroxypyrene levels in urine may be used as a biomarker of exposure to PAHs in certain situations (Tolos et al. 1990). Additional studies have evaluated the usefulness of determining PAH or metabolite levels in human urine as a measure of exposure in industrial and environmental exposure settings (Granella and Clonfero 1993; Hansen et al. 1993; Herikstad et al. 1993; Kanoh et al. 1993; Likhachev et al. 1993; Ovrebo et al. 1994; Santella et al. 1993; Strickland et al. 1994; Van Hummelen et al. 1993; Van Rooij et al. 1993a, 1993b; Viau et al. 1993). Based on these results, the identification

of PAH metabolites in the urine could serve as a method of biological monitoring of exposed workers, and possibly individuals living in the vicinity of hazardous waste sites where PAHs have been detected although it would be very difficult to distinguish exposures resulting from hazardous waste sites form those resulting from normal human activities.

Autopsies performed on cancer-free patients found PAH levels of 1l-2,700 ppt in fat samples. Several PAHs were detected, including anthracene, pyrene, benzo[e]pyrene, benzo[k]fluoranthene, benzo[a]pyrene, and benzo[g,h,i]perylene, with pyrene being detected in the highest concentrations (Obana et al. 1981). A similar study done on livers from cancer-free patients found levels of 6-500 ppt of all of the same PAHs except benzo[e]pyrene, which was not detected in the liver. As in the fat samples studies, pyrene appeared in the highest concentrations in the liver, but the overall levels were less than in fat (Obana et al. 1981). However, because of the ubiquitous nature of PAHs in the environment, detection of PAH metabolites in the body tissues or fluids is not specific for exposure to PAHs from hazardous waste sites. In addition, it is impossible to determine from these biological media whether exposure was to high or low levels of PAHs or if the exposure duration was acute, intermediate, or chronic. Benzo[a]pyrene and 1-nitropyrene were determined in excised lung samples from Chinese and Japanese cancer patients (Tokiwa et al. 1993). Exposure to the two marker compounds was from burning coal (Chinese, benzo[a]pyrene) or oil (Japanese, 1-nitropyrene). Compound levels in the lung correlated with individual exposure history. Using a large sample population, total PAH levels in lung tissue has also been shown to correlate to cancer incidence (Seto et al. 1993).

PAHs form DNA adducts that can be measured in body tissues or blood in both humans and laboratory animals following exposure to PAHs or mixtures containing PAHs (e.g., Assennato et al. 1993; Bjelogrlic et al. 1994; Chou et al. 1993; Culp and Beland 1994; Day et al. 1990; Fuchs et al. 1993a, 1993b; Garg et al. 1993; Garner et al. 1988; Gallagher et al. 1993; Herberg et al. 1990; Hughes and Phillips 1990; Hughes et al. 1993; Jones et al. 1993; Khanduja and Majid 1993; Lee et al. 1993; Lewtas et al. 1993; Likhachev et al. 1993; Lu et al. 1993; Mass et al. 1993; Mumford et al. 1993; Newman et al. 1988, 1990; Nowak et al. 1992; Oueslati et al. 1992; Roggeband et al. 1994; Ross et al. 1990, 1991; Shamshuddin and Gan 1988; Van Schooten et al. 1991, 1992; Weston et al. 1988, 1993a; Weyand et al. 1993a, 1993b). PAHs also form adducts with other cellular macromolecules, such as hemoglobin, globin, and other large serum proteins (e.g., Bechtold et al. 1991; Sherson et al. 1990; Weston et al. 1988). Again, these PAH-DNA and PAH-protein adducts are not specific for any

particular source of PAHs, and the adducts measured could have been from exposure to other sources of PAHs, such as complex mixtures that contain PAHs (e.g., crude oils, various high-boiling point distillates, complex petroleum products, coal tars, creosote, and the products of coal liquification processes), as well as vehicle exhausts, wild fires, agricultural burning, tobacco smoke, smoke from home heating of wood, cereals, grains, flour, bread, vegetables, fruits, meat, processed or pickled foods, beverages, and grilled meats. It is impossible to determine from these adducts whether exposure was to high or low levels of PAHs or if the exposure duration was short or long.

In another study, an evaluation of mutations in peripheral lymphocytes was conducted in workers in or near an iron foundry; data were examined for correlations to benzo[a]pyrene exposure determined by personal monitors. Exposure levels for benzo[a]pyrene were 2-60 ng/m^3, which are the lowest levels yet analyzed in foundry workers. Mutations at the hypoxanthine guanine phosphoribosyl transferase (HPRT) and glycophorin A (GPA) loci, which are measures of molecular effects in lymphocytes and erythrocytes, respectively, were assessed to demonstrate their relationship to external exposure at these low levels. The rate of mutation was also compared to PAH-DNA adducts in the blood (Santella et al. 1993). Workers were classified into three exposure categories, low (<5), medium (5-12), and high (>12). HPRT mutant frequencies for these groups were 1.04, 1.13, and 1 .82x10^{-6} cells, respectively, and demonstrated an upward trend that was marginally significant. In contrast, HPRT mutations were highly correlated with PAH-DNA adducts (Santella et al. 1993). GPA variants were not correlated with PAH exposure. These results support the use of both biomonitoring and personal environmental monitoring in the determination of exposure.

Three methods were evaluated for their usefulness as biomarkers of exposure to benzo[a]pyrene in Wistar rats administered a single dose of l-200 mg/kg (Willems et al. 1991). These three methods were mutagenicity observed in urine and fecal extracts, chromosome aberrations and sister chromatid exchanges in peripheral blood lymphocytes, and DNA adduct formation in peripheral blood lymphocytes and liver. Mutagens were measured in urine and feces at levels of 10 and 1 mg/kg, respectively. DNA adduct formation (measured by ^{32}P-postlabelling) could be detected at doses of ≥10 mg in lymphocytes and ≥100 mg in liver, and the levels were twice as high in the lymphocytes as in the liver. Only a slight increase in sister chromatid exchanges and no enhanced frequency of chromosomal aberrations were seen. These results indicate that mutagenicity observed in excreta and DNA adducts in lymphocytes are both useful biomarkers of exposure in the rat, with mutagenic activity in feces being the more sensitive.

The ability of phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, indeno[l,2,3-c,d]pyrene, and dibenz[a]anthracene to bind to mouse hemoglobin and serum proteins after tail vein injection was investigated (Singh and Weyand 1994). Urinary excretion of these compounds was also investigated. A direct correlation between urinary excretion and hydrocarbon molecular weight was observed. Binding to both globin and serum proteins was detectable, with binding to serum proteins 10-fold higher than to globin. These results provide an assessment of the potential usefulness of various PAHs as biomarkers of exposure to complex mixtures.

2.5.2 Biomarkers Used to Characterize Effects Caused by Polycyclic Aromatic Hydrocarbons

The available genotoxicity data indicate that several of the 17 PAHs discussed in this profile are genotoxic in both nonmammalian and mammalian systems and are indirect mutagens (i.e., requiring the presence of an exogenous mammalian metabolic system). There were no tests reported for humans exposed to benzo[a]pyrene (the most widely tested PAH) *in vivo*, but several types of cultured human tissue cells demonstrated positive results for benzo[a]pyrene-induced genotoxicity (as evidenced by the induction of chromosomal aberrations, sister chromatid exchange) and binding of benzo[a]pyrene to DNA. The measurement of DNA adduct formation as well as the induction of sister chromatid exchange in human lymphocytes has been proposed as a biomarker of benzo[a]pyrene-induced effects for human monitoring programs (Wiencke et al. 1990). It is probable, however, that the analysis of DNA adducts would be the more sensitive diagnostic tool since hundreds of benzo[a]pyrene-DNA adducts per nucleus would be required to yield a detectable increase in the sister chromatid exchange frequency for an exposed population. Although these results are exclusively from *in vitro* tests and the limited genotoxicity tests conducted on urine obtained from humans exposed to creosote (a complex mixture containing PAHs) have been negative, the genotoxic effects observed in human tissue cells, particularly DNA adduct formation, may serve as a biomarker of effects for at least one of the PAHs, benzo[a]pyrene. It would not be possible to identify the source.of the benzo[a]pyrene, however.

PAHs have been shown to cause noncancer adverse effects on rapidly proliferating tissues such as the hematopoietic system, the lymphoid system, and the skin in both humans and animals. The skin is susceptible to PAH-induced toxicity in both humans and animals. Regressive verrucae were reported following intermediate-duration application of benzo[a]pyrene to human skin (Cottini and Mazzone

1939). Although reversible and apparently benign, these changes were thought to represent neoplastic proliferation. Benzo[a]pyrene application also apparently exacerbated skin lesions in patients with pre-existing skin conditions (pemphigus vulgaris and xeroderma pigmentosum) (Cottini and Mazzone 1939). Workers exposed to substances that contain PAHs (e.g., coal tar) experienced chronic dermatitis and hyperkeratosis (EPA 1988a). However, none of these end points is specific to PAHs, and all can be seen with other agents. No other biomarkers of effect (specific or otherwise) have been identified following exposure to PAHs.

For more information on biomarkers for renal and hepatic effects of chemicals see ATSDR/CDC Subcommittee Report on Biological Indicators of Organ Damage (1990) and for information on biomarkers for neurological effects see OTA (1990). Additional information can be found in a series of reports on biomarkers issued by the National Research Council (NRC 1989, 1992).

2.6 INTERACTIONS WITH OTHER SUBSTANCES

Because humans are usually exposed to PAHs in complex mixtures rather than to individual PAHs, it is important to understand the potential interactions between the PAHs and other components of the mixture. Interactions may occur among chemicals in a mixture prior to exposure, or may occur after exposure as a result of differing effects of the mixture components on the body. Synergistic and/or antagonistic interactions with regard to the development of health effects, particularly carcinogenesis, may occur.

The extent of human exposures to PAH mixtures in occupational settings is generally not known in quantitative terms. However, exposures to complex chemical mixtures that include PAHs, such as use of tobacco products and exposure to roofing tar emissions, coke oven emissions, coal tar, and shale oils, have been associated with adverse health effects in humans. The biological consequences of human exposure to complex mixtures of PAHs depend on the interaction of the various strongly carcinogenic, weakly carcinogenic, or noncarcinogenic PAHs. For example, there is evidence to suggest that PAHs in cigarette smoke require other components in the smoke in order to exert their tumorigenic effect (Akin et al. 1976).

The interaction between noncarcinogenic and carcinogenic PAHs has been extensively examined in animals. Noncarcinogenic PAHs exhibit co-carcinogenic potential and tumor-initiating and promoting

activity when applied with benzo[a]pyrene to the skin of mice. Simultaneous administration of weakly carcinogenic or noncarcinogenic PAHs including benzo[e]pyrene, benzo[g,h,i]perylene, fluoranthene, or pyrene significantly elevated the benzo[a]pyrene-induced tumor incidence. Benzo[e]pyrene, fluoranthene, and pyrene were more potent co-carcinogens than benzo[g,h,i]perylene (Van, Duuren and Goldschmidt 1976; Van Duuren et al. 1973). Benzo[e]pyrene, fluoranthene, and pyrene have also demonstrated weak tumor-promoting activity following initiation with benzo[a]pyrene, and these compounds increased benzo[a]pyrene-DNA adduct formation (Di Giovanni et al. 1982; Lau and Baird 1992; Rice et al. 1984, 1988; Slaga et al. 1979; Smolarek et al. 1987; Van Duuren and Goldschmidt 1976; Van Duuren et al. 1973).

Interactions between selected noncarcinogenic PAHs and carcinogenic benzo[a]pyrene have also been documented to reduce the carcinogenic potential of benzo[a]pyrene in animals. Benzo[a]fluoranthene, benzo[k]fluoranthene, chrysene, perylene, and a mixture of anthracene, phenanthracene, and pyrene significantly inhibited benzo[a]pyrene-induced injection-site sarcomas. However, other PAHs including anthracene, benzo[g,h,i]perylene, fluorene, and indeno[1,2,3-c,d]pyrene had no antagonistic effects (Falk et al. 1964). Coexposure of tracheal explants to benzo[e]pyrene and benzo[a]pyrene resulted in an increased incidence of tracheal epithelial sarcomas over that seen with either PAH alone (Topping et al. 1981). Phenanthrene administration with benzo[a]pyrene decreased the DNA adduct formation in mice (Rice et al. 1984).

There is evidence to suggest that benz[a]anthracene may serve as an anticarcinogen when administered with benzo[a]pyrene. Coadministration of benz[a]anthracene and benzo[a]pyrene decreased benzo[a]pyrene metabolism, benzo[a]pyrene-DNA adduct formation, and reduced the mutagenic activity of benzo[a]pyrene on hamster embryo cells. It has been postulated that the antimutagenic effect of benz[a]anthracene results from competition with benzo[a]pyrene for MFO enzymes, rather than the induction of detoxifying enzymes (Smolarek et al. 1986).

The synergistic effect of individual PAHs on the mutagenicity of benzo[a]pyrene has also been demonstrated. Anthracene and benzo[e]pyrene enhanced the mutagenicity of benzo[a]pyrene, the maximal increase being obtained with anthracene. Benzo[e]pyrene (at a ratio of 2:l) had no effect on benzo[a]pyrene-induced mutation frequencies in V79 cells, but at a ratio of 15:1, benzo[e]pyrene inhibited the benzo[a]pyrene-induced mutations by approximately 10-fold. Benzo[e]pyrene inhibited the metabolism of benzo[a]pyrene by cultured hamster embryo only at high doses, but at both low and

high doses, the proportion of metabolites formed was altered by benzo[e]pyrene (Baird et al. 1984). The percentage of water-soluble metabolites was decreased, whereas the percentage of diols was increased. The authors postulated that benzo[e]pyrene alters the activity of other PAHs by inhibiting the conversion of the proximate carcinogenic diol of a particular PAH to a diol epoxide.

Benzo[a]pyrene and dibenz[a,h]anthracene in combination with 10 noncarcinogenic PAHs were less potent tumor-inducers than was dibenz[a,h]anthracene alone or in combination with benzo[a]pyrene. The noncarcinogenic or weakly carcinogenic PAHs include benzo[e]pyrene, phenanthrene, anthracene, pyrene, fluoranthene, chrysene, perylene, benzo[g,h,i]pyrene, and coronene. Dose-response relationships for tumor incidences were observed for benzo[a]pyrene and dibenz[a,h]anthracene either alone or in combination with the 10 noncarcinogenic PAHs; however, no treatment-related sarcoma incidences were observed for any of the 10 noncarcinogenic PAHs (Pfeiffer 1977).

Phenanthrene, a noncarcinogenic PAH, demonstrated a dose-related inhibition of dibenz[a,h]anthracene-induced carcinogenicity in mice. Phenanthrene significantly reduced the incidence of injection-site sarcomas elicited by dibenz[a,h]anthracene, especially at low doses. However, when triethylene glycol was the vehicle administered in combination with phenanthrene and dibenz[a,h]anthracene, a substantial increase (50%) in the rate of tumor induction was observed (Falk et al. 1964).

Several experiments have shown that most PAH mixtures are considerably less potent than individual PAHs. Various combustion emissions and benzo[a]pyrene have been examined for carcinogenic potency and tumor initiation activity on mouse skin. In all cases, PAH mixtures were much less potent than benzo[a]pyrene. The authors calculated relative potency estimates that ranged from 0.007 for coke oven emissions extract to less than 0.002 for diesel engine exhaust extract, using papillomas per mouse per milligram of the mixture as the end point (Slaga et al. 1980b). Another study demonstrated that the relative tumorigenicities, as compared to benzo[a]pyrene, of automobile exhaust .condensate (AEC), diesel emission condensate, and a representative mixture of carcinogenic PAHs were 0.0053, 0.00011, and 0.36, respectively, following chronic application to mouse skin (Misfeld 1980). AEC has also exhibited an antagonistic influence on benzo[a]pyrene carcinogenicity when subcutaneously administered to mice; this effect was particularly augmented at higher benzo[a]pyrene concentrations (Pott et al. 1977).

Carcinogenic and noncarcinogenic PAHs, comprising a quantitative fraction of automobile exhaust gas condensate, were selected for carcinogenicity testing via dermal exposure of female NMRI mice. The purpose was to identify interactions between mixtures of the carcinogenic and noncarcinogenic PAHs (Schmahl et al. 1977). The carcinogenic PAHs were benzo[a]pyrene, dibenz[a,h]anthracene, benz[a]anthracene, benzo[b]fluoranthene; and the noncarcinogenic PAHs were phenanthrene, anthracene, fluoranthene, pyrene, chrysene, benzo[e]pyrene, and benzo[g,h,i]perylene. Treatment was carried out twice a week, for the natural lifetime of the animals. Although the carcinogenic action observed could be attributed almost entirely to the action of the carcinogenic PAHs, in relatively small doses, addition of the noncarcinogenic PAHs did not inhibit carcinogenesis, but had an additive effect.

Predicting the toxicity of a complex mixture on the basis of one of several of its components may be misleading, because the interactions among the components may modify toxicity. Since PAHs require metabolic activation by monoxygenases to elicit carcinogenic effects, any alteration in these metabolic pathways will influence the observed toxicity. There are two primary mechanisms by which chemicals interact with PAHs to influence toxicity. A compound may compete for the same metabolic activating enzymes and thereby reduce the toxicity of carcinogenic PAHs, or it may induce the metabolizing enzyme levels to result in a more rapid detoxification of the carcinogenic PAHs (Levin et al. 1982). Chaloupka et al. (1993) showed that a mixture of PAHs, produced as by-products from a manufactured gas plant, was 706 times more potent than expected, based on its benzo[a]pyrene content (0.17%) at inducing mouse hepatic microsomal ethoxyresorufin O-deethylase. Alternatively, compounds may compete for a deactivating pathway, thereby increasing the toxicity of PAHs (Furman et al. 1991). Many monooxygenase inducers are ubiquitous in the environment, and they may have an effect on the toxicity of PAHs. For example, environmental contaminants such as tetrachlorodibenzo-p-dioxin (TCDD), polychlorinated biphenyls (PCBs) and 3,3’,4,4’-tetrachlorobiphenyl (TCBP) can increase microsomal enzyme activity and consequently affect PAH toxicity (Jacob et al. 1987; Kouri et al. 1978). The dermal absorption of benzo[a]pyrene was measured in the presence or absence of complex organic mixtures derived from coal liquefaction processes (Dankovic et al. 1989). The dermal half-life of benzo[a]pyrene was 3.0 hours when applied alone, 6.7 hours when measured as a component of a mixture, and ranged from 7.8 to 29.7 hours in the presence of different mixtures. The authors proposed that these mixtures inhibit the dermal absorption of benzo[a]pyrene by inhibiting the metabolism of benzo[a]pyrene at the application site. Interactions. can thus play important modulatory roles in the expression of PAH toxicity that may not be adequately reflected based on the toxicity of a single PAH.

The majority of human exposures to PAHs occur in the presence of particles that affect the pharmacokinetics of PAHs in a manner that can enhance their carcinogenicity. Coadministration of benzo[a]pyrene and particulate material, such as hematite (Fe_2O_3) and arsenic trioxide (As_2O_3), greatly increases respiratory tract tumor yields in laboratory animals following intratracheal instillation (Pershagen et al. 1984; Saffiotti et al. 1972; Stenback and Rowland 1979; Stenback et al. 1976). The effects of particles on the potential human carcinogenicity of PAHs are likely to be similar. When benzo[a]pyrene is particle-bound, clearance from hamster lungs is slower than that of pure benzo[a]pyrene aerosol, increasing the length of time the lungs are exposed and increasing the dose to the gastrointestinal tract as a result of mucocilliary clearance. Respirable benzo[a]pyrene-containing particulates such as diesel exhaust, when coated with the phospholipid component of a pulmonary surfactant, are genotoxic (Wallace et al. 1987). Dusts can increase the rates of pulmonary cell proliferation (Harris et al. 1971; Stenback and Rowland 1979; Stenback et al. 1976), which in turn increases the cells' susceptibility to an initiation event in the presence of a carcinogen.

Environmental exposure to PAHs can also occur along with exposure to other environmental pollutants. The effects of exposure to SO_2 (either by inhalation or systemically with endogenous sulfite/bisulfite anions that accumulated as a result of induced sulfite oxidase deficiency) on benzo[a]pyrene-induced lung tumors were studied in male Sprague-Dawley rats (Gunnison et al. 1988). The animals, were administered benzo[a]pyrene (1 mg) by weekly intratracheal instillation for 15 weeks during which time they were exposed daily by inhalation to 30 or 60 ppm SO_2 or were maintained on a high tungsten to molybdenum diet. There were no statistically significant differences between the benzo[a]pyrene only and the benzo[a]pyrene + SO_2 or benzo[a]pyrene + sulfite/bisulfite groups with respect to the incidence of squamous cell carcinomas of the lung, latency for tumor development, or rate of appearance. Although benzo[a]pyrene alone induced almost 100% tumor incidence leaving little room for an SO_2-induced enhanced response, a shortened latency or increased rate of appearance would have suggested that SO_2 potentiates the carcinogenicity of benzo[a]pyrene, and this did not occur. Therefore, the authors concluded that SO_2 does not potentiate the carcinogenicity of benzo[a]pyrene in the lung.

Concomitant exposure to solvents may also occur, particularly in an occupational setting. It has been demonstrated that pretreatment of rats with toluene (1 g/kg intraperitoneally) inhibits the total cytochrome P-450 content in microsomes isolated from the lungs (Furman et al. 1991). In addition, formation of 3-hydroxybenzo[a]pyrene (a nontoxic metabolite) was inhibited by 36% by the

microsomes *in vitro* whereas the formation of several diols (reactive intermediates) was unaffected by toluene pretreatment. These results indicate that toluene alters the balance between toxification and detoxification of benzo[a]pyrene by cytochrome P-450 in the lung, favoring the formation of reactive genotoxic/carcinogenic intermediates. Therefore, the authors suggested that concomitant exposure to solvents, such as toluene, and PAHs may result in an increased risk for lung cancer.

Asbestos exerts a synergistic influence on cigarette smoke (which contains several PAHs) in the development of bronchopulmonary cancers. This has important implications for workers occupationally exposed to asbestos, who also smoke. The interaction between cigarette smoke and asbestos may be explained partly by differences in the kinetics of PAH cell uptake when PAHs are preadsorbed on asbestos (Foumier and Pezerat 1986). Plutonium oxide (PuO_2) has also been shown to enhance benzo[a]pyrene-induced lung carcinogenesis following simultaneous inhalation of both compounds (Metivier et al. 1984).

Another component of cigarette smoke, nicotine, may also affect the toxicokinetics of PAHs. When introduced in the perfusion medium with benzo[a]pyrene, nicotine inhibited the elimination of benzo[a]pyrene from the lung (Foth et al. 1988a).

Naturally occurring compounds have been found to induce the enzymes that metabolize PAHs, leading to either increased or decreased toxicity. Compounds that exert a protective effect against the carcinogenicity of PAHs and are enzyme inducers include plant flavonoids, plant phenols, antioxidants, retinoids (vitamin A), garlic oil, selenium, molybdenum, turmeric extracts, nitrates, soy sauce, and Chinese herbs. Plant flavonoids can induce microsomal monooxygenases and reduce the carcinogenicity of benzo[a]pyrene (Weibel 1980). Flavones administered orally or dermally increased benzo[a]pyrene hydroxylase activity in the small intestine and skin, respectively, and prevented the formation of pulmonary adenomas and forestomach and skin tumors initiated by benzo[a]pyrene (Rahimtula et al. 1977; Wattenberg and Leong 1970). A series of flavonoids and isoflavonoids, compounds that are found in fruits and vegetables, were tested for their ability to inhibit metabolism of benzo[a]pyrene in cultured hamster embryo cells (Chae et al. 1992). The results indicated that the flavonoids are generally more active than the isoflavonoids, and that two hydroxyl, two methoxyl, or methyl and hydroxyl substituents at the 5- and 7-positions and a 2,3-double bond are the structural characteristics required for inhibition of benzo[a]pyrene metabolism to reactive intermediates. Two of these compounds, acacetin and kaempferide also inhibited benzo[a]pyrene-induced mutation in Chinese

hamster V79 cells. Therefore, the authors proposed that the protective effect of these compounds may be due to their ability to inhibit metabolism of benzo[a]pyrene to reactive intermediates. Similar results have been obtained with pine cone extracts, tested in the *Salmonella typhimurium* assay (Lee et al. 1993). These results suggest that these compounds may be useful as potential chemopreventive agents in individuals exposed to genotoxic/carcinogenic PAHs.

Dietary plant phenols, such as tannic acid, quercetin, myricetin, and anthraflavic acid exhibit a protective effect against the tumorigenicity of benzo[a]pyrene and other PAHs by altering the metabolic pathways that detoxify and activate PAHs to their ultimate carcinogenic metabolites, thus suppressing PAH metabolism and subsequent PAH-DNA adduct formation. It has been suggested that the possible mechanism for the anticarcinogenic effect of these plant phenols may be an inhibitory effect on the binding of the ultimate carcinogen to the target tissue DNA (Mukhtar et al. 1988). Oral administration of these compounds has been associated with a decrease in tumorigenesis induced by benzo[a]pyrene in mouse forestomach (Katiyar et al. 1993a, 1993b; Zheng et al. 1993). Antioxidants also affect benzo[a]pyrene hydroxylation by rat liver microsomal MFOs, and reduce the bacterial mutagenicity of benzo[a]pyrene in the presence of rat liver microsomes and cofactors (Rahimtula et al. 1977). Antioxidants such as BHA, BHT, phenothiazine, phenothiazine methosulfate, and ethoxyquin all can reduce the quantitative yield of benzo[a]pyrene metabolites in incubations with rat liver microsomes (Sullivan et al. 1978).

Retinoids, of which vitamin A is a member, have demonstrated an antagonistic effect on benzo[a]pyrene-induced carcinogenicity. (Vitamin A has been shown to prevent and/or reverse the genetic damage caused by benzo[a]pyrene.) Similarly, the ability of benzo[a]pyrene (75 mg/kg, oral administration) to induce micronuclei *in vivo* was completely inhibited in Swiss mice orally administered doses of vitamin A ranging from 750 to 1,500 mg/kg 1 hour prior to benzo[a]pyrene treatment (Rao and Nandan 1990). Although the protective mechanism has not been fully elucidated, it has been suggested that vitamin A interferes with the activation of benzo[a]pyrene to its reactive metabolites, thus reducing the amount of benzo[a]pyrene-DNA binding in rat liver and target tissues (i.e., stomach) to prevent the mutagenic action of benzo[a]pyrene. It has also been suggested that vitamin A can enhance DNA repair (McCarthy et al. 1987; Rao et al. 1986). Conversely, vitamin A deficiency enhances the mutagenicity and carcinogenic effect of cigarette smoke and benzo[a]pyrene. This activity is related to a decreased level of free radical scavengers like ascorbic acid and glutathione in the liver (Alzieu et al. 1987). Another study observed that vitamin A deficient animals exposed to

cigarette smoke via inhalation exhibited enhanced benzo[a]pyrene-DNA adduct formation (Gupta et al. 1987, 1990). This has important implications for humans who smoke and consume diets deficient in vitamin A. Mammary tumor incidence was reduced by 27% (from 67% to 40%) in female rats receiving retinyl acetate before, during, and after the administration of either a single dose or eight weekly doses of benzo[a]pyrene. These results demonstrate that retinyl acetate is capable of inhibiting benzo[a]pyrene-induced mammary tumor formation in rats when given before, during, and after carcinogen treatment (McCormick et al. 1981).

The oral gavage administration of 25 mg/kg *n*-acetylcysteine (NAC) prevented the formation of benzo[a]pyrene-diol-epoxide-DNA adducts in rats receiving benzo[a]pyrene by intratracheal instillation for 3 consecutive days (25 mg/kg in 2% Tween 80) (De Flora et al. 1991). Inhibition of DNA adduct formation was more efficient in the liver than in the lungs. Similarly, micronuclei induction in the benzo[a]pyrene-treated rats was completely reversed by NAC. These results suggest that NAC, which is a glutathione precursor, may be effective in preventing or reversing the binding of the reactive intermediates of PAHs to cellular macromolecules and, therefore, may prevent the subsequent toxic effects of PAHs.

Coumarin, also known to be anticarcinogenic, inhibited benzo[a]pyrene-induced micronuclei in male ICR mice pretreated with 65 or 130 mg/kg/day coumarin for 6 days prior to the intraperitoneal administration of 150 mg/kg benzo[a]pyrene (Morris and Ward 1992). However, pretreatment with either dose of coumarin did not alter the genotoxicity of benzo[a]pyrene when females were included in the study.

Garlic oil also exhibits an antagonistic effect on benzo[a]pyrene by inhibiting benzo[a]pyrene-induced skin carcinogenesis in Swiss mice during the initiation phase (Sadhana et al. 1988). A primary constituent of garlic oil, allyl methyl trisulfide (ATM), has also demonstrated an inhibitory effect on benzo[a]pyrene induced neoplasia of the forestomach in mice (Spamins et al. 1986).

Selenium has been shown to reduce the mutagenicity of benzo[a]pyrene as well as AHH activity (Lee and Lin 1988). Selenium also inhibits the metabolism of benzo[a]pyrene *in vitro* (Bompart and Clements 1990). Several different salts of molybdenum inhibited the formation of certain metabolites of benzo[a]pyrene by lung and liver microsomes *in vitro* obtained from rats pretreated with 3-methylcholanthrene (Bompart et al. 1989). In a later study, it was demonstrated that benzo[a]pyrene

metabolism *in vitro* by lung and liver microsomes isolated from rats that were exposed to 40 or 80 mg/kg of ammonium heptamolybdate for 8 weeks was inhibited (Bompart 1990). These results suggest that molybdenum interferes with the cytochrome P-450 enzymes responsible for the activation of benzo[a]pyrene, and thus may have a protective effect against benzo[a]pyrene-induced toxicity/carcinogenicity.

Ferric oxide has been shown to increase the metabolism of benzo[a]pyrene by hamster alveolar macrophages (Greife and Warshawsky 1993). Alveolar macrophages, the primary lung defense cell, have been shown to metabolize benzo[a]pyrene to a more biologically active form, and then release the metabolites. Concurrent exposure of hamster alveolar macrophages to benzo[a]pyrene-coated ferric oxide resulted in a significant increase in the amount of benzo[a]pyrene metabolites and superoxide anions, which have been shown to produce localized lipid peroxidation and edema *in vivo.*

Lindane, an isomer of hexachlorocyclohexane, is an organochlorine pesticide which is extensively used in agricultural and public health programs in developing countries (Khan et al. 1993). Pretreatment of rat lungs with lindane by intratracheal injection inhibited benzo[a]pyrene hydoxlase activity in the lungs. Reduced elimination of intravenously administered benzo[a]pyrene from the lungs of rats after lindane pretreatment was also observed, suggesting that lindane may alter the clearance of benzo[a]pyrene from the lungs.

Prostacyclin has been shown to significantly reduce genetic damage caused by benzo[a]pyrene to mouse bone marrow cells, using the micronucleus test (Koratkar et al. 1993).

Chinese herbs commonly used in anti-cancer drugs have also been demonstrated to inh.ibit the mutagenicity of benzo[a]pyrene (Lee and Lin 1988).

Aqueous extracts of turmeric, curcumin-free aqueous turmeric extract, and curcumin were tested for their ability to inhibit benzo[a]pyrene-induced mutagenicity in the *S. typhimurium* assay and the bone marrow micronucleus test in Swiss mice (Azuine et al. 1992). A dose-dependent inhibition of benzo[a]pyrene-induced mutagenicity was observed in two strains of *Salmonella* in the presence of Aroclor-1254-induced rat liver homogenate, and 3 mg/kg of these three extracts also significantly inhibited benzo[a]pyrene-induced bone marrow micronuclei formation by 43%, 76%, and 65%. Female Swiss mice were treated with either aqueous turmeric extract (3 mg/day), curcumin-free

aqueous tumeric extract (1 mg/day), or curcumin (1 mg/day) 5 days/week for 2 weeks prior to receiving twice weekly gavage administrations of 20 mg/kg benzo[a]pyrene for 4 weeks. The treatment with the turmeric extracts continued for another 2 weeks after the cessation of benzopyrene treatment, and the animals were observed until they were 180 days old. A group receiving just benzo[a]pyrene served as a control. The benzo[a]pyrene-only animals exhibited 100% tumor incidence with 9.1±0.6 papillomas/mouse. All three extracts significantly ($p<0.00l$) inhibited the formation of forestomach papillomas by benzo[a]pyrene by 53%, and the average numbers of papillomas per mouse was also significantly decreased. The authors suggested that turmeric extracts may be useful as chemopreventive agents, but that there are probably several mechanisms of action for these inhibitory effects.

Pumark, a mixture of solvent extracts of tumeric, betel leaf, and catechu, was tested for its chemopreventative activity against benzo[a]pyrene-induced DNA damage (Ghaisas and Bhide 1994) Sister chromatid exchange and micronuclei formation in human lymphocyte culture were used as markers to assess the protective effect of Pumark. Pumark gave 50-60% protection against benzo[a]pyrene-induced chromosomal damage.

Other environmentally ubiquitous substances, such as nitrites and nitrates, have been shown to interact with PAHs. Pyrene is not mutagenic in the *Salmonella typhimurium* assay. However, when injected intraperitoneally into mice at doses of 10-200 mg/kg in combination with inhalation exposure to 50 or 100 ppm nitrous oxide (NO_2) mutagenic metabolites of pyrene were recovered from the urine (Kanoh et al. 1990). In addition, 1-hydroxypyrene (the major urinary metabolite of pyrene) administration in combination with NO_2 exposure also produced mutagenic metabolites. These results suggest that combined exposure to pyrene, a prevalent environmental PAH, and nitrogen compounds could result in the formation of nitrogenated mutagenic metabolites of pyrene. The effects of nitrite (in drinking water) and/or soy sauce (in food) on the forestomach tumors induced by twice weekly gavage administration of eight total doses of benzo[a]pyrene were studied in mice (Benjamin et al. 1988). The combination of nitrite and soy sauce resulted primarily in a significant reduction in the number of tumors per animal induced by benzo[a]pyrene, and also a reduction in tumor incidence. Neither substance alone had much effect on the carcinogenicity of benzo[a]pyrene alone. The mechanism for this protective effect of the combination of nitrite and soy sauce is not known.

The fungicide (prochloraz), the topical antifungal agent (miconazole) and 7,8-benzoflavone (a strong inhibitor of cytochrome P-450) limited the conversion of benzo[a]pyrene to a mutagen in S. *typhimurium.* The order of inhibitory action was 7,8-benzoflavone ≥ prochloraz ≥ miconazole (Antignac et al. 1990).

Diet (i.e., dietary fat levels) can also have an effect on the disposition and toxicity of PAHs. The metabolism of benzo[a]pyrene in hepatocytes *in vitro* from rats fed high-fat (as corn oil) diets was decreased (Zaleski et al. 1991). This effect was not due to a decrease in the activity of AHH. The authors postulated that the high-fat diets allowed benzo[a]pyrene, which is highly lipophilic, to become sequestered in lipid droplets and, therefore, become inaccessible to the P-450 enzymes. Another study suggests that caloric restriction, per se, can reduce the metabolic activation capacity of the liver, thereby reducing the production of mutagenic metabolites from PAHs (Xiao et al. 1993).

Organosulphur compounds, e.g., S-methyl cysteine sulphoxide (SMCSO) and its metabolite methyl methane thiosulphinate, both naturally occurring compounds present in Brassica vegetables (broccoli, cabbage) were found to inhibit benzo[a]pyrene-induced micronucleus formation in mouse bone marrow by 31 and 33%, respectively, after oral administration (Marks et al. 1993).

o-Cresol, often found in conjunction with PAHs in industrial waste from coking, oil processing, shale processing, and other industries, was found to protect mice from benzo[a]pyrene-induced forestomach tumors after oral administration, when o-cresol was administered before or after benzo[a]pyrene (Yanysheva et al. 1993).

Topical application of 1% croton oil twice weekly at 4 weeks of age had an inhibitory effect on tumor formation in offspring of ICF/Ha female mice treated with intraperitoneal injections of benzo[a]pyrene in sesame oil on the llth, 13th and 15th days of pregnancy (Bulay and Wattenberg 1971).

Administration of a diet containing 3% myo-inositol to mice beginning one week after oral benzo[a]pyrene administration reduced the number of pulmonary adenomas by 40% but did not prevent forestomach tumors (Estensen and Wattenberg 1993). Under the same conditions, administration of 0.5% dexamethasone in the diet inhibited pulmonary adenomas by 57% and also inhibited forestomach tumor formation to a similar degree. A combination of the two compounds resulted in additive chemoprevention.

The ubiquitous nature of PAHs in the environment, particularly as constituents of complex mixtures such as automobile emissions, coal tar, coke oven emissions, and combustion products of tobacco, increases the likelihood that the type of interactions discussed will occur. Thus, interactions may play a decisive role in the expression of toxicity and the development of cancer in exposed populations.

2.7 POPULATIONS THAT ARE UNUSUALLY SUSCEPTIBLE

A susceptible population will exhibit a different or enhanced response to PAHs than will most persons exposed to the same level of PAHs in the environment. Reasons include genetic make-up, developmental stage, age, health and nutritional status (including dietary habits that may increase susceptibility, such as inconsistent diets or nutritional deficiencies), and substance exposure history (including smoking). These parameters result in decreased function of the detoxification and excretory processes (mainly hepatic, renal, and respiratory) or the pre-existing compromised function of target organs (including effects or clearance rates and any resulting end-product metabolites). For these reasons we expect the elderly with declining organ function and the youngest of the population with immature and developing organs will generally be more vulnerable to toxic substances than healthy adults. Populations who are at greater risk due to their unusually high exposure are discussed in Section 5.6, Populations With Potentially High Exposure.

Data suggest that specific subsections of the population may be susceptible to the toxic effects produced by exposure to PAHs. These include people with various conditions, such as aryl hydrocarbon hydroxylase (AHH) that is particularly susceptible to induction, nutritional deficiencies, genetic diseases that influence the efficiency of DNA repair, and imrnunodeficiency due to age or disease. Other subsections of the population that may be susceptible to the toxic effects of PAHs are people who smoke, people with a history of excessive sun exposure, people with liver and skin diseases, and women, especially of child-bearing age. Human fetuses may also be particularly susceptible to the toxic effects produced by exposure to PAHs. Data also indicate that the general population may be at increased risk of developing lung cancer following prolonged inhalation of PAH-contaminated air, and skin cancer following concurrent dermal exposure to PAHs and sunlight. There is some limited evidence that indicates that all people could be sensitive at some point to the toxic effects of environmental contaminants, such as PAHs, as a result of stress and/or circadian rhythms.

Pre- and post-natal exposure to PAHs could produce adverse reproductive and developmental effects in human fetuses. Most PAHs and their metabolites cross the placenta because of their lipid solubility (Calabrese 1978; Shendrikova and Aleksandrov 1974). Fetuses are susceptible to the toxic effects produced by maternal exposure to PAHs, such as benzo[a]pyrene, because of an increased permeability of the embryonic and fetal blood-brain barrier and a decreased liver-enzyme conjugating function (Calabrese 1978; Shendrikova and Aleksandrov 1974). Because of PAH exposure, higher incidences of embryo- and fetolethality, stillbirths, resorptions, and malformations of the kidney and bladder have been observed in animals (Legraverend et al. 1984; Urso and Gengozian 1980; Urso and Johnson 1987). Delayed effects have been observed in the progeny of mothers exposed to PAHs, such as benzo[a]pyrene (Urso and Gengozian 1980). These .delayed effects include sterility of progeny, immune suppression, possible alteration of endocrine function, and cancer in rodents (Csaba and Inczefi-Gonda 1992; Csaba et al. 1991; Legraverend et al. 1984; Mackenzie and Angevine 1981). Tobacco smoke contains both PAHs and particulate matter. These could interact synergistically in pregnant women who smoke to produce decreased birth weight, increased perinatal morbidity and mortality, and other diseases of the newborn (NRC 1983). PAHs in cigarette smoke, such as benzo[a]pyrene, have been associated with the induction of AHH activity in human placental tissue and a decrease in placental size (NRC 1983). Results of *in vitro* studies indicate that benzo[a]pyrene alters human placental endocrine and metabolic function (Avigdor et al. 1992; Bamea and Shurtz-Swirski 1992; Guyda 1991; Guyda et al. 1990).

People with AHH that is particularly susceptible to induction may also be susceptible to the possible carcinogenic effect of exposure to PAHs. This enzyme is mixed function oxidase (MFO) that is involved in the metabolism of PAHs to certain reactive intermediates that can cause cell transformation, mutagenicity, and cytotoxicity. The incidence of this inducible genetic trait is low in 53%, intermediate in 37%, and high in 10% of the white population in the United States (Calabrese 1978). It has been proposed that genetically expressed AHH inducibility is related to the development of bronchogenic carcinoma in persons exposed to PAHs contained in tobacco smoke. On the other hand, individuals with a greater ability to induce AHH may be able to rapidly detoxify PAHs and eliminate them, thus making them less susceptible to the toxic effects of PAHs. Based on the population frequency of genetically controlled AHH induction, some scientists predict that approximately 45% of the general population are considered to be at high risk, and 9% of the 45% are considered to be at very high risk, of developing bronchogenic carcinoma following exposure to PAHs (Calabrese 1978).

Certain nutritional deficiencies have been associated with an increased cancer incidence in PAH-exposed animals. These include deficiencies in vitamins A and C, iron, and riboflavin (Calabrese 1978). It is estimated that at least 25% of all children between the ages of 7 and 12 years and all children of low-income families consume less than the recommended dietary allowance (RDA) of vitamin A. It has also been estimated that between 10% and 30% of the infants, children, and adults of low-income groups consume less than the RDA for vitamin C, 98% of all children consume less than the RDA for iron, and 30% of women and 10% of men between the ages of 30 and 60 years consume less than two-thirds of the RDA for riboflavin (Calabrese 1978). Other nutrients such as vitamin D, selenium, and protein can also influence the cancer incidence in animals exposed to PAHs (NRC 1983; Prasanna et al. 1987). Several studies have been conducted to investigate the interaction between nutrition and PAH exposure by administering benzo[a]pyrene to laboratory animals. The nutritional factors listed above either reduced the amount of benzo[a]pyrene binding to DNA in rat liver or forestomach tissue (McCarthy et al. 1987), prevented or reversed genetic damage (Rao et al. 1986), or reduced the activity of AHH (Prasanna et al. 1987). It has also been observed that fasted rats showed altered toxicokinetics of PAHs resulting from benz[a]anthracene and chrysene exposure. This altered toxicokinetics included reduced hepatic clearance because of decreased AHH activity and the acceleration of the depletion of cytochrome P-450 and other microsomal enzymes required to metabolize PAHs (Fiume et al. 1983).

Individuals who undergo a rapid reduction in body fat may be at risk from increased toxicity because of the systemic release and activation of PAHs that had been stored in fat. The metabolism of benzo[a]pyrene in hepatocytes *in vitro* from rats fed high-fat (as corn oil) diets was decreased (Zaleski et al. 1991). This effect was not due to a decrease in the activity of AHH. The authors postulated that the high-fat diets allowed benzo[a]pyrene, which is highly lipophilic, to become sequestered in lipid droplets and, therefore, become inaccessible to the P-450 enzymes.

People exposed to PAHs in conjunction with particulates from tobacco smoke, fossil-fuel combustion, coal fly ash, and asbestos fibers are at increased risk of developing toxic effects, primarily cancer. Even people not susceptible to the toxic effects of PAHs may become affected when exposure occurs in conjunction with exposure to particulates (NRC 1983). This enhanced effect results from the adsorption of PAHs onto the particulates. They are vacuolized into cells, and distributed differently in tissues depending on the size and type of particulate matter. This increased PAH uptake may result in more efficient induction of AHH activity at low PAH concentrations. This activity also increases the

dose to the gastrointestinal tract as a result of mucocilliary clearance (NRC 1983). This synergistic action between PAHs and particulate matter in air pollution has been associated with the occurrence of stomach cancer in humans (Fraumeni 1975).

Immunocompetence is an important factor in decreasing or preventing human susceptibility to toxicity and disease after exposure to environmental contaminants. Small children have an immature immune system, and the elderly may have a deficient immune system due to age, genetic factors, or disease (Calabrese 1978; NRC 1983). It is possible that individuals whose immune systems are compromised could be at an increased risk of carcinogenesis, including that produced by PAHs. Some genetic diseases that may predispose a person to immune deficiency include ataxia telangiectasia, Wiskott-Aldrich syndrome, Bloom's syndrome, common variable immunodeficiency, selective IgA deficiency, Bruton's agammaglobulinemia, severe combined immunodeficiency, selective IgM deficiency, AIDS, and immunodeficiency with normal or increased immunoglobulins (NRC 1983).

Genetic diseases that reduce DNA-repair capabilities also increase an individual's susceptibility to PAH-related malignancy by reducing the efficiency of DNA repair. In fact, the level of benzo[a]pyrene/DNA adducts in peripheral lymphocytes was slightly but significantly higher in 22 lung cancer patients who had at least one "first-degree" relative with lung cancer than in 30 healthy controls (Nowak et al. 1992). This finding led the authors to speculate that altered metabolic activation and deactivation and increased formation of adducts may indicate a genetic predisposition for lung cancer. Some of the diseases that reduce DNA repair capability are also associated with an abnormality of the immune system (NRC 1983). Diseases that may be associated with DNA-repair deficiencies are classical and variant xeroderma pigmentosum, ataxia telangiectasia, Bloom's syndrome, Fanconi's anemia, familial retinoblastoma, D-deletion retinoblastoma, progeria (Hutchinson-Gilford) syndrome, Down's syndrome, dyskeratosis congenita, Cockayne's syndrome, actinia keratosis, and cutaneous malignant melanoma (NRC 1983).

Women may be at increased risk of reproductive dysfunction following exposure to high levels of PAHs. Data from animal studies indicate that oocyte and follicle destruction occurs following dosing with PAHs (Mattison et al. 1989; Miller et al. 1992; Urso and Gengozian 1980; Urso and Johnson 1987). Benzo[a]pyrene exposure may reduce fertility and the ability to bear children (Mackenzie and Angevine 1981; Rigdon and Rennels 1964). Exposure may also reduce fertility of exposed women by

causing ovarian dysfunction (Swartz and Mattison 1985). However, the doses that produced the effects discussed above are high relative to expected environmental exposures to PAHs.

Subsections of the population that suffer from liver and skin diseases may be at increased risk of developing adverse effects from exposure to PAHs. People with pre-existing skin conditions, such as pemphigus vulgaris and xeroderma pigmentosum, and those with normal skin may be at increased risk of developing adverse dermal effects ranging from rashes to cancer following exposure to some PAHs, such as benzo[a]pyrene, anthracene, benz[a]anthracene, and pyrene (Bingham and Falk 1969; Cavalieri et al. 1977, 1988b; Cottini and Mazzone 1939; Forbes et al. 1976; Habs et al. 1980; Shubik and Porta 1957). Exposure to more than one PAH may enhance or reduce tumor development (Slaga et al. 1979; Van Duuren and Goldschmidt 1976; Van Duuren et al. 1973). Skin cancer induction in laboratory animals has been associated with exposure to benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzohlfluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene.

People with significant exposure to ultraviolet radiation, such as from sunlight, may also be at increased risk of developing skin cancer due to PAH exposure. Ultraviolet radiation has a synergistic influence on PAH-induced skin cancer following dermal exposure. It enhances benzo[a]pyreneinduced skin carcinogenesis in the mouse, which is dependent on the dose of benzo[a]pyrene (Gensler 1988). Combined exposure to anthracene and sunlight could produce mutagenic lesions (Blackbum and Taussig 1975; Forbes et al. 1976). Laboratory animals exposed concurrently to chronic ultraviolet irradiation and to PAHs were at a higher risk of skin tumor induction (Mukhtar et al. 1986).

2.8 METHODS FOR REDUCING TOXIC EFFECTS

This section will describe clinical practice and research concerning methods for reducing toxic effects of exposure to PAHs. However, because some of the treatments discussed may be experimental and unproven, this section should not be used as a guide for treatment of exposures to PAHs. When specific exposures have occurred, poison control centers and medical toxicologists should be consulted for medical advice.

2.8.1 Reducing Peak Absorption Following Exposure

General recommendations to reduce absorption follo.wing acute exposure to PAHs include removing the individual from the source of exposure, removing contaminated clothing, and decontaminating exposed areas of the body. It has been suggested that contaminated skin should be washed with soap and water, and eyes exposed to PAHs should be flushed with water or saline (Stutz and Janusz 1988). Administration of activated charcoal following ingestion of PAHs is recommended; however, it has not been proven to reduce absorption of PAHs in the gastrointestinal system (Stutz and Janusz 1988). The use of emetics as a means of gastrointestinal decontamination of PAHs is not recommended (Bronstein and Currance 1988). There is a risk of causing chemical pneumonitis in the patient by the aspiration of the PAHs.

2.8.2 Reducing Body Burden

There are no known methods currently available for reducing the body burden of PAHs. Evidence from acute-duration studies in experimental animals indicates that PAHs are rapidly metabolized and conjugated to form water-soluble metabolites that are essentially completely eliminated in the urine and feces within a matter of days (see Sections 2.3.3 and 2.3.4). No data are available on the kinetics of PAHs following chronic exposure, so it is not known if PAHs or their metabolites bioaccumulate in these exposure situations. Given the relatively rapid and complete excretion observed following short-term exposures, it is not likely that PAHs bioaccumulate to an appreciable degree. However, PAHs are lipophilic, so it is conceivable that unmetabolized parent compound could accumulate in tissue fat stores. In fact, diet (i.e., dietary fat levels) may have an effect on the disposition and toxicity of PAHs. The metabolism of benzo[a]pyrene in hepatocytes *in vitro* from rats fed high-fat (as corn oil) diets was decreased (Zaleski et al. 1991). This effect was not due to a decrease in the activity of AHH. The authors postulated that the high-fat diets allowed benzo[a]pyrene, which is highly lipophilic, to become sequestered in lipid droplets and, therefore, become inaccessible to the P-450 enzymes. Therefore, high-fat diets may favor the accumulation of parent PAHs in lipids so that they are not metabolized to reactive intermediates or water-soluble conjugates. Alternatively, rapid fat loss may result in the release of sequestered parent PAHs, making them available to the P-450 enzymes to be metabolized to reactive intermediates as well as water-soluble conjugates that can be easily excreted. Thus, modulating body fat content may reduce body burden of PAHs by hastening

their metabolism to water-soluble conjugates. However, the result may also be an increase in toxicity due to increased metabolism to reactive intermediates.

2.8.3 Interfering with the Mechanism of Action for Toxic Effects

As discussed in Sections 2.3.5 and 2.4, it is currently believed that the toxic and carcinogenic effects of PAHs are mediated by reactive diol-epoxide intermediates that interact directly with DNA and RNA, producing adducts. The formation of these adducts leads to neoplastic transformation as well as interfering with the normal functioning of rapidly proliferating tissues. As discussed above, these reactive intermediates are formed when PAHs are biotransformed by the P-450 enzymes. Interference with these metabolic pathways, by inactivation of the activated diol epoxides, reduction in tissue levels of cytochrome P-450, and direct inhibition of the cytochrome P-450 enzymes responsible for the formation of the reactive intermediates, could reduce the toxic and carcinogenic effects of PAHs. A number of drugs, such as cobaltous chloride, SKF-525-A, and 6-nitro- 1,2,3-benzothioadiazole, have been reported to inhibit P-450 enzymes. In addition, as discussed in Section 2.7, other compounds that exert a protective effect against the carcinogenicity of PAHs by interfering with cytochrome P-450 enzymes include plant flavonoids, plant phenols, antioxidants (such as BHA, BHT, phenothiazine, phenothiazine methosulfate, and ethoxyquin), retinoids (vitamin A), garlic oil, selenium, organosulphur compounds, o-cresol, myo-inositol, lindane, and molybdenum (Bompart 1990; Bompart et al. 1989; Chae et al. 1992; Estensen and Wattenberg 1993; Ghaisas and Bhide 1994; Katiyar et al. 1993a, 1993b; Khan et al. 1993; Lee and Lin 1988; Lee et al. 1993; Marks et al. 1993; Mukhtar et al. 1988; Rahimtula et al. 1977; Rao and Nandan 1990; Sullivan et al. 1978; Weibel 1980, Yanysheva et al. 1994; Zheng et .al. 1993). Reduced caloric intake has also been shown to cause decreased metabolism of PAHs by liver microsomes, thus protecting against genotoxic effects (Xiao et al. 1993). P-450 metabolism also results in products that can be more readily eliminated than can the parent compound. Hence, any side products of the drugs or substances listed above, along with their potential to increase the biological half-life of the PAHs, would also need to be considered in any protocol. Further research to determine which cytochrome P-450 isozymes are involved in the metabolism to the reactive intermediates, as well as which isozymes are involved in enhancing the elimination of PAHs, could lead to the development of strategies to selectively inhibit specific isozymes and, thus, reduce the toxic effects of PAHs.

It has also been suggested that some of these compounds may act at other points in the activation, macromolecular binding sequence described above. For instance, vitamin A can also enhance DNA repair (McCarthy et al. 1987; Rao et al. 1986).

Because PAHs are detoxified by conjugation with substances such as glutathione (see Sections 2.3.3 and 2.3.4), sufficient glutathione stores in the body may reduce the chances of toxic effects following acute exposure to PAHs. For example, the oral gavage administration of NAC prevented the formation of benzo[a]pyrene-diol-epoxide-DNA adducts in rats receiving benzo[a]pyrene (De Flora et al. 1991). Inhibition of DNA adduct formation was more efficient in the liver than in the lungs. Similarly, micronuclei induction in the benzo[a]pyrene-treated rats was completely reversed by NAC. These results suggest that NAC, which is a glutathione precursor, may be effective in preventing or reversing the binding of the reactive intermediates of PAHs to cellular macromolecules and, therefore, may prevent the subsequent toxic effects of PAHs.

2.9 ADEQUACY OF THE DATABASE

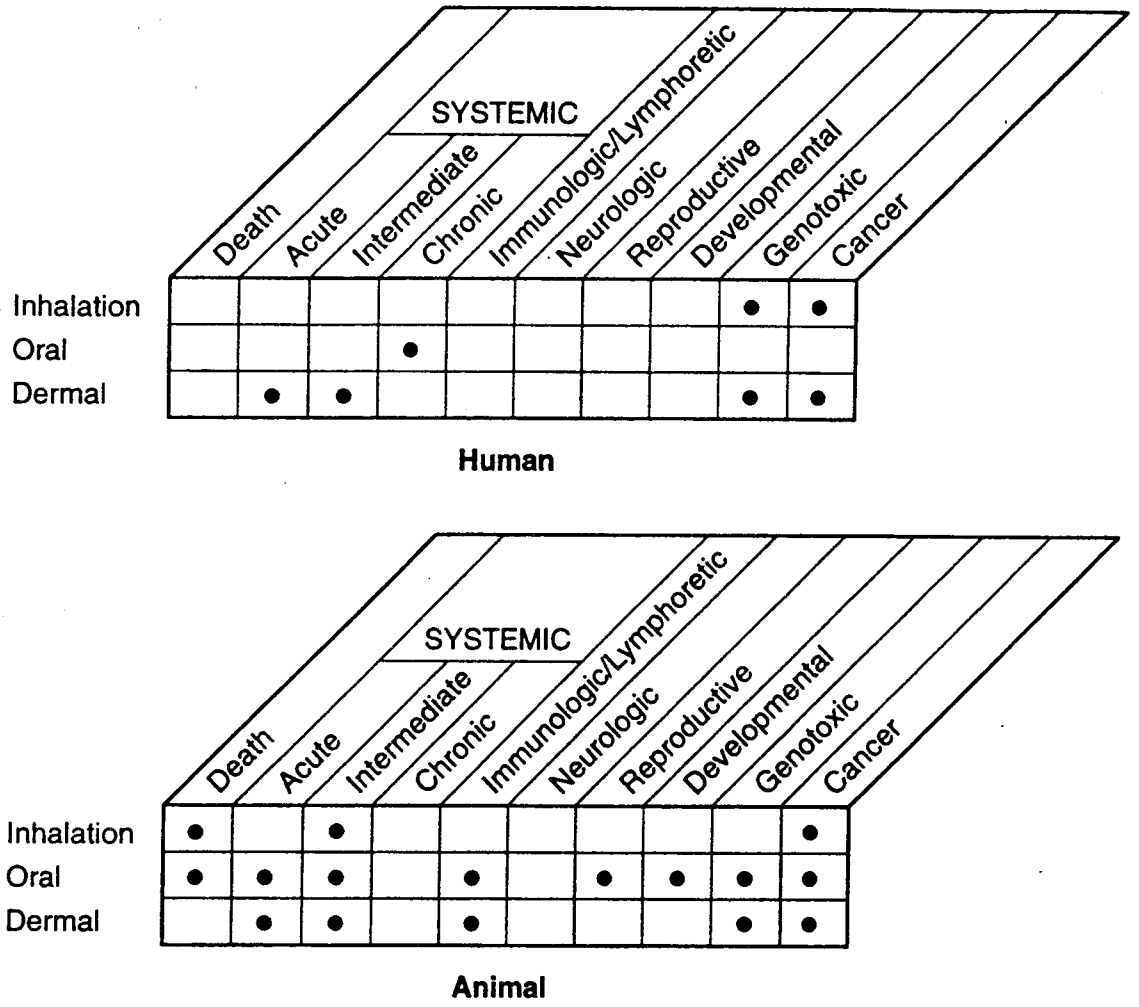
Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of PAHs is available. Where adequate information is not available, ATSDR, in conjunction with the National Toxicology Program (NTP), is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of PAHs.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

2.9.1 Existing Information on Health Effects of Polycyclic Aromatic Hydrocarbons

The existing data on health effects of inhalation, oral, and dermal exposure of humans and animals to PAHs are summarized in Figure 2-5. The purpose of this figure is to illustrate the existing

FIGURE 2-5. Existing Information on Health Effects of Polycyclic Aromatic Hydrocarbons



● Existing Studies

information concerning the health effects of PAHs. Each dot in the figure indicates that one or more studies provide information associated with that particular effect. The dot does not imply anything about the quality of the study or studies. Gaps in this figure should not be interpreted as "data needs." A data need, as defined in ATSDR's Decision Guide for Identifying Substance-Specific Data Needs Related to Toxicological Profiles (ATSDR 1989), is substance-specific information necessary to conduct comprehensive public health assessments. Generally, ATSDR defines a data gap more broadly as any substance-specific information missing from the scientific literature.

The vast majority of literature reviewed concerning the health effects of PAHs in humans described case reports and chronic-duration studies in workers linking the occurrence of lung and skin cancer and adverse noncancer skin effects with exposure to PAH-containing mixtures such as coke oven emissions, roofing-tar emissions, shale oils, and soot, and exposure to cigarette smoke. The predominant routes of exposure in the studies are inhalation and dermal, but the possibility of some degree of oral exposure cannot be ruled out, especially in light of muco-cilliary clearance and ingestion following inhalation exposure. Because of the lack of quantitative exposure information and the presence of other potentially carcinogenic substances in these mixtures, it is impossible to evaluate the contribution of an individual PAH or even the PAHs as a class to the effects observed.

The database for the health effects of PAHs in experimental animals consists primarily of older animal studies that would be considered inadequate by current standards, and two-stage dermal carcinogenesis studies. As can be seen in Figure 2-5, very little information is available on the effects of inhalation exposure to PAHs in animals. However, oral and dermal exposures to relatively high doses of PAHs have been shown in numerous studies to induce skin, lung, and forestomach tumors in animals, and noncancer adverse effects in rapidly proliferating tissues such as bone marrow, lymphoid organs, gonads, and intestinal epithelium. Benzo[a]pyrene is by far the most extensively studied of the PAHs; therefore, the adverse effects of other less-studied PAHs must generally be inferred from the results obtained with benzo[a]pyrene. This may over- or underestimate the health risk associated with the various PAHs.

2.9.2 Identification of Data Needs

Acute-Duration Exposure. Little is known regarding the adverse health effects associated with acute-duration inhalation exposure to any of the PAHs in either humans or animals. Limited

information is available on the effects of acute-duration oral and dermal exposures to PAHs in animals; the skin and the liver have been identified as target organs of PAH toxicity in animals (Iwata et al. 1981; Nousiainen et al. 1984). Available information is insufficient to derive an acute inhalation or oral MRL. Identification of target organs (other than the developing fetus) from acute-duration animal studies following inhalation and oral exposures would be helpful in order to assess the risk associated with the acute inhalation of contaminated air or ingestion of PAH-contaminated water or soils by humans living in areas surrounding hazardous waste sites. Additional inhalation and oral studies in animals involving a range of exposure concentrations and employing sensitive histological and biochemical measurements of injury to a comprehensive set of end points would be useful for establishing dose-response relationships and identifying thresholds for these effects. This information would be useful for determining levels of significant exposure to PAHs that are associated with adverse health effects. Both routes are considered significant for individuals living in the vicinity of hazardous waste sites because exposures to particulate PAHs in air and PAHs bound to soil particles, sediments in water, and contaminated food are possible in such areas. Furthermore, the pharmacokinetic data on PAHs are insufficient to determine whether similar effects may be expected to occur across different routes of exposure. Additional studies should be conducted on the effects of PAHs after acute-duration dermal exposure, since dermal exposure may be important to populations around hazardous waste sites. It is known that acute-duration dermal exposure to PAHs results in adverse dermal effects. Further studies determining the relative importance of exposure by this route, with regard to subsequent toxicity, would be useful. Studies describing dermal and oral absorption of PAHs from complex mixtures, including soil and other mixtures that may actually be the vehicles of human exposure, would be useful in furthering understanding of the toxicity of these compounds. The studies should be conducted with benzo[a]pyrene, because this PAH has been found at the highest number of NPL sites and it is a representative altemant PAH; studies should also be conducted with a representative nonaltemant PAH such as fluoranthene, benzo[b]fluoranthene, or benzo[j]fluoranthene. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be cOnducted to determine the most appropriate animal species for extrapolation to humans.

Intermediate-Duration Exposure. Little is known regarding the adverse health effects associated with intermediate-duration inhalation exposure to any of the PAHs in either humans or animals. One inhalation study in rats failed to establish an effect level (Wolff et al. 1989c). Information is available

on the effects of intermediate-duration exposures to some of the PAHs in humans (dermal) and in animals (oral and dermal). Regressive verrucae and other epidermal changes were noted in the skin of human volunteers treated with topically applied benzo[a]pyrene (Cottini and Mazzone 1939). Intermediate-duration dermal exposure to benzo[a]pyrene in patients with preexisting dermal conditions of pemphigus vulgaris and xeroderma pigmentosum was associated with an exacerbation of the abnormal skin lesions (Cottini and Mazzone 1939). Target organs identified in animal studies with some of the PAHs were the skin, the liver, and the hemolymphatic system (Legraverend et al. 1983; Old et al. 1963; Robinson et al. 1975). The available information is insufficient to derive an intermediate inhalation MRL for PAHs because no intermediate-duration inhalation animal studies exist that adequately describe the effects of inhalation exposure to PAHs. Intermediate duration MRLs have been derived for acenaphthene, fluoranthene, fluorene, and anthracene, based on 90-day gavage studies in mice (EPA 1988e; 1989c; 1989d, 1989e). For acenaphthene, fluoranthene, and fluorene, liver effects, supported by effects in other organ systems were identified as the target toxicity. For anthracene, no effect was seen in the liver or any other organ system, even at the highest dose of 1,000 mg/kg/day. The PAHs in these studies were administered by gavage, a route that does not mimic the potential exposure of people living near hazardous waste sites. Identification of target organs from intermediate-duration animal studies following inhalation and oral (drinking water) exposures would be useful in order to assess the risk associated with the intermediate-duration inhalation of contaminated air or ingestion of PAH-contaminated water or soils by humans living in areas surrounding hazardous waste sites. Ninety-day studies in animals by the inhalation and oral (drinking water) routes would be helpful to establish dose-response relationships and to identify other possible target organs or systems in individuals living around hazardous waste sites who can be exposed to low levels of PAHs for an intermediate-duration period of time. Both routes are considered important for individuals living in the vicinity of hazardous waste sites because exposure to particulate PAHs in air and PAHs bound to soil particles, sediments in water, and contaminated food are significant routes of exposure for individuals living in the vicinity of hazardous waste sites. Furthermore, the pharmacokinetic data on PAHs are insufficient to determine whether similar effects may be expected to occur across different routes of exposure. Additional studies should be conducted on the effects of PAHs after intermediate-duration dermal exposure, since dermal exposure may be important to populations around hazardous waste sites. It is known that acute-duration dermal exposure to PAHs results in adverse dermal effects. Further studies determining the relative importance of exposure by this route, with regard to subsequent toxicity, would be useful. Studies describing dermal and oral absorption of PAHs from complex mixtures, including soil and other

mixtures that may actually be the vehicles of human exposure, would be useful in furthering the understanding of the toxicity of these compounds. The studies should be conducted with benzo[a]pyrene, because it has been found at the hi.ghest number of NPL sites and it is a representative altemant PAH, and with a representative nonaltemant PAH such as fluoranthene, benzo[b]fluoranthene, or benzofilfluoranthene. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans.

Chronic-Duration Exposure and Cancer. Few controlled epidemiological studies have been reported in humans on the effects of exposure to PAHs or PAH-containing mixtures; such studies would be difficult to conduct because of the presence of too many confounding factors. However, information is available on the effects of chronic-duration dermal exposures to PAH-containing mixtures in humans. Workers exposed to substances that contain PAHs (e.g., coal tar) experience chronic dermatitis and hyperkeratosis (EPA 1988a). Several chronic ingestion, intratracheal installation, and skin-painting studies have been conducted in animals using various PAHs, but none identified adverse effects other than cancer. Therefore, threshold levels for chronic-duration inhalation and oral exposure have not been thoroughly investigated, and no MRLs have been developed from this database. Although the existing animal studies are inadequate to establish threshold levels and dose-response relationships for toxic effects resulting from chronic exposure to PAHs, the data from 90-day studies recommended above should be evaluated before chronic studies are conducted. Inhalation and ingestion are probably the most significant routes of exposure for individuals living in the vicinity of hazardous waste sites contaminated with PAHs. Low dose chronic studies are needed to mimic these exposures.

Human data on the carcinogenicity of PAHs are available only for mixtures containing PAHs. Animal carcinogenicity data are available for only benzo[a]pyrene following inhalation exposure, for a limited number of PAHs following ingestion, and for almost all of the 17 PAHs following dermal exposure. A large database on carcinogenicity exists on complex mixtures that contain PAHs (such as crude oils, various high boiling point distillates, complex petroleum products, coal tars, creosote, and the products of coal liquification processes). It is difficult to ascertain the carcinogenicity of the component PAHs in these mixtures because of the potential interactions that could occur and the presence of other carcinogenic substances in the mixtures. Furthermore, the levels of PAHs were not quantified in any

of these reports. However, most of the available information on the carcinogenicity of PAHs in humans must be inferred from studies that reported the effects of exposure to complex mixtures that contain PAHs. Epidemiologic studies have shown increased mortality due to lung cancer in humans exposed to coke oven emissions (Lloyd 1971; Mazumdar et al. 1975; Redmond et al. 1976), roofing-tar emissions (Hammond et al. 1976), and cigarette smoke (Maclure and MacMahon 1980; Wynder and Hoffmann 1967). Despite the limitations inherent in these studies, reports of this nature provide qualitative evidence of the potential for mixtures containing PAHs to cause cancer in humans, and more definitive studies in humans on individual PAHs are not recommended at this time.

Inhalation exposure to benzo[a]pyrene has been shown to induce respiratory tract tumors in hamsters (Thyssen et al. 1981). Certain PAHs are carcinogenic to animals by the oral route (e.g., benz[a]anthracene, benzo[a]pyrene, and dibenz[a,h]anthracene), and tumors have been noted in the liver, mammary gland, and respiratory and gastrointestinal tracts following oral administration of these compounds (Neal and Rigdon 1967; Rigdon and Neal 1969). However, only a few PAHs have been assayed by the oral route. The results of dermal studies indicate that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[l,2,3-c,d]pyrene are tumorigenic in rats and mice following dermal exposure. Although many of these studies would be considered inadequate by current standards, the results nevertheless indicate that these PAHs can induce skin tumors as well as act as tumor initiators and promoters (Habs et al. 1984; Warshawsky and Barkley 1987; Wynder and Hoffmann 1959b). Therefore, additional studies on the carcinogenicity of PAHs in animals are probably not necessary at this time.

Genotoxicity. The genotoxic potential of several of the PAHs (both altemant and nonaltemant) has been extensively investigated using both *in vivo* and *in vitro* assays. All but three of the PAHs (acenaphthene, acenaphthylene, and fluorene) were reported to be mutagenic in at least one *in vitro* assay with the bacteria *S. typhimurium*. No further genotoxicity data are considered necessary at this time.

Reproductive Toxicity. No data were located regarding reproductive effects of PAHs in humans, and the available information regarding reproductive effects of PAHs in animals is limited; data exist on only one of the PAHs (benzo[a]pyrene), and these data are conflicting. Adverse effects such as decreased fertility and total sterility in F1 progeny of CD-1 mice (Mackenzie and Angevine 1981) and

decreased incidence of pregnant female rats at parturition (Rigdon and Rennels 1964) were reported following oral exposure to benzo[a]pyrene. However, no adverse reproductive effects were observed in Swiss mice fed benzo[a]pyrene in their diet (Rigdon and Neal 1965). The metabolic differences and method of benzo[a]pyrene administration could account for the differential response to benzo[a]pyrene-induced toxicity in these studies. Parenteral studies in animals have also demonstrated adverse reproductive effects (Bui et al. 1986; Cervello et al. 1992; Mattison et al. 1992; Miller et al. 1992; Swartz and Mattison 1985). The limited animal data suggest that PAHs may be reproductive toxicants, but these data are not extensive enough to draw firm conclusions. Furthermore, the testes and ovaries contain rapidly proliferating cells and therefore should be considered susceptible to damage by PAHs. The 90-day studies identified above should be conducted with special emphasis on reproductive organ pathology. If reproductive effects are observed in these studies, multigeneration animal studies could then be conducted to evaluate properly the relevance of this end point. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans. Future epidemiological studies should give special emphasis to evaluation of reproductive toxicity.

Developmental Toxicity. No studies were located regarding developmental effects in humans exposed to PAHs by any route. However, results of *in vitro* studies suggest that human placental endocrine and hormonal function may be affected by exposure to benzo[a]pyrene (Avigdor et al. 1992; Bamea and Shurtz-Swirski 1992; Guyda 1991). Only limited data are available in animals on a few PAHs (mostly benzo[a]pyrene). These data indicate that ingested or parenterally administered PAHs have a potential to induce adverse developmental effects such as resorptions and malformations (Legraverend et al. 1984; Shum et al. 1979), sterility in F_1 progeny (Mackenzie and Angevine 1981), testicular changes including atrophy of seminiferous tubules with lack of spermatids and spermatozoa, interstitial cell tumors (Payne 1958), immunosuppression (Urso and Gengozian 1980), and tumor induction (Bulay and Wattenberg 1971; Soyka 1980). However, another study found no developmental effects when benzo[a]pyrene was administered orally to mice (Rigdon and Neal 1965). The available animal data suggest that PAHs may be developmental toxicants. However, most of the data are from parenteral routes of exposure, and there are no inhalation data. The oral data are limited because of conflicting results across studies, the use of inconsistent protocols (e.g., varying numbers of animals, administration of the test compound during different times of gestation), the use of only one

dose, lack of study details, and the fact that data are available only on benzo[a]pyrene. Furthermore, some studies have shown that the toxic manifestations of benzo[a]pyrene are dependent on the route of exposure. Therefore, a two-species developmental toxicity study would be helpful to assess fully the potential for PAHs to affect development in humans. The route of exposure should be determined following evaluation of the reproductive organs in the 90-day studies to see if any particular route of exposure has a greater effect. The pharmacokinetic data on PAHs are insufficient,to determine whether similar effects may be expected to occur across different routes of exposure. Developmental toxicity should also be assessed in future animal reproductive toxicology testing and human epidemiological studies. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans.

Immunotoxicity.No studies were located regarding immunological effects in humans after exposure to PAHs by any route, or in animals following inhalation exposure. In the one oral exposure study in animals that was located, a single dose of fluorene failed to affect thymus or spleen weight (Danz and Brauer 1988). However, there is information available in animals on the immunotoxicity of several PAHs following dermal exposure (contact hypersensitivity) (Old et al. 1963) and intraperitoneal or subcutaneous administration (suppression of both humoral and cellular immunity) (Blanton et al. 1986, 1988; Lubet et al. 1984; Lyte and Bick 1985; White and Holsapple 1984). In general, the degree of immunosuppression correlates with the individual PAH's carcinogenic potency. Because of the information in animals that suggests that PAHs may affect the immune system, Tier I testing to assess PAH-induced immunotoxicity, as recently defined by the NTP (Luster et al. 1988) is recommended. The parameters that should be measured include immunopathology, humoral-mediated immunity, cell-mediated immunity, and nonspecific immunity. Although relatively high doses of PAHs must be used to obtain immunotoxicity in animals, much information could be gained from these studies. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans. Future epidemiologic studies should also place emphasis on evaluation of this end point.

Neurotoxicity. The potential for short- or long-term neurotoxic effects following exposure to PAHs by any route has not been specifically studied in humans or animals. Although acute-, intermediate-, and chronic-duration studies conducted in animals do not indicate that any of the PAHs tested showed gross evidence of neurotoxicity, these tests were not designed to detect subtle neurological changes. It is recommended that neurobehavioral as well as neuropathological end points be included in future 90-day toxicity testing of PAHs. If these preliminary data indicate that any of the PAHs are neurotoxicants, then a more comprehensive neurotoxicity battery, using sensitive functional and neuropathological tests, could be conducted to characterize further the neurotoxic potential of these PAHs. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans.

Epidemiological and Human Dosimetry Studies. There are no epidemiological studies available that have investigated the effects of single PAHs by any route of exposure. Most of the available information on the effects of PAHs in humans comes from reports of occupational exposures to PAH-containing mixtures. For example, epidemiologic studies have shown increased mortality due to lung cancer in humans exposed to coke oven emissions (Lloyd 1971; Mazumdar et al. 1975; Redmond et al. 1976), roofing-tar emissions (Hammond et al. 1976), and cigarette smoke (Maclure and MacMahon 1980; Wynder and Hoffmann 1967). Each of these mixtures contains benzo[a]pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, and dibenz[a,h]anthracene as well as other potentially carcinogenic PAHs and other carcinogenic and potentially carcinogenic chemicals, tumor promoters, initiators, and co-carcinogens such as nitrosamines, coal tar pitch, and creosote. Limitations inherent in these studies include unquantified exposure concentrations and durations, as well as concomitant exposure to other potentially toxic substances. Despite their inadequacies, studies in humans suggest that PAH-containing mixtures are dermal irritants and carcinogens following inhalation and/or derrnal exposure. If either worker or general populations with appropriate exposure can be identified, epidemiologic studies should be undertaken with special emphasis placed upon evaluation of cancer (of the skin and other organs) and other adverse skin effects, reproductive/ developmental toxicity, and immunotoxicity. However, such studies would be difficult to conduct. With a group of chemicals that are as ubiquitous as PAHs, it would be extremely difficult to distinguish between exposed and nonexposed populations. The more these groups overlap, the higher the chance for misclassification bias. In addition, the statistical power of an epidemiological study

depends partially on the variance of the exposure measurements. If there is enormous variation in the exposure levels among the exposed and nonexposed groups, then the population size needed to obtain statistical significance in the study would be unmanageable and would most likely not be found in any one occupational setting or hazardous waste site. Furthermore, because of the size of the population needed, it would be very difficult to control for confounding factors such as smoking, geographical location, lifestyle.

Biomarkers of Exposure and Effect.

Exposure. Sensitive analytical methods are available to quantify PAH exposure in humans. Although PAHs can be detected in the body fluids and tissues, because of the ubiquitous nature of PAHs in the environment, these biomarkers are not specific for any particular source of PAH exposure. PAHs and their metabolites (e.g., 1-hydroxypyrene) can be measured in the urine of exposed individuals. PAHs form DNA adducts that can be measured in body tissues or blood following exposure to PAHs and mixtures that contain PAHs. Studies attempting to identify suitable and reliable biomarkers from phenanthrene, chrysene, and fluoranthene have been conducted (e.g., Grimmer et al. 1988). However, no other biomarkers (specific or otherwise) that have practical utility have been identified following exposure to PAHs. Further work on developing biomarkers that enable exposure to be quantified would be useful to ascertain whether individuals have been exposed to potentially toxic levels of PAHs. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies addressing mixtures of PAHs should be conducted.

Effect. The available biomarkers of effect for PAHs are not specific for effects induced by PAHs. The available genotoxicity data indicate that several of the 17 PAHs considered here are genotoxic in both nonmammalian and mammalian systems and are indirect mutagens (i.e., requiring the presence of an exogenous mammalian metabolic system). There were no tests reported for humans exposed to benzo[a]pyrene (the most widely tested PAH) *in vivo*, but several types of cultured human tissue cells demonstrated positive results for benzo[a]pyrene-induced genotoxicity (as evidenced by the induction of chromosomal aberrations, sister chromatid exchange) and binding of benzo[a]pyrene to DNA. Thus, although these results are exclusively from *in vitro* tests and the limited genotoxicity tests conducted on urine obtained from humans exposed to PAHs have been negative, these genotoxic effects observed in human tissue cells may serve as a biomarker of effects for at least one of the PAHs, benzo[a]pyrene. The formation of benzo[a]pyrene-DNA adducts has been demonstrated, and

this may serve as a biomarker of PAH-induced carcinogenicity. Additional studies on the relative sensitivity of DNA adducts and sister chromatid exchanges to identify threshold levels of exposure that could be detected in human populations would be useful. In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies addressing mixtures of PAHs should be conducted.

Absorption, Distribution, Metabolism, and Excretion. The quantitative data on the toxicokinetics of PAHs are based, to a large extent, on short-term exposure to benzo[a]pyrene in animals. Occupational exposure to PAHs generally occurs as a mixture. Therefore, inhalation, oral, and dermal studies exploring how PAHs interact with each other to affect their disposition would be more representative of exposures in humans.

The presence of PAHs and their metabolites in human urine and blood following inhalation, oral, and dermal exposures indicates that PAH absorption occurs in humans (Becher and Bjorseth 1983; Buckley and Lioy 1992; Hecht et al. 1979). However, there was no quantitative information on the extent and rate of PAH absorption in humans. Most of the information regarding the pulmonary and oral absorption and distribution of PAHs in animals is based on acute-duration exposures (Chang 1943; Hecht et al. 1979; Weyand and Bevan 1986, 1987b, 1988; Withey et al. 1991; Wolff et al. 1989c). PAHs appear to be widely distributed in tissues of animals following oral and inhalation exposure; peak tissue concentrations occurred earlier with higher exposure levels. Studies on the absorption and distribution of PAHs following long-term exposures would indicate whether the kinetics are similar to acute-duration exposures. The dermal study conducted by Storer et al. (1984) revealed that several PAHs in a crude coal tar mixture were absorbed, but that benzo[a]pyrene was not. In contrast, animal studies indicate that benzo[a]pyrene was dermally absorbed (Ng et al. 1992; Wester et al. 1990; Yang et al. 1989); however, tissue distribution was not discussed.

PAH metabolism has been extensively reviewed in human and animal tissue homogenates, cultures, and perfused systems (Autrup et al. 1978; Cavalieri et al. 1987; Cohen et al. 1976; Kiefer et al. 1988; Leung et al. 1988). However, these studies are limited to the biotransformation of individual compounds. Since most metabolic pathways have been identified or can be predicted for the individual PAHs, it is now important to understand how these metabolic pathways are affected when the PAHs compete. The carcinogenic and toxic potential of PAHs is associated with their metabolites. Alterations in rates of metabolism and metabolite profiles may affect the toxic consequences of PAHs.

Available data on several of the nonaltemant tumorigenic PAHs discussed in this profile indicate that they exert their adverse effects by mechanisms that differ from those that have been more recently elucidated for altemant PAHs (Amin et al. 1982, 1985b; Rice et al. 1987b). The mechanisms by which benzo[b]fluoranthene and benzo[j]fluoranthene are metabolically activated to genotoxic agents have been elucidated (LaVoie et al. 1993b; Marshall et al. 1993; Weyand et al. 1993a, 1993b). Additional studies designed to assess the potential toxic effects of these reactive metabolites in various species and at various organ sites would be useful.

No studies were located that monitored the rate and extent of PAH excretion in humans. Most studies in animals concentrated on the extent of PAH excretion and the distribution of the compound and its metabolites in urine, feces, and bile following short-term exposures (Bevan and Weyand 1988; Grimmer et al. 1988; Petridou-Fischer et al. 1988; Weyand and Bevan 1986; Wolff et al. 1989c; Yamazaki and Kakiuchi 1989). Data regarding the excretion pattern and rate following long-term exposure to PAHs would be useful to determine if bioaccumulation occurs.

In addition, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans.

Comparative Toxicokinetics. Occupational studies provide evidence that inhaled PAHs are absorbed. Animal studies also show that pulmonary absorption of benzo[a]pyrene occurs, but the extent of absorption is not known. Ingestion of benzo[a]pyrene is low in humans while oral absorption in animals varies among the PAH compounds depending on the lipophilicity. The absorption and distribution of PAHs in various species would be expected to be similar based on the lipophilicity of the compounds. In general, percutaneous absorption of PAHs in several animal species appears to be rapid and high (Ng et al. 1992; Sanders et al. 1986; Wester et al. 1990; Yang et al. 1989). This suggests that dermal absorption in humans may also occur rapidly; however, the extent of absorption may vary depending on the vehicle.

There was no information available on the distribution of PAHs in humans. In general, tissue distribution of benzo[a]pyrene following inhalation exposure is qualitatively similar for different species (Bevan and Weyand 1988; Weyand and Bevan 1986, 1987a, 1988; Wolff et al. 1989c). In

general, orally absorbed PAHs were rapidly and widely distributed in the rat (Bartosek et al. 1984; Withey et al. 1991; Yamazaki and Kakiuchi 1989). Qualitative similarities in distribution among species suggest that distribution in humans would also be similar. Placental transfer of PAHs in mice and rats appears to be limited (Neubert and Tapken 1988; Withey et al. 1992); therefore, human fetuses may be exposed to PAHs, but levels would not be as high as maternal levels.

Qualitatively, metabolism and excretion would be relatively similar in humans and animals, but variability in specific activities of enzymes will alter the metabolic profiles among the species. Knowledge of these differences in enzyme activity in various species would assist in predicting which pathways and metabolites would prevail. For instance, AHH activity is not induced by PAHs in some strains of mice. Therefore, it would be useful to examine the metabolism of those less-well-studied PAHs in several species (i.e., rodent and nonrodent) so that the carcinogenic potential of PAHs in various species could be predicted. The feces (via the bile) appears to be the major excretion route, but the extent of elimination of PAHs varies among species (Bevan and Weyand 1988; Grimmer et al. 1988; Ng et al. 1992; Petridou-Fischer et al. 1988; Sanders et al. 1986; Weyand and Bevan 1986; Wolff et al. 1989c). Further comparative studies on excretion would be useful because differences in human and animal excretion rates are not known. In addition, many of the toxicity tests have used mice, while a larger proportion of toxicokinetic studies have used rats. Thus, more kinetic studies should be conducted in mice to provide data to correspond to the toxicity data. Further, since PAHs rarely occur alone, but are found in the environment in combinations and mixtures, studies, particularly feeding studies, addressing mixtures of PAHs should be conducted. In all cases, research should be conducted to determine the most appropriate animal species for extrapolation to humans.

Methods for Reducing Toxic Effects. Efforts are currently underway to develop ways to mitigate the adverse effects of PAHs, especially with regard to natural products. Efforts to reduce or eliminate cigarette smoking in the general population also contribute toward reducing exposure to and toxic effects of PAHs. The target organs of PAHs have been identified (i.e., the skin and rapidly proliferating tissue such as the hematopoietic and lymphoid systems). Furthermore, several PAHs are considered to be carcinogenic. The mechanism of action for altemant PAH-induced carcinogenicity is fairly well understood. However, additional information would be useful to understand the mechanism of nonaltemant PAH-induced carcinogenicity, how PAHs exert their adverse effects on rapidly proliferating tissue, and how various interactions between PAHs can affect their toxicity and carcinogenicity.

2.9.3 Ongoing Studies

Ongoing research on the health effects and toxicokinetics of PAHs is summarized in Table 2-7.

TABLE 2-7. Ongoing Studies on Polycyclic Aromatic Hydrocarbons[a]

Investigator	Affiliation	Research description	Sponsor
E.J. La Voie	Rutgers State University, New Brunswick, NJ	Environmental polyclics—Metabolism and activation (mice, humans)	National Institute of Environmental Health Sciences
S.P. Mudzinski	Albany Medical College of Union University, Albany, NY	Immunotoxicologic screening of chemical carcinogens (mice)	National Institute of Environmental Health Sciences
W.F. Busby	Massachusetts Institute of Technology, Cambridge, MA	Core—Tumorigenicity testing (mice)	National Institute of Environmental Health Sciences
D.R. Bevan	Virginia Polytechnic Institute, Blacksburg, VA	Disposition of benzo(*a*)pyrene *in vivo*	U.S. Department of Agriculture
R.L. Hill	Florida State University, Tallahassee, FL	The impact of energy-related pollutants on chromosome structure	Not specified
N. Hahon	NIOSH DRDS, Morgantown, WV	Polycyclic aromatic hydrocarbons, particulates and defense mechanisms	National Institute of Occupational Safety and Health
M.K. Sanyal	Yale University, New Haven, CT	Abnormal fetal development during to toxic exposure (humans, rats, mice)	National Institute of Environmental Health Sciences
M. Koreeda	University of Michigan, Ann Arbor, MI	Synthesis and reactions of polycyclic aromatic hydrocarbon metabolites	National Institute of Environmental Health Sciences
L.M. Anderson	National Institutes of Health, Bethesda, MD	Metabolic and pharmacological determinants in perinatal carcinogenesis	National Institutes of Health
K. Frenkel	New York University Medical Center, New York, NY	Tumor promoters affecting base modification in DNA (mice)	National Institutes of Health
M.E. Knuckles	Meharry Medical College, Nashville, TN	Acute and subchronic inhalation and oral toxicity testing of benzo(a)pyrene and fluoranthene	Agency for Toxic Substances and Disease Registry

[a]Information obtained from Federal Research in Progress (October, November 1992) and CRISP (October 1992) databases

3. CHEMICAL AND PHYSICAL INFORMATION

3.1 CHEMICAL IDENTITY

Information regarding the chemical identity of PAHs is located in Table 3-l.

3.2 PHYSICAL AND CHEMICAL PROPERTIES

Information regarding the physical and chemical properties of PAHs is located in Table 3-2.

TABLE 3-1. Chemical Identity of Polycyclic Aromatic Hydrocarbons[a]

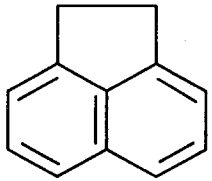
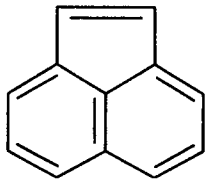
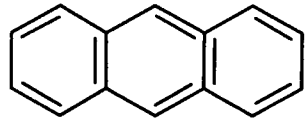
Characteristic	Acenapthene	Acenaphthylene	Anthracene
Synonym(s)	1,2-Dihydroacenaphthylene; 1,8-dihydroacenapthaline; 1,8-ethylenenapthalene; 1,2-dihydroacenapththylene	Cyclopenta[d,e]naphthalene	Anthracin; green oil; paranaphthalene[b]
Registered trade name(s)	No data	No data	Tetra olive NZG; Anthracene oil[d]
Chemical formula	$C_{12}H_{10}$	$C_{12}H_8$	$C_{14}H_{10}$[b]
Chemical structure			
CAS registry	83–29–9	208–96–8	120–12–7[b]
NIOSH RTECS	AB1000000	AB1254000	CA 9350000
EPA hazardous waste	No data	No data	No data
OHM/TADS	8200126	No data	82001222
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	2659	2661	702
NCI	No data	No data	No data

TABLE 3-1. Chemical Identity of Polycyclic Aromatic Hydrocarbons[a] (continued)

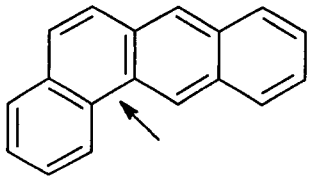
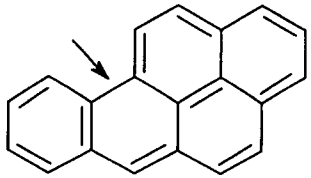
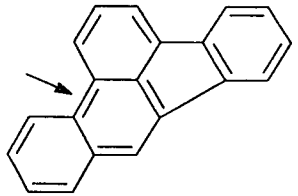
Characteristic	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene
Synonym(s)	BA; benz[a]anthracene; 1,2-benzanthracene; benzo[b]-phenanthrene; 2,3-benzophenanthrene; tetraphene[c,d]	Benzo[d,e,f]chrysene; 3,4-benzopyrene, 3,4-benzpyrene; benz[a]pyrene; BP; B[a]P[b]	3,4-Benz[e]acephenanthrylene; 2,3-benzfluoranthene; 3,4-benzfluoranthene; 2,3-benzofluoranthene; 3,4-benzofluoranthene; benzo[e]fluoranthene;B[b]F[b]
Registered trade name(s)	No data	No data	No data
Chemical formula	$C_{18}H_{12}$	$C_{20}H_{12}$[b]	$C_{20}H_{12}$[b]
Chemical structure			
Identification numbers:			
CAS Registry	56–55–3	50–32–8	205–99–2[b]
NIOSH RTECS	CV 9275000[e]	DJ3675000	CU 1400000[e]
EPA Hazardous Waste	U018	U022	No data
OHM/TADS	8200123	No data	8200124[e]
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	4003	2554	4035
NCI	No data	No data	No data

TABLE 3-1. Chemical Identity of Polycyclic Aromatic Hydrocarbons[a] (continued)

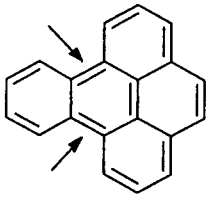
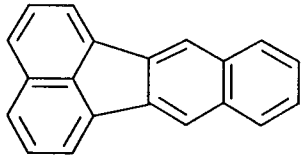
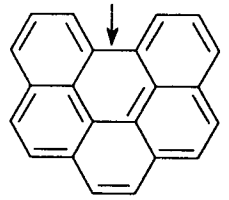
Characteristic	Benzo[e]pyrene	Benzo[k]fluoranthene	Benzo[g,h,i]perylene
Synonym(s)	1.2-Benzopyrene; 1.2-benzpyrene; 4.5 benzopyrene; 4.5-benzpyrene; B[e]P[e]	8.9-Benzfluoranthene; 8.9-benzofluoranthene; 11.12-benzofluoranthene; 2,3,1.8-binaphthylene; dibenzo[b,j,k]fluorene[b]	1,12-Benzoperylene[c]
Registered trade name(s)	No data	No data	No data
Chemical formula	$C_{20}H_{12}$[e]	$C_{20}H_{12}$[b]	$C_{22}H_{12}$[c]
Chemical structure			
CAS registry	192–97–2[e]	207–08–9[b]	191–24–2[c]
NIOSH RTECS	D4500000[e]	DF 350000[e]	DI 6200500[e]
EPA hazardous waste	No data	No data	No data
OHM/TADS	No data	8200125[e]	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	4031[e]	6012[e]	6177[e]
NCI	No data	No data	No data

TABLE 3-1. Chemical Identity of Polycyclic Aromatic Hydrocarbons[a] (continued)

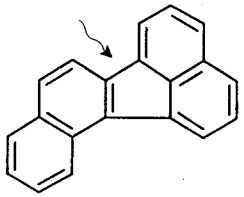
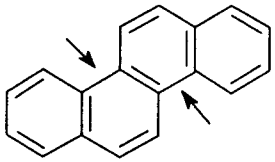
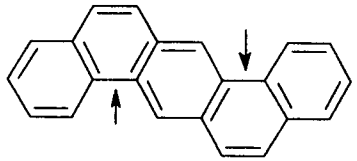
Characteristic	Benzo[j]fluoranthene	Chrysene	Dibenz[a,h]anthracene
Synonym(s)	10.11-Benzofluoranthene; benzo-12.13-fluoranthene; dibenzo[a,j,k]-fluorene; 7.8-benzofluoranthene; B[j]F[e]	1.2-Benzophenanthrene; benzo[a]-phenanthrene; 1,2-benzphenanthrene; benz[a]phenanthrene; 1,2,5,6-dibenzonaphthalene	Dibenz[a,h]anthracene; DB[a,h]A; DBA; 1,2:5,6-dibenz[a]anthracene[b,e]
Registered trade name(s)	No data	No data	No data
Chemical formula	$C_{20}H_{12}$	$C_{18}H_{12}$[b]	$C_{22}H_{14}$[b]
Chemical structure			
CAS registry	205–82–3[e]	218–01–9[b]	53–70–3[b]
NIOSH RTECS	DF 6300000[e]	GC 0700000[e]	HN 2625000[e]
EPA hazardous waste	No data	U050[e]	U063
OHM/TADS	No data	No data	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	4034[e]	2810	5097
NCI	No data	No data	No data

TABLE 3-1. Chemical Identity of Polycyclic Aromatic Hydrocarbons[a] (continued)

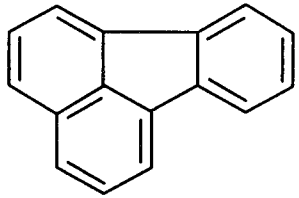
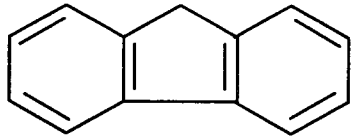
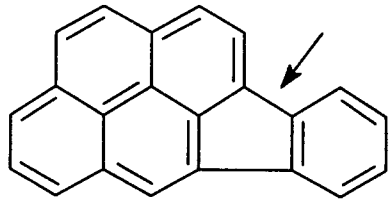
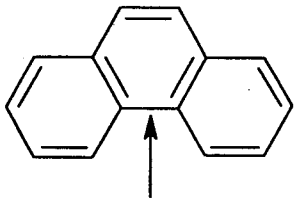
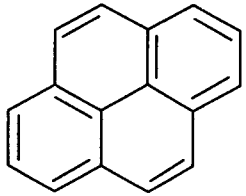
Characteristic	Fluoranthene	Fluorene	Indeno[1,2,3-c,d]pyrene
Synonym(s)	1.2-[1,8-Naphthylene]benzene; 1.2-benzacenaphthene; 1.2-[1.8-naphthalenediyl] benzene; benzo[j,k]fluorene	ortho-Biphenylene methane; diphenylenemethane; 2,2-methylene biphenyl; 2.3-benzidene[b,f]	Indenopyrene; IP; ortho-phenylene pyrene; 1,10-[ortho-phenylene]pyrene; 1,10-[1,2-phenylene]pyrene; 2,3-ortho-phenylene pyrene[b]
Registered trade name(s)	No data	No data	No data
Chemical formula	$C_{16}H_{10}$	$C_{13}H_{10}$[b]	$C_{22}H_{12}$[b]
Chemical structure			
Identification numbers:			
CAS registry	206–44–0	86–73–7[b]	193–39–5[b]
NIOSH RTECS	LL4025000	LL5670000	NK 9300000
EPA hazardous waste	U120	No data	U137
OHM/TADS	8200136	No data	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data
HSDB	5486	2165	5101
NCI	No data	No data	No data

TABLE 3-1. Chemical Identity of Polycyclic Aromatic Hydrocarbons[a] (continued)

Characteristic	Phenanthrene	Pyrene
Synonym(s)	Phenanthrene; Phenantrin[b]	Benzo[d,e,f]phenanthrene; 8-pyrene[b]
Registered trade name(s)	No data	No data
Chemical formula	$C_{14}H_{10}$[b]	$C_{16}H_{10}$[b]
Chemical structure		
Identification numbers:		
CAS registry	85–01–8[b]	129–00–00[b]
NIOSH RTECS	SF7175000	UR 245000[e]
EPA hazardous waste	No data	No data
OHM/TADS	8200140	No data
DOT/UN/NA/IMCO shipping	No data	No data
HSDB	2166	4023
NCI	No data	No data

[a]All information obtained from HSDB 1994, except where noted.
[b]IARC 1983
[c]Eller 1984
[d]Sax and Lewis 1989
[e]HSDB 1992
[f]Weast et al. 1988

CAS = Chemical Abstracts Service; DOT/UN/NA/IMCO = Department of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; EPA = Environmental Protection Agency; HSDB = Hazardous Substance Data Bank; NCI = National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; PAHs = polycyclic aromatic hydrocarbons; RTECS = Registry of Toxic Effects of Chemical Substances; ⟶ = bay region; ⇝ = pseudo bay region

TABLE 3-2. Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons[a]

Property	Acenaphthene	Acenaphthylene	Anthracene
Molecular weight	154.21	152.20	178.2[b]
Color	White	No data	Colorless with violet fluorescence when pure; yellow with green fluorescence when impure
Physical state	Solid (needles)	Solid (prisms/plates)	Solid (tablet or prism)[b]
Melting point	95 °C	92–93 °C	218 °C[b]
Boiling point	96.2 °C	265–275 oC	342 °C[b], 340 °C[e]
Density at 20/4 °C	1.225 g/cm^3 at 0 °C	No data	No data
Specific gravity	1.0242 at 90 °C/4 °C[e]	0.8988 at 16 °C/2 °C	1.25 at 27 °C/4 °C; 1.283 at 25 °C/4 °C[e]
Odor	No data	No data	Weak aromatic odor
Odor threshold:			
Water	0.08 ppm	No data	No data
Air	0.08 ppm	No data	No data
Solubility:			
Water	1.93 mg/L[p]	3.93 mg/L water	0.076 mg/L[p]
Organic solvents	Soluble in alcohol, methanol, propanol, chloroform, benzene, toluene, glacial acetic acid	Alcohol, ether, benzene	Acetone; benzene, carbon disulphide, carbon tetrachloride, chloroform, ether, ethanol, methanol, toluene[e,b]
Partition coefficients:			
Log K_{ow}	3.98[k]	4.07[k]	4.45[k]
Log K_{oc}	3.66[k]	1.40[k]	4.15[k]
Vapor pressure	4.47x10^{-3} mm Hg[m]	0.029 mm Hg at 20 °C[k]	1 mm Hg at 145 °C[b]; 1.7x10^{-5} mm Hg at 25 °C[k]
Henry's law constant	7.91x10^{-5} atm-^{3}/mol[r]	1.45x10^{-3} atm-m^3/mol	1.77x10^{-5} atm-m^3/mol[r]
Autoignition temperature	No data	No data	540 °C[i]
Flashpoint	No data	No data	121 °C(closed cup)[d]
Flammability limits	Dust is moderately flammable[n]	No data	No data
Conversion factors	0	0	0
Explosive limits	No data	No data	Lower, 0.6% by volume[d]

TABLE 3-2. Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons[a] (continued)

Property	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene
Molecular weight	228.29[c]	252.3[b]	252.3[b]
Color	Yellow-blue fluorescence[e]	Pale yellow	Colorless
Physical state	Solid (plates)	Solid (plates or needles)[f]	Solid (needles)[e] (recrystallized from benzene/ligroin)
Melting point	158–159 °C[c]; 162 °C[e]	179–179.3 °C[f]	168.3 °C[b]
Boiling point	400 °C[i]; 435 °C sublimes[f]	310–312 °C at 10 mm Hg[f]; 495 °C[j]	No data
Density	1.274 g/cm^3 at 20 °C	1.351 g/cm^{3,h}	No data
Specific gravity	No data	No data	No data
Odor	No data	Faint aromatic odor	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	0.010 mg/L[p]	2.3x10^{-3} mg/L[p]	0.0012 mg/L[q]
Organic solvents	Slightly soluble in acetic acid and hot ethanol; soluble in acetone and diethyl ether; very soluble in benzene[b]	Sparingly soluble in ethanol and methanol; soluble in benzene, toluene, xylene, and ether	Slightly soluble in benzene, acetone[b]
Partition coefficients:			
Log K_{ow}	5.61[k]	6.06[k]	6.04[k]
Log K_{oc}	5.30[k]	6.74[k]	5.74[k]
Vapor pressure	2.2x10^{-8} mm Hg at 20 °C	5.6x10^{-9} mm Hg[k]	5.0x10^{-7} mm Hg at 20–25 °C[r]
Henry's law constant	1x10^{-6} atm–m^3/mol	4.9x10^{-7} atm-m^3/mol[k]	1.22x10^{-5} atm-m^3/mol[k]
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	0	0	0
Explosive limits	No data	No data	No data

TABLE 3-2. Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons[a] (continued)

Property	Benzo[e]pyrene	Benzo[k]fluoranthene	Benzo[g,h,i]perylene
Molecular weight	252.30[d]	252.3	276.34[c]
Color	Colorless[b]	Pale yellow	Pale yellow-green
Physical state	Prisms or plates (recrystallized from benzene)[g]	Solid (needles)	Solid (plate)
Melting point	178–179 °C[d]	215.7 °C	273 °C[c]
Boiling point	310–312 °C at 10 mm Hg[g]	480 °C	550 °C
Density	No data	No data	No data
Specific gravity	No data	No data	No data
Odor	No data	No data	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	6.3×10^{-3} mg/L at 25 °C[d]	7.6×10^{-4} mg/L at 25 °C	2.6×10^{-4} mg/L at 25 °C
Organic solvents	Acetone[g]	Soluble in benzene, acetic acid, ethanol[b]	Soluable in benzene, dichloromethane, acetone[g]
Partition coefficients:			
Log K_{ow}	No data	6.06[k]	6.50[k]
Log K_{oc}	No data	5.74[k]	6.20[k]
Vapor pressure	5.7×10^{-9} mm Hg at 25 °C[d]	9.59×10^{-11} mm Hg	1.03×10^{-10} mm Hg at 25 °C[k]
Henry's law constant	No data	3.87×10^{-5} atm–m^3/mol[k]	1.44×10^{-7} atm-m^3/mol[k]
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	0	0	0
Explosive limits	No data	No data	No data

TABLE 3-2. Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons[a] (continued)

Property	Benzo[j]fluoranthene	Chrysene	Dibenz[a,h]anthracene
Molecular weight	252.32[d]	228.3[b]	278.35[c]
Color	Yellow or orange[d]	Colorless with blue or red-blue fluorescence[b,e]	Colorless[b]
Physical state	Plates (recrystallized from ethanol) or needles (recrystallized from acetic acid)[d,h]	Solid (plates)[e]	Solid (plates or leaftlets)[e]
Melting point	166 °C[d]	255–256 °C[b]	262 °C[c]
Boiling point	No data	448 °C[b]	No data
Density	No data	No data	1.282 g/cm^3[,h]
Specific gravity	No data	1.274 at 20 °C/4 °C[i]	No data
Odor	No data	No data	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	6.76x10^{-3} mg/L at 25 °C[d]	2.8x10^{-3} mg/L[p]	5x10^{-4} mg/L[b]
Organic solvent(s)	Slightly soluble in alcohol and acetic acid; soluble in hydrogen sulfide on heating[d]	Slightly soluble in acetone, carbon disulphide, diethyl ether, ethanol glacial acetic acid toluene hot xylene; soluble in benzene[b]	Slightly soluble in ethyl alcohol; soluble in acetone, acetic acid, benzene, toluene and xylene[e]
Partition coefficients:			
Log K_{ow}	6.12[d]	5.16[k]	6.84[k]
Log K_{oc}	4.7–4.8[d]	5.30[k]	6.52[k]
Vapor pressure	1.50x10^{-8} mm Hg at 25 °C[d]	6.3x10^{-7} mm Hg at 25 °C[k]	1x10^{-10} mm Hg at 20 °C[k]
Henry's law constant	1x10^{-6} atm–m^3/mol[d]	1.05x10^{-6} atm-m^3/mol[k]	7.3x10^{-8} atm-m^3/mol[k]
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	0	0	0
Explosive limits	No data	No data	No data

TABLE 3-2. Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons[a] (continued)

Property	Fluoranthene	Fluorene	Indeno[1,2,3-c,d]pyrene
Molecular weight	202.26	166.2[g]	276.3[g]
Color	Pale yellow	White[g]	Yellow plates or needles showing a greenish-yellow fluorescence[g]
Physical state	Solid (needles or plates)	Solid (leaflets or flakes; crystalline plates)[g]	Solid (plates or needles)[g]
Melting point	11 °C	116–117 °C[g]	163.6 °C[g]
Boiling point	~375 °C	295 °C[g]	530 °C
Density	No data	No data	No data
Specific gravity	1.252 at 0 °C/4 °C	1.203 at 0 °C/4 °C	No data
Odor	No data	No data	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	0.20–0.26 mg/L[g]	1.68–1.98 mg/L[g]	0.062 mg/L[g]
Organic solvents	Alcohol, ether, benzene, acetic acid	Acetic acid, acetone, benzene, carbon disulphide, carbon tetrachloride, diethyl ether, ethanol, pyrimidine, solution, toluene[g]	Soluble in organic solvents[g]
Partition coefficients:			
Log K_{ow}	4.90[k]	4.18[k]	6.58[k]
Log K_{oc}	4.58[k]	3.86[k]	6.20[k]
Vapor pressure	5.0×10^{-6} mm Hg at 25 °C[k]	3.2×10^{-4} mm Hg at 20 °C[d]	$\sim 10^{-11}$–10^{-6} mm Hg at 20 °C[k]
Henry's law constant	6.5×10^{-6} atm–m^3/mol[k]	1.0×10^{-4} atm-m^3/mol[r]	6.95×10^{-8} atm-m^3/mol[k]
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	0	0	0
Explosive limits	No data	No data	No data

TABLE 3-2. Physical and Chemical Properties of Polycyclic Aromatic Hydrocarbons[a] (continued)

Property	Phenanthrene	Pyrene
Molecular weight	178.2[b]	202.3[b]
Color	Colorless[b]	Colorless, pale yellow plates (recrystallized from toluene) or slight blue fluorescence (recrystallized from ethanol or sublimation)[b]
Physical state	Solid (plates, crystals, or leaflets)[b]	Solid (plates or tablets)[b]
Melting point	100 °C[b]	156 °C
Boiling point	340 °C	393 °C[e]; 404 °C[l]
Density	0.980 g/cm^3 at 4 °C	1.271 g/cm^3 at 23 °C
Specific gravity	No data	1.271 at 23 °C/4 °C
Odor	Faint aromatic odor	No data
Odor threshold:		
Water	No data	No data
Air	No data	No data
Solubility:		
Water at 25 °C	1.20 mg/L[p]	0.077 mg/L[p]
Organic solvents	Soluble glacial acetic acid, benzene, carbon disulphide, carbon tetrachloride, anhydrous diethyl ether, ethanol, toluene[b]	Soluble in alcohol benzene, carbon disulphide, diethyl ether, ethanol, petroleum ether, toluene, race tone[b]
Partition coefficients:		
Log K_{ow}	4.45[k]	4.88[k]
Log K_{oc}	4.15[k]	4.58[k]
Vapor pressure	6.8x10^{-4} mm Hg at 25 °C[d]	2.5x10^{-6} mm Hg at 25 °C[k]
Henry's law constant	2.56x10^{-5} atm–m^3/mol[r]	1.14x10^{-5} atm-m^3/mol[r]
Autoignition temperature	No data	No data
Flashpoint	No data	No data
Flammability limits	No data	No data
Conversion factors	0	0
Explosive limits	No data	No data

[a]All information obtained from HSDB except where noted
[b]IARC 1973
[c]Eller 1984
[d]HSDB 1994
[e]Weast et al. 1988
[f]Weast 1987
[g]IARC 1983
[h]Temperature not specified
[i]Sax and Lewis 1989
[j]Aldrich 1986
[k]Mabey et al. 1982
[l]Windholz 1983
[m]EPA 1987a
[n]ITII 1982
[p]Yalkowsky et al 1993
[q]Sims and Overcash 1983
[r]Nirmalakhandan and Speece 1988

The following equation can be used for the converstion of vapor phase PAHs at 25 °C:

$$\frac{\text{mg/m}^3 \times 24.45}{\text{Mol. wt.}}$$

4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

4.1 PRODUCTION

The commercial production of PAHs is not a significant source of these compounds in the environment. The primary source of many PAHs in air is the incomplete combustion of wood and fuel (Perwak et al. 1982). PAHs are a ubiquitous product of combustion from common sources such as motor vehicles and other gas-burning engines, wood-burning stoves and furnaces, cigarette smoke, industrial smoke or soot, and charcoal-broiled foods (IARC 1983). Natural sources include volcanoes, forest fires, crude oil, and shale oil (HSDB 1994).

Of the 17 PAHs included in this profile, only three are produced commercially in the United States in quantities greater than research level: acenaphthene, acenaphthylene, and anthracene. Acenaphthene is manufactured by passing ethylene and benzene or naphthalene through a red hot tube or by heating tetrahydroacenaphthene with sulfur to 180 ºC. It can also be made from acenaphthenone or acenaphthenequinone by high-pressure hydrogenation in decalin with nickel at 180-240 ºC (Windholz 1983). Another manufacturing process involves the isolation and recovery of acenaphthene from a concentrated tar-distillation fraction (Grayson 1978). Technical grades of acenaphthene are typically 98% pure (HSDB 1994). Acenaphthylene is produced by catalytic degradation of acenaphthene (Grayson 1978). Toxic Release Chemical Inventory (TRI) production data for acenaphthylene and acenaphthene are not available (TRI92 1994) and no other data on the production volumes for these compounds in the United States could be found.

Anthracene is produced commercially by recovery from the coal tar distillation fraction known as “anthracene oil” or “green oil.” Purification techniques, including heating and vacuum distillation, are required to remove the major contaminant, potassium carbazole (IARC 1985). Zone melting of solid anthracene and crystallization from benzene followed by sublimation are also effective purification techniques (Hampel and Hawley 1973). Technical grades of anthracene are typically 90-98% pure (HSDB 1994). Table 4-l shows the number of facilities per state that manufacture or process anthracene, as well as a range of the maximum amounts of anthracene present at the facilities (TR192 1994). The following companies have been cited as current U.S. manufacturers of anthracene for sale/distribution: ABC Coke Division (Tarrant City, Alabama); Granite City Steel (Granite City, Illinois); Citizens Gas and Coke Utility (Indianapolis, Indiana); National Steel Corporation (Encore,

Table 4-1. Facilities that Manufacture or Process Anthracene

State[a]	Number of facilities	Range of maximum amounts on site in thousands of pounds[b]	Activities and uses[c]
AL	7	1-1000	1, 4, 6, 8, 9
AR	1	1-10	3, 9
CA	1	10-100	1, 5
FL	2	1-100	8
IL	5	10-10000	1, 2, 4, 5, 6, 8, 10
IN	5	1-1000	1, 4, 5, 8
KY	2	1-100	1, 6, 11
LA	7	0-10000	1, 2, 5, 6, 9
MI	2	1-100	1, 4, 5, 6, 8
MN	1	1-10	1, 4
MO	1	1-10	13
MS	2	1-100	1, 6, 8
NJ	3	10-50000	1, 3, 4, 7, 8, 10
NY	2	1-1000	1, 5, 6, 8
OH	12	0-10000	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
OK	1	10-100	2, 3, 9
PA	7	0-10000	1, 4, 5, 6, 7, 8, 10
SC	2	1-10	5, 8
TX	13	0-10000	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13
UT	2	10-50000	1, 3, 4, 7, 10
VI	1	10000-50000	1, 4, 7
WA	2	10-1000	1, 2, 6, 12
WV	3	10-10000	1, 5, 6, 9, 12

Source: TRI92 1994

[a]Post office state abbreviations used
[b]Data in TRI are maximum amounts on site at each facility.
[c]Activities/Uses

1. Produce
2. Import
3. For on-site use/processing
4. For sale/distribution
5. As a byproduct
6. As an impurity
7. As a reactant
8. As a formulation component
9. As a product component
10. For repackaging
11. As a chemical processing aid
12. As a manufacturing aid
13. Ancillary or other uses

Missouri); Koch Refining Company (Pine Bend, Montana); Amerada Hess Corporation (Port Reading, New Jersey); Reilly Industries, Incorporated (Cleveland, Ohio, and Lone Star, Texas); New Boston Coke Corporation (New Boston, Ohio); Bethlehem Steel Structural (Bethlehem, Pennsylvania); Geneva Steel (Vineyard, Utah); and Hess Oil Virgin Islands Corporation (St. Croix, Virgin Islands). It should be noted that another source (SRI 1994) lists no anthracene processing or manufacturing facilities. In 1982, more than 2,270 kg of anthracene were produced in the United States; more recent production data are not available (HSDB 1994).

The following compounds are not produced commercially in the United States: benz[a]anthracene, benzo[b]fluoranthene, benzo[e]pyrene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, fluoranthene, fluorene, indeno[l,2,3-c,d]pyrene, phenanthrene, and pyrene (HSDB 1994; IARC 1985).

4.2 IMPORT/EXPORT

The most recent data available on U.S. import and export volumes of individual PAHs are as follows: in 1986, 4,000 kg of acenaphthene were imported into the United States; in 1985, 5,730,000 kg of anthracene oil, 882,000 kg of anthracene (≥ 30% purity by weight), 1,040 kg of fluoranthene, and 57,400 kg of pyrene were imported into the United States; in 1984, 79,200 kg of chrysene, 9,440 kg of fluoranthene, 9.1 kg of fluorene, and 551 kg of phenanthrene were imported into the United States; in 1984, 502,000 kg of anthracene oil and pitch of tar coke were exported from the United States, increasing to 3,890,000 kg by 1987 (HSDB 1994; USDOC 1985). In 1985, the United States imported a total of almost 12 million gallons of creosote oil from the Netherlands, France, West Germany, and other countries and almost 185 million pounds of coal tar pitch, blast furnace tar, and oil-gas tar from Canada, Mexico, West Germany, Australia, and other countries (USDOC 1985). The only relevant information found on more recent import and export volumes is for the following group of compounds which contains two PAHs: acenaphthene, chrysene, cymene, and indene (NTDB 1994). Annual import volumes for this group of compounds were $2x10^6$, $3x10^6$, and $9x10^5$ kg for the years 1991, 1992, and 1993, respectively. While these numbers set an upper limit on the import volume for any one of the compounds in this group, they do not provide any further information on import volumes of acenaphthene and chrysene.

4.3 USE

There is no known use for acenaphthylene, benz[a]anthracene, benzo[b]fluoranthene, benzo[e]pyrene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, indeno[1,2,3-c,d]pyrene, or pyrene except as research chemicals (Hawley 1987; HSDB 1994).

Anthracene is used as an intermediate in dye production, in the manufacture of synthetic fibers, and as a diluent for wood preservatives. It is also used in smoke screens, as scintillation counter crystals, and in organic semiconductor research (Hawley 1987). Anthracene is used to synthesize the chemotherapeutic agent, Amsacrine (Wadler et al. 1986). Acenaphthene is used as a dye intermediate, in the manufacture of pharmaceuticals and plastics, and as an insecticide and fungicide (HSDB 1994; Windholz 1983).

Fluorene is used as a chemical intermediate in many chemical processes, in the formation of polyradicals for resins, and in the manufacture of dyestuffs (Hawley 1993; HSDB 1994). Phenanthrene is used in the manufacture of dyestuffs and explosives and in biological research (Hawley 1987; HSDB 1994). Fluoranthene is used as a lining material to protect the interior of steel and ductile-iron drinking water pipes and storage tanks (NRC 1983).

4.4 DISPOSAL

PAHs serve as the basis for listing certain hazardous wastes under the Resource Conservation and Recovery Act (RCRA); they are listed as constituents for groundwater monitoring and are monitored in hazardous wastes as part of the RCRA land disposal restrictions (EPA 1989c). Specific regulations governing the generation, treatment, storage and disposal of hazardous wastes containing PAHs are listed in Chapter 7.

Approximately two-thirds of the PAHs in surface waters are particle-bound and can be removed by sedimentation, flocculation, and filtration processes. The remaining one-third of the dissolved PAHs usually require oxidation for partial removal/transformation (EPA 1980).

Acenaphthene, acenaphthylene, benz[a]anthracene; benzo[a]pyrene, benzo[b]fluoranthene, chrysene, dibenz[a,h]anthracene, indeno[1,2,3-c,d]pyrene, and fluoranthene are all good candidates for rotary kiln incineration at temperatures ranging from 820 to 1,600 ºC and residence times of seconds for liquids and gases, and hours for solids (EPA 1981a; HSDB 1994). Benz[a]anthracene, benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, indeno[1,2,3-c,d]pyrene, and fluoranthene all are good candidates for fluidized-bed incineration at a temperature of 450-980 ºC and residence times of seconds for liquids and gases and longer for solids (EPA 1981a; HSDB 1994). Benz[a]anthracene also is a good candidate for liquid injection incineration at a temperature range of 650-1,600 ºC and a residence time of 0.1 to 2 seconds (EPA 1981a; HSDB 1994). Liquids containing pyrene should be atomized in an incinerator. Combustion is improved by mixing with a more flammable solvent. Solids should be combined with paper or other flammable material prior to incineration (UN 1985). Benz[a]anthracene, chrysene, dibenz[a,h]anthracene, benzo[k]fluoranthene, benzo[j]fluoranthene, benzo[b]fluoranthene, and benzo[a]pyrene laboratory wastes can be oxidized using agents such as concentrated sulfuric acid, potassium dichromate, or potassium permanganate (IARC 1985). Water contaminated with benzo[g,h,i]perylene can be decontaminated by carbon adsorption (EPA 1981c). Anthracene in waste chemical streams may be subjected to ultimate disposal by controlled incineration (HSDB 1994; EPA 1981a).

Bioremediation is emerging as a practical alternative to traditional disposal techniques (Cemiglia 1993; Thomas and Lester 1993; Wilson and Jones 1993). It has only recently been considered as a viable treatment method for contaminated soils but is now being used or is under consideration by the EPA for clean-up in over 135 Super-fund and underground storage tank sites (Carraway and Doyle 1991; Sims 1990; EPA 1989d). *In situ* treatment involves addition of nutrients, an oxygen source, and, sometimes, specifically adapted microorganisms that enhance degradation. Current *in situ* treatments have been used with some success for removal of two- and three-ring PAHs but generally are considered ineffective for removal of most PAHs from soil (Wilson and Jones 1993).

On-site methods such as landfarming also have been used successfully to degrade PAHs with three or fewer aromatic rings. The waste material is applied to the soil as a slurry and the area is fertilized, irrigated, limed, and tilled. The major disadvantage of landfarming is that contaminants can move from the treatment area. To enhance treatment and minimize movement of contaminants, prepared beds have been used. For this type of remediation, the contaminated soil is removed to a specially

prepared area lined with a low permeability material and the bed is managed to optimize degradation (Wilson and Jones 1993).

A third type of bioremediation involves the use of a bioreactor in a dedicated treatment area. The contaminated soil is excavated, slurried with water, and treated in the reactor. The horizontal drum and airlift-type reactors are usually operated in the batch mode but may also be operated in a continuous mode. Because there is considerable control over the operating conditions, treatment often is quick and effective. Contaminated groundwater and effluent also may be treated in either fixed-film' or stirred-tank bioreactors. However, bioreactors are still in the developmental stages and further research is required to optimize their efficiency and cost effectiveness (Wilson and Jones 1993).
A pilot-scale evaluation of the bioreactor method was carried out in a joint Superfund Innovative Technology Evaluation (SITE) project and a project to collect information for the Best Demonstrated Available Technologies (BDAT) database (Lewis 1993). Five 64-L bioslurry reactors were charged with a 30% (wt/vol) ratio of creosote-contaminated soil from a Superfund site, inoculated with PAH degraders, and inorganic nutrients were added. Total PAH -degradation averaged 93.4 ± 3.2% over all reactors during the 12-week study, with 97.4% degradation of the 2- and 3-ring PAHs and 90% degradation of the 4- to 6-ring PAHs.

Huesemann et al. (1993) carried out a 16-week laboratory study to assess the biotreatability of PAHs in refinery American Petroleum Institute (API) oil separator sludge. Two biotic treatments were evaluated: (1) a nutrient-amended, inoculated, aerated slurry reactor, and (2) an oxygen-sparged reactor. A sterile, nitrogen-sparged reactor was used as a control. Naphthalene, anthracene, phenanthrene, and benzo[a]pyrene were completely biodegraded in 4 weeks in both biotic reactors. Chrysene biodegraded in 4 weeks in the aerated reactor and in 16 weeks in the oxygen-sparged reactor. No significant changes in pyrene concentration were observed in the oxygen-sparged reactor and only a 30% degradation was observed in the aerated reactor. The authors concluded that aerobic biotreatment was successful in removing most BDAT PAHs from refinery API oil separator sludge.

5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

This chapter provides a discussion of the environmental fate and potential for human exposure to 17 PAHs. For the purposes of describing environmental fate, these PAHs have been grouped into low, medium, and high molecular weight classes (see Section 5.3.1, Transport and Partitioning). In general, chemicals within each class have similar environmental fates. When available, data are provided for the individual PAHs that are the subject of the profile. When data on each compound are not available, data on members of the weight class are provided. Data regarding total PAHs or generalizations about PAHs are also used to provide insight into the behavior of the compounds cbvered in this profile.

PAHs are released to the environment through natural and synthetic sources with emissions largely to the atmosphere. Natural sources include emissions from volcanoes and forest fires. Synthetic sources provide a much greater release volume than natural sources; the largest single source is the burning of wood in homes. Automobile and truck emissions are also major sources of PAHs. Environmental tobacco smoke, unvented radiant and convective kerosene space heaters, and gas cooking and heating appliances may be significant sources of PAHs in indoor air. Hazardous waste sites can be a concentrated sources of PAHs on a local scale. Examples of such sites are abandoned wood-treatment plants (sources of creosote) and former manufactured-gas sites (sources of coal tar). PAHs can enter surface water through atmospheric deposition and from discharges of industrial effluents (including wood-treatment plants), municipal waste water, and improper disposal of used motor oil. Several of the PAHs have been detected at hazardous waste sites at elevated levels. In air, PAHs are found sorbed to particulates and as gases. Particle-bound PAHs can be transported long distances and are removed from the atmosphere through precipitation and dry deposition. PAHs are transported from surface waters by volatilization and sorption to settling particles. The compounds are transformed in surface waters by photooxidation, chemical oxidation, and microbial metabolism. In soil and sediments, microbial metabolism is the major process for degradation of PAHs. Although PAHs are accumulated in terrestrial and aquatic plants, fish, and invertebrates, many animals are able to metabolize and eliminate these compounds. Bioconcentration factors (BCFs), which express the concentration in tissues compared to concentration in media, for fish and crustaceans are frequently in

the 10-10,000 range. Food chain uptake does not appear to be a major source of exposure to PAHs for aquatic animals.

The greatest sources of exposure to PAHs for most of the United States population are active or passive inhalation of the compounds in tobacco smoke, wood smoke, and contaminated air, and ingestion of the compounds in foodstuffs. The general population may also be exposed to PAHs in drinking water and through skin contact with soot and tars. Higher than background levels of PAHs are found in foods that are grilled or smoked. Estimates of human exposures to PAHs vary. The average total daily intake of PAHs by a member of the general population has been estimated to be 0.207 µg from air, 0.027 µg from water, and 0.16-l .6 µg from food. The total potential exposure to carcinogenic PAHs for adult males in the United States was estimated to be 3 µg/day. Smokers of unfiltered cigarettes may experience exposures twice as high as these estimates. Persons living in the vicinity of hazardous waste sites where PAHs above background levels have been detected may also be exposed to higher levels.

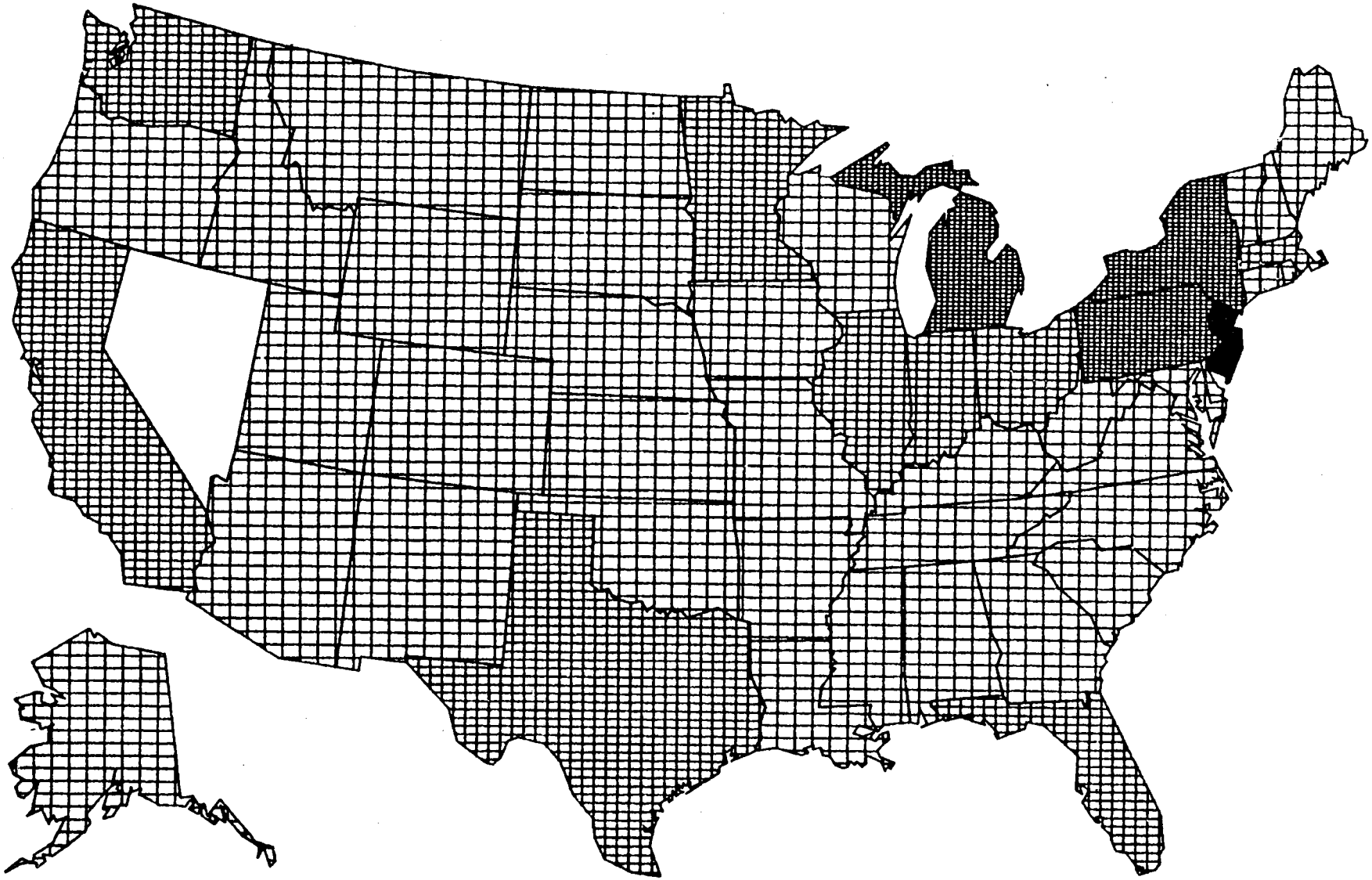
PAHs have been identified in at least 600 of the 1,408 hazardous waste sites that have been proposed for inclusion in the EPA National Priorities List (NPL) (HazDat 1994). However, the number of sites evaluated for PAHs is not known. The frequencies of these sites can be seen in Figure 5-1.

5.2 RELEASES TO THE ENVIRONMENT

5.2.1 Air

Most of the direct releases of PAHs to the environment are to the atmosphere from both natural and anthropogenic sources, with emissions from human activities predominating. PAHs in the atmosphere are mostly associated with particulate matter; however, the compounds are also found in the gaseous phase (NRC 1983; Yang et al. 1991). The primary natural sources of airborne PAHs are forest fires and volcanoes (Baek et al. 1991; NRC 1983). The residential burning of wood is the largest source of atmospheric PAHs (Peters et al. 1991; Ramdahl et al. 1982); releases are primarily the result of inefficient combustion and uncontrolled emissions (Freeman and Cattell 1990; NRC 1983; Tan et al. 1992). Other important stationary anthropogenic sources include industrial power generation, incineration (Shane et al. 1990; Wild et al. 1992); the production of coal tar, coke, and asphalt; and petroleum catalytic cracking (Baek et al. 1991; Guerin 1978; Perwak et al. 1982; Santodonato 1981).

FIGURE 5-1. FREQUENCY OF NPL SITES WITH PAHs CONTAMINATION*



*Derived from HazDat 1994

Environmental tobacco smoke, unvented radiant and convective kerosene space heaters, and gas cooking and heating appliances may be important sources of PAHs in indoor air (Chuang et al. 1991; Hoffmann and Hoffmann 1993; Mumford et al. 1991; NRC 1986; Traynor et al. 1990). Stationary sources account for about 80% of total annual PAH emissions; the rest are from mobile sources. The most important mobile sources of PAHs are vehicular exhaust from gasoline and diesel-powered engines (Baek et al. 1991; Johnson 1988; Yang et al. 1991). Mobile sources are often the major contributors to PAH releases to the atmosphere in urban or suburban areas (Baek et al. 1991). The amount of anthracene released to the atmosphere in 1992 by U.S. industrial facilities sorted by state is given in Table 5-l (TRI92 1994). The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. TRI92 (1994) data were not available for other PAHs included in this profile.

The U.S. annual emissions (from early to mid 1970s) of polycyclic organic matter (a term generally used to describe PAHs, their nitrogen-containing analogs, and their quinone degradation products [Santodonato et al. 1981]) were estimated by NRC (1983) as follows: open buming 4,024 metric tons (39%), residential heating-3,956 metric tons (38%), automobiles and trucks-2,266 metric tons (22%), and industrial boilers-74 metric tons (1%). NRC (1983) estimated that the total amount of benzo[a]pyrene produced in the United States is between 300 and 1,300 metric tons annually. Peters et al. (1981) estimated that a total of 11,031 metric tons of PAHs were released to the atmosphere in the United States on an annual basis, with 36% of the total coming from residential heating, 6% from industrial processes, 1% from incineration, 36% from open burning, 1% from power generation, and 21% from mobile sources. This estimate can be compared to that of Ramdahl et al. (1982), who reported that a total of 8,598 tons of PAHs were emitted to the atmosphere annually from the following sources: (1) residential heating-16%; (2) industrial processes 41%; (3) incineration-l % (4) open burning-13%; (5) power generation-5%; and (6) mobile sources-25%.

The composition of PAH emissions varies with the combustion source. For example, emissions from residential wood combustion contain more acenaphthylene than other PAHs (Perwak et al. 1982), whereas auto emissions contain more benzo[g,h,i]perylene and pyrene (Rogge et al. 1993a; Santodonato et al. 1981). PAHs in diesel exhaust particulates are dominated by three- and four-ring compounds, primarily fluoranthene, phenanthrene, and pyrene (Kelly et al. 1993; Rogge et al. 1993a; Westerholm and Li 1994). Diesel exhaust vapor emissions are dominated by phenanthrene and anthracene (Westerholm and Li 1994). Acenaphthene, fluorene, and phenanthrene have been found to

Table 5-1. Releases to the Environment from Facilities that Manufacture or Process Anthracene

State[b]	Number of facilities	Range of reported amounts released in pounds per year[a]						
		Air	Water	Land	Underground Injection	Total Environment[c]	POTW Transfer	Off-site Waste Transfer
AL	7	2-3500	0-5	0	0	2-3505	0	0-465000
AR	1	327-327	0	0	0	327-327	0	0
CA	1	1-1	0	0	0	1-1	0	0
FL	2	0-702	0	0	0	0-702	0	0-250
IL	5	126-1000	0	0	0	126-1000	0-250	0-10273
IN	5	0-11090	0	0	0	0-11090	0-88	0
KY	2	20-94	0-78	0	0	20-172	0	0-680
LA	7	0-125	0-9	0	0	0-125	0	0-7370
MI	2	85-4085	0	0	0	85-4085	0-5	0-1190
MN	1	160-160	0	0	0	160-160	0	0
MO	1	10-10	5-5	0	0	15-15	0	0
MS	2	0-250	108-250	0-250	0	108-750	0	0
NJ	3	0-272	0-5	0-7	0	0-272	0	2-250
NY	2	0-910	0	0	0	0-910	0	0
OH	12	0-3700	0-250	0-720	0	0-4425	0-5	0-14112
OK	1	0-0	0	1-1	0	1-1	0	5-5
PA	7	0-997	0-37	0-560	0	0-1594	0	0-7900
SC	2	0-255	0	0	0	0-255	0-250	0-145
TX	13	0-2780	0	0-1532	0	0-2780	0	0-493911
UT	2	2-4	0	0	0	2-4	0	0
VI	1	3879-3879	15-15	0	0	3894-3894	0	0
WA	2	34-5395	11-250	0	0	45-5645	0	0-6650
WV	3	10-1500	0	0	0	10-1500	0	0-250

Source: TRI92 1994

be predominant in total (particle- and vapor-phase) diesel emissions (Lowenthal et al. 1994). Phenanthrene was the most abundant and frequently detected PAH in samples of fly ash and bottom ash collected from municipal refuse incinerators in the United States (Shane et al. 1990), whereas benzo[g,h,i]perylene was the most abundant and frequently detected PAH in fly ash samples collected from municipal solid waste incinerators in the United Kingdom (Wild et al. 1992). Fluoranthene, benzo[a]fluoranthene, benzo[g,h,i]perylene, indeno[1,2,3-c,d]pyrene, phenanthrene, and chrysene were predominant in emission particle samples collected from a municipal waste incinerator, whereas benzo[g,h,i]perylene and benz[a]anthracene were predominant in emission particle samples collected from a municipal and medical/pathological waste incinerator (Williams et al. 1994). Emission particle samples from a pilot scale rotary kiln incinerator charged with polyethylene contained predominantly benz[a]anthracene and phenanthrene when an afterburner was used, whereas pyrene, fluoranthene, and phenanthrene were predominant without an afterburner; total PAH concentrations were reduced by a factor greater than 100 by the use of an afterburner (Williams et al. 1994). In coal tar pitch emissions, concentrations of phenanthrene and pyrene have been reported to be 20-80 times greater than the concentrations of benzo[a]pyrene and benzo[g,h,i]perylene (Sawicki 1962). Chrysene/triphenylene, pyrene, and fluoranthene were dominant among the PAHs found in fine particle emissions from natural gas home appliances (Rogge et al. 1993b). Cigarette mainstream smoke contains a wide variety of PAHs with reported concentrations of benzo[a]pyrene ranging from approximately 5-80 ng/cigarette; sidestream smoke concentrations are significantly higher with sidestream/mainstream concentration ratios for benzo[a]pyrene ranging from 2.5 to 20 (Hoffmann and Hoffmann 1993; IARC 1983).

5.2.2 Water

Important sources of PAHs in surface waters include deposition of airborne PAHs (Jensen 1984), municipal waste water discharge (Barrick 1982), urban storm water runoff (MacKenzie and Hunter 1979), runoff from coal storage areas (Stahl et al. 1984; Wachter and Blackwood 1979), effluents .from wood treatment plants and other industries (DeLeon et al. 1986; Snider and Manning 1982; USDA 1980), oil spills (Giger and Blumer 1974), and petroleum pressing (Guerin 1978). Brown and Weiss (1978) estimated that l-2 tons of benzo[a]pyrene were released from municipal sewage effluents and 0.1-0.4 tons of benzo[a]pyrene were released from petroleum refinery waste waters in the United States in 1977.

Most of the PAHs in surface waters are believed to result from atmospheric deposition (Santodonato et al. 1981). However, for any given body of water, the major source of PAHs could vary. Jensen (1984) studied benzo[a]pyrene loading in a marine coastal area and determined that atmospheric deposition was indeed the major source of benzo[a]pyrene, with lesser amounts contributed by refinery effluent, municipal waste water, urban runoff, and rivers. Prahl et al. (1984) found that combustion-derived PAHs adsorbed to suspended sediments in rivers accounted for the major portion of PAHs in the waters of a Washington coastal area, and other studies have identified industrial effluents, road runoff, and oil spills as the major contributors in specific bodies of water (DeLeon et al. 1986; Santodonato et al. 1981).

The amount of anthracene released to surface water and publicly owned treatment works (POTWs) in 1992 by U.S. industrial facilities sorted by state is shown in Table 5-l (TRI92 1994). The TRI data should be used with caution since only certain facilities are required to report. This is not an exhaustive list. TRI92 (1994) data were not available for other PAHs included in this profile. Because most of the PAHs released to aquatic environments tend to remain near the sites of deposition, lakes, rivers, estuaries, and coastal marine environments near centers of human populations and industrial activity tend to be the major repositories of aquatic PAHs (Neff 1979).

5.2.3 Soil

Most of the PAHs in soil are believed to result from atmospheric deposition after local and long-range transport. The presence of PAHs in the soil of regions remote from any industrial activity supports this contention (Thomas 1986). Other potential sources of PAHs in soil include sludge disposal from public sewage treatment plants, automotive exhaust, irrigation with coke oven effluent, leachate from bituminous coal storage sites, and use of soil compost and fertilizers (Perwak et al. 1982; Santodonato et al. 1981; Stahl et al. 1984; White and Lee 1980). The principal sources of PAHs in soils along highways and roads are vehicular exhausts and emissions from wearing of tires and asphalt. PAHs may also be released to soils at concentrations above background and landfill sites (Black et al. 1989) and industrial sites, including creosote production (Ellis et al. 1991), wood-preserving (Mueller et al. 1991; Weissenfels et al. 1990), and coking plants (Weissenfels et al. 1990; Werner et al. 1988). Soils at the sites of former manufactured gas plants are also heavily contaminated with PAHs (Bewley et al. 1989; Tumey and Goerlitz 1990).

The amount of anthracene released to surface water and publicly owned treatment works (POTWs) in 1992 by U.S. industrial facilities sorted by state is shown in Table 5-l (TRI92 1994). Based on data in Table 5-1, only relatively small amounts of anthracene were discharged in hazardous waste sites from U.S. industrial facilities in 1992. However, some of the anthracene wastes transferred off-site (see Table 5-l) ultimately may be disposed of on land. The TRI data should be used with caution since only certain facilities are required to report. This is not an exhaustive list. TRI92 (1994) data were not available for other PAHs included in this profile.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

The global movement of PAHs can be summarized as follows: PAHs released to the atmosphere are subject to short- and long-range transport and are removed by wet and dry deposition onto soil, water, and vegetation. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms (with bioconcentration factors often in the 10-10,000 range). In sediments, PAHs can biodegrade or accumulate in aquatic organisms. PAHs in soil can volatilize, undergo abiotic degradation (photolysis and oxidation), biodegrade, or accumulate in plants. PAHs in soil can also enter groundwater and be transported within an aquifer.

Transport and partitioning of PAHs in the environment are determined to a large extent by physicochemical properties such as water solubility, vapor pressure, Henry's law constant, octanol-water partition coefficient (K_{ow}), and organic carbon partition coefficient (K_{oc}). In general, PAHs have low water solubilities. The Henry's law constant is the partition coefficient that expresses the ratio of the chemical's concentrations in air and water at equilibrium and is used as an indicator of a chemical's potential to volatilize. The K_{oc} indicates the chemical's potential to bind to organic carbon in soil and sediment. The K_{ow} is used to estimate the potential for an organic chemical to move from water into lipid and has been correlated with bioconcentration in aquatic organisms. Some of the transport and partitioning characteristics (e.g., Henry's law constant, K_{oc} values, and K_{ow}, values) of the 17 PAHs are roughly correlated to their molecular weights. These properties are discussed by grouping these PAHs as follows:

- Low molecular weight compounds (152-l 78 g/mol)-acenaphthene, acenaphthylene, anthracene, fluorene, and phenanthrene;
- Medium molecular weight compounds (202 g/mol)-fluoranthene and pyrene; and
- High molecular weight compounds (228-278 g/mol)-benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, benzo[e]pyrene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene.

As an example, Hattemer-Frey and Travis (1991) found that the low solubility, low vapor pressure and high K_{ow} of benzo[a]pyrene result in its partitioning mainly between soil (82%) and sediment (17%), with ≈1% partitioning into water and <1% into air, suspended sediment and biota.

PAHs are present in the atmosphere in the gaseous phase or sorbed to particulates. The phase distribution of PAHs in the atmosphere is important in determining their fate because of the difference in rates of chemical reactions and transport between the two phases. The phase distribution of any PAH depends on the vapor pressure of the PAH, the atmospheric temperature, the PAH concentration, the affinity of the PAH for the atmospheric suspended particles (K_{oc}), and the nature and concentrations of the particles (Baek et al. 1991). In general, PAHs having two to three rings (naphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, phenanthrene) are present in air predominantly in the vapor phase. PAHs that have four rings (fluoranthene, pyrene, chrysene, benz[a]anthracene) exist both in the vapor and particulate phase, and PAHs having five or more rings (benzo[a]pyrene, benzo[g,h,i]perylene) are found predominantly in the particle phase (Baek et al. 1991; Jones et al. 1992). The ratio of particulate to gaseous PAHs in air samples collected in Antwerp, Belgium, was 0.03 for anthracene, 0.49 for pyrene, 3.15 for summed benz[a]anthracene and chrysene, and 11.5 for summed benzo[a]fluoranthene and benzo[b]fluoranthene (NRC 1983).

Using field data from Osaka, Japan, Pankow et al. (1993) examined the effects of relative humidity. (RH) on measured gas/particle partition coefficients over the range 42% ≥ 95%. They found that for seven PAHs or groups of PAHs (including phenanthrene + anthracene, fluoranthene, and pyrene) sorption decreased with increasing RH.

Atmospheric residence time and transport distance depend on the size of the particles to which PAHs are sorbed and on climatic conditions which will determine rates of wet and dry deposition. About 90-95% of particulate PAHs are associated with particle diameters <3.3 μm, and the peak distributions

are localized between 0.4 and 1.1 μm (Baek et al: 1991). Both coarse particles with aerodynamic diameters >3-5 μm and nucleic particles with diameters <0.1 μm have limited atmospheric residence times. The coarse particles are removed from the atmosphere by wet and dry deposition, while the nucleic particles are removed mainly by coagulation with other nucleic particles or with larger particles, followed by wet and dry deposition. Particles with a diameter range of 0.1-3.0 μm, with which airborne PAHs are principally associated, remain airborne for a few days or longer, due to slower dry deposition and less efficient wet deposition (Baek et al. 1991). Therefore, airborne particulate PAHs in this size range can transport long distances (Lunde and Bjorseth 1977). Larger particles emitted from urban sources tend to settle onto streets and become part of urban runoff. However, PAHs in urban air are primarily associated with submicrometer-diameter soot particles that have residence times of weeks and are subject to long-range transport (Butler and Crossley 1981). Long-range transport of PAHs was examined by Lunde and Bjorseth (1977), Bjorseth et al. (1978a), and Bjorseth and Olufsen (1983) who found that PAHs originating in Great Britain had been transported as far as Norway and Sweden.

The relative importance of wet and dry deposition in removing PAHs from the atmosphere varies with the individual PAH. For example, Perwak et al. (1982) estimated that a total of 23% of benzo[a]pyrene released to the atmosphere is deposited on soil and water surfaces. Dry deposition of benzo[a]pyrene adsorbed to atmospheric aerosols accounts for most of the removal; wet deposition is less significant by a factor of 3-5. In a mass balance study of the atmospheric deposition of PAHs to Siskiwit Lake, which is located on a wilderness island in northern Lake Superior, dry aerosol deposition of particulate phase PAHs was found to be the predominant form of input to surface waters by an average ratio of 9:l over wet deposition (McVeety and Hites 1988).

PAH compounds tend to be removed from the water column by volatilization to the atmosphere, by binding to suspended particles or sediments, or by being accumulated by or sorbed onto aquatic biota. The transport of PAHs from water to the atmosphere via volatilization will depend on the Henry's law constants (Hs) for these compounds. The low molecular weight PAHs have Henry's law constants in the range of 10^{-3}-10^{-5} atm-m^3/mol; medium molecular weight PAHs have constants in the 10^{-6} range; and high molecular weight PAHs have values in the range of 10^{-5}-10^{-8}. Compounds with values ranging from 10^{-3} to 10^{-5} are associated with significant volatilization, while compounds with values less than 10^{-5} volatilize from water only to a limited extent (Lyman et al. 1982). Half-lives for volatilization of benz[a]anthracene and benzo[a]pyrene (high molecular weight PAHs) from water have

been estimated to be greater than 100 hours (Southworth 1979). Southworth et al. (1978) stated that lower molecular weight PAHs could be substantially removed by volatilization if suitable conditions (high temperature, low depth, high wind) were present. Southworth (1979) estimated half-lives for volatilization of anthracene (a low molecular weight PAH) of 18 hours in a stream with moderate current and wind, versus about 300 hours in a body of water with a depth of 1 meter and no current. Even for PAHs susceptible to volatilization, other processes, such as adsorption, photolysis or biodegradation (see Section 5.3.2.2) may become more important than volatilization in slow-moving, deep waters.

Because of their low solubility and high affinity for organic carbon, PAHs in aquatic systems are primarily found sorbed to particles that either have settled to the bottom or are suspended in the water column. It has been estimated that two-thirds of PAHs in aquatic systems are associated with particles and only about one-third are present in dissolved form (Eisler 1987). In an estuary, volatilization and adsorption to suspended sediments with subsequent deposition are the primary removal processes for medium and high molecular weight PAHs, whereas volatilization and biodegradation (see Section 5.3.2.2) are the major removal processes for low molecular weight compounds (Readman et al. 1982). In an enclosed marine ecosystem study, less than 1% of the original amount of radiolabeled benz[a]anthracene added to the system remained in the water column after 30 days; losses were attributed to adsorption to settling particles and to a lesser extent to photodegradation (Hinga and Pilson 1987).

Baker et al. (1991) found that several PAHs were significantly recycled in the water column of Lake Superior. Fluorene and phenanthrene were rapidly removed from surface waters and settled through the water column to the sediment-water interface where a large fraction of the recently settled contaminants were released back into the water column. Higher molecular weight PAHs were found to have lower settling fluxes, but these compounds were efficiently buried in the surficial sediments with little recycling. Settling particles were found to be greatly enriched in hydrophobic organic chemicals.

The K_{oc} of a chemical is an indication of its potential to bind to organic carbon in soil and sediment. The low molecular weight PAHs have K_{oc} values in the range of 10^3-10^4, which indicates a moderate potential to be adsorbed to organic carbon in the soil and sediments. The medium molecular weight compounds have K_{oc} values in the lo4 range. High molecular weight PAHs have K_{oc} values in the

range of 10^5-10^6, which indicates stronger tendencies to adsorb to organic carbon (Southworth 1979). PAHs from lands cleared by slash and bum methods have been found to be deposited in charred litter and to move into soils by partitioning and leaching (Sullivan and Mix 1985). Phenanthrene and fluoranthene (low and medium molecular weight PAHs, respectively) from these areas were incorporated into soil to a greater extent (i.e., less strongly adsorbed to organic carbon in the charred litter) than high molecular weight PAHs such as benzo[g,h,i]pyrene and indeno[1,2,3-c,d]pyrene.

Because mobile colloids may enhance the mobility in porous medias of hydrophobic pollutants such as PAHs, Jenkins and Lion (1993) tested bacterial isolates from soil and subsurface environments for their ability to enhance transport of phenanthrene in aquifer sand. The most mobile isolates tested significantly enhanced the transport of phenanthrene, as a model PAH, in sand.

Sorption of PAHs to soil and sediments increases with increasing organic carbon content and with increasing surface area of the sorbent particles. Karickhoff et al. (1979) reported adsorption coefficients for sorption of pyrene to sediments as follows: sand-9.4-68; silt-1,500-3,600; and clay-l ,400-3,800. Gardner et al. (1979) found that from three to four times more anthracene and about two times more fluoranthene, benz[a]anthracene, and benzo[a]pyrene were retained by marsh sediment than by sand.

PAHs may also volatilize from soil. Volatilization of acenaphthene, acenaphthylene, anthracene, fluorene, and phenanthrene (low molecular weight PAHs) from soil may be substantial (Coover and Sims 1987; Southworth 1979; Wild and Jones 1993). However, of 14 PAHs studied in two soils, volatilization was found to account for about 20% of the loss of 1-methylnaphthalene and 30% of the loss of naphthalene; volatilization was not an important loss mechanism for anthracene, phenanthrene, fiuoranthene, pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, dibenz[a,h]anthracene, benzo[a]pyrene, and indeno[l,2,3-c,d]pyrene (Park et al. 1990).

Physicochemical properties of several phenanthrene and anthracene metabolites [1-hydroxy-2-napthoic acid (lH2NA); 2,3-dihydroxy naphthalene (23DHN); 2-carboxy benzaldehyde (2CBA); and 3,4-dihydroxy benzoic acid (34DHBA)] were experimentally measured and/or estimated and used with a Fugacity Level 1 model to estimate the distribution of the metabolites and their parent compounds in a contaminated soil (Ginn et al. 1994). The volumes of the air, water and soil phases were assumed to be 20%, 30%, and 48%, respectively. A volume of 2% was assumed for nonaqueous phase liquid

(NAPL) phase. The parent compounds, anthracene and phenanthrene, had the greatest tendency to be associated with the NAPL and soil phases. The polar metabolites of phenanthrene, lH2NA and 34DHBA, were associated more with the water phase of the subsurface. The metabolites 2CBA and 23DHN had a stronger affinity for the NAPL phase than for the water phase.

PAHs have been detected in groundwater either as a result of migration directly from contaminated surface waters or through the soil (Ehrlich et al. 1982; Wilson et al. 1986). Fluorene from an abandoned creosote pit was found to migrate through sand and clay into groundwater (Wilson et al. 1986). PAHs have also been shown to be transported laterally within contaminated aquifers (Ehrlich et al. 1982).

PAHs can be accumulated in aquatic organisms from water, sediments, and food. Bioconcentration factors (BCFs) for several species of aquatic organisms are listed in Table 5-2. In fish and crustaceans BCFs have generally been reported in the range of 10-10,000 (Eisler 1987). In general, bioconcentration was greater for the higher molecular weight compounds than for the lower molecular weight compounds. Bioconcentration experiments performed with radiolabeled compounds may overestimate the BCFs of some PAHs. For example, Spacie et al. (1983) estimated BCFs of 900 for anthracene and 4,900 for benzo[a]pyrene in bluegills (whole body) based on total radiolabeled carbon (^{14}C) activity. However, the estimated BCFs based only on the parent compounds were 675 and 490, respectively, indicating that biotransformation of the parent compounds occurred in addition to bioconcentration. Biotransformation by the mixed function oxidase (MFO) system in the fish liver can result in the formation of carcinogenic and mutagenic intermediates; exposure to PAHs has been linked to the development of tumors in fish (Eisler 1987). The ability of fish to metabolize PAHs may explain why benzo[a]pyrene frequently is not detected or found only at very low levels in fish from environments heavily contaminated with PAHs (Varanasi and Gmur 1980, 1981). The breakdown products (polyhydroxy compounds) are eliminated in feces (via bile) and urine. Although fish and most crustaceans evaluated to date have the MFO system required for biotransformation of PAHs, some molluscs and other aquatic invertebrates are unable to metabolize PAHs efficiently (Varanasi et al. 1985). Varanasi et al. (1985) ranked the extent of benzo[a]pyrene metabolism by aquatic organisms as follows: fish > shrimp > amphipod crustaceans > clams. Half-lives for elimination of PAHs in fish ranged from >2 days to 9 days (Niimi 1987).

TABLE 5-2. Polycyclic Aromatic Hydrocarbon (PAHs) Bioconcentration Factors (BCFs) for Selected Species of Aquatic Organisms[a]

PAH compound and organism	Exposure period[b]	BCF
ANTHRACENE		
Mayfly, *Hexagenia* sp.	28 h	3,500
Cladoceran, *Daphnia pulex*	24 h	760–1,200
Cladoceran, *Daphnia magna*	60 m	200
Fathead minnow, *Pimephales promelas*	2–3 d	485
Rainbow trout, *Salmo gairdneri*	72 h	4,400–9,200
BENZ(*a*)ANTHRACENE		
Cladoceran, *D. pulex*	24 h	10,109
BENZO(*a*)PYRENE		
Midge, *Chironomus riparius*, larvae	8 h	166
Mosquito, *Culex pipiens quinquefasciatus*	3 d	11,536
Alga, *Oedogonium cardiacum*	3 d	5,258
Periphyton, mostly diatoms	24 h	9,600
Cladoceran, *D. pulex*	3 d	134,248
Cladoceran, *D. magna*	6 h	2,837
Snail, *Physa* sp.	3 d	82,231
Clam, *Rangia cuneata*	24 h	9–236
Oyster, *Crassostrea virginica*	14 d	242
Northern pike *Esox lucius*	3.3 h–23 d	<55
Mosquitofish, *Gambusia affinis*	3 d	930
Bluegill, *Lepomis macrochirus*	4 h	12
Bluegill, *L. macrochirus*		
No dissolved humic material (DHM)	48 h	2,657
20 mg/L DHM	48 h	225
CHRYSENE		
Clam, *Rangia cuneata*	24 h	8
Pink shrimp, *Penaeus duorarum*		
Cephalothorax	28 d	248–361
Cephalothorax	28 d + 28 d postexposure	21–48
Abdomen	28 d	84–199
Abdomen	28 d + 28 d postexposure	22–91

TABLE 5-2. Polycyclic Aromatic Hydrocarbon (PAHs) Bioconcentration Factors (BCFs) for Selected Species of Aquatic Organisms[a] (continued)

PAH compound and organism	Exposure period[b]	BCF
FLUORENE		
Bluegill	30 d	200–1,800
PHENANTHRENE		
Cladoceran, *D. pulex*	24 h	325
Clam, *R. cuneata*	24 h	32
PYRENE		
Cladoceran, *D. pulex*	24 h	2,702

[a]Data summary from multiple studies; adapted from Eislen (1987)

[b]m = minutes; h = hours; d = days

Mollusks also eliminate accumulated PAHs. Neff (1982) reported that oysters (*Crassostrea gigas*) eliminated the following percentages of accumulated PAHs during a 7-day elimination period: benzo[a]pyrene-0%; benz[a]anthracene-32%; fluoranthene-66%; and anthracene-79%.

Fish and crustaceans readily assimilate PAHs from contaminated food, whereas mollusks and polychaete worms have limited assimilation (Eisler 1987). Biomagnification (a systematic increase in tissue concentrations moving up a food chain) has not been reported because of the tendency of many aquatic organisms to eliminate these compounds rapidly (Eisler 1987). In general, PAHs obtained from the diet contribute to total tissue concentrations only to a limited extent. For example, food chain uptake of anthracene by fathead minnows *(Pimephales promelas)* consuming water fleas *(Daphnia pulex)* was estimated to be about 15% of the amount accumulated from the water (Southworth 1979). In a simple aquatic food chain involving seston (i.e., organic and inorganic particulate matter >0.45 μm), blue mussels, and the common eider duck, significant changes were observed in the composition of 19 PAHs moving through the trophic levels. Decreasing PAH concentrations were found with increasing trophic level, probably as a result of the selective biotransformation capacity of the organisms for different PAHs. The high theoretical flux of PAHs through the food chain did not result in increasing concentrations with increasing trophic level (i.e., biomagnification was not observed), indicating rapid biotransformation of the compounds (Broman et al. 1990).

Sediment-associated PAHs can be accumulated by bottom-dwelling invertebrates and fish (Eisler 1987). For example, Great Lakes sediments containing elevated levels of PAHs were reported by Eadie et al. (1983) to be the source of the body burdens of the compounds in bottom-dwelling invertebrates. Varanasi et al. (1985) found that benzo[a]pyrene was accumulated in fish, amphipod crustaceans, shrimp, and clams when estuarine sediment was the source of the compound. Approximate tissue to sediment ratios were 0.6-1.2 for amphipods, 0.1 for clams, and 0.05 for fish and shrimp.

Some terrestrial plants can take up PAHs from soil via the roots or from air via the foliage; uptake rates are dependent on the concentration, solubility, and molecular weight of the PAH and on the plant species (Edwards 1983). Mosses and lichens have been used to monitor atmospheric deposition of PAHs (Thomas et al. 1984). About 30-70% of atmospheric PAHs (indeno[l,2,3-c,d]pyrene, fluoranthene, and benzo[a]pyrene) deposited on a forest were sorbed onto tree foliage (i.e., leaves and

needles) and then deposited as falling litter (Matzner 1984). Vaughan (1984) stated that atmospheric deposition on leaves often greatly exceeds uptake from soil by roots as a route of PAH accumulation.

The uptake of PAHs from soil to plants and the subsequent biomagnification is generally quite low (Sims and Overcash 1983). Ratios of PAH concentrations in vegetation to those in soil have been reported to range from 0.001 to 0.18 for total PAHs and from 0.002 to 0.33 for benzo[a]pyrene (Edwards 1983). ,In a study of PAH uptake from cropland soils conducted in the United Kingdom, elevated concentrations of PAHs in soils were not correlated with concentrations in plant tissues (Wild et al. 1992). The cropland soils had received repeated applications of PAHs in sewage sludge that was applied to the soils over a number of years. PAH content of the soils substantially increased as a result of the sludge amendments, and residues of some PAHs persisted in the soils for years. Tissues from plants grown in the treated soils were relatively enriched with low molecular weight PAHs (e.g., acenaphthene, fluorene, phenanthrene), but increased PAH concentrations (relative to tissues from plants grown in control plots that did not receive sludge amendments) were not consistently detected. The PAH concentrations in aboveground plant parts were not strongly related to soil PAH levels but were probably the result of atmospheric deposition. The presence of PAHs in root crop tissues was probably due to adsorption of the compounds to root surfaces. In a similar study, Wild and Jones (1993) used carrots. (Daucus carotu) as a test crop to investigate the potential for PAHs to move from sewage sludge amended soil into the human food chain. Due to the over-riding influence of atmospheric delivery of PAHs, there was no evidence that sludge application increased the PAH concentration of the foliage. Low molecular weight PAHs such as fluoranthene and pyrene were relatively enriched in the peel, probably because of their greater bioavailability. Transfer of PAHs from the root peel to the core appeared to be minimal. This again suggests that simple adsorption onto the peel maybe an important process.

Simonich and Hites (1994a) studied the partitioning of PAHs between vegetation and the atmosphere throughout the growing season and under natural conditions. They found the partitioning process to be dependent primarily upon the atmospheric gas-phase PAH concentration and the ambient temperature. During the spring and fall, when ambient temperatures are low, gas-phase PAHs partition into vegetation. In the summer, some PAHs volatilize and return to the atmosphere. They also developed a mass-balance model for PAHs in the northeastern United States and published values for PAH concentrations and fluxes in air, water, sediments, and soils (Simonich and Hites 1994b). Their model showed that 44 ± 18% of PAHs emitted into the atmosphere from sources in the region studied

were removed by vegetation. They further hypothesized that most of the PAHs absorbed by vegetation at the end of the growing season are incorporated into the soil and permanently removed from the atmosphere.

PAHs may accumulate in terrestrial animals through the food chain or by ingestion of soil. The environmental fate of creosote coal tar distillate (which contained 21% phenanthrene and 9% acenaphthene) was studied in a terrestrial microcosm containing soil, rye grass, insects, snails, mealworm larvae, and earthworms by Gile et al. (1982). Two gray-tailed voles (*Microtus canicaudus)* were added 54 days after the start of the experiment, which continued for 19-26 more days. Average surface soil concentrations (measured on an unspecified day) were 0.60 ppm (phenanthrene) and 1.19 ppm (acenaphthene). During the last 3 days of the experiment, the following phenanthrene concentrations were measured: snail-3.27 ppm; pill bugs-l .72 ppm; and earthworm-l 8.30 ppm. The acenaphthene concentrations measured were as follows: snail-11.2 ppm (day 37); pill bugs-0.99 ppm (day 75); and earthworm-71.9 ppm (days 72-75). The whole body concentration in the vole analyzed for phenanthrene was 7.20 ppm; in the vole analyzed for acenaphthene it was 37.00 ppm. The authors found that these compounds were not metabolized in this system. Whole body concentrations in the vole exceeded soil concentrations by a factor of 12 for phenanthrene and 31 for acenaphthene; however, most of the radiolabeled acenaphthene was found as bound residues in the gastrointestinal tract of the animal and, therefore, was not accumulated.

5.3.2 Transformation and Degradation

5.3.2.1 Air

The processes that transform and degrade PAHs in the atmosphere include photolysis and reaction with NO_x, N_2O_5, OH, ozone, sulfur dioxide, and peroxyacetyl nitrate (Baek et al. 1991; NRC 1983). Possible atmospheric reaction products are oxy-, hydroxy-, nitro- and hydroxynitro-PAH derivatives (Baek et al. 1991). Photochemical oxidation of a number of PAHs has been reported with the formation of nitrated PAHs, quinones, phenols, and dihydrodiols (Holloway et al. 1987; Kamens et al. 1986). Some of these breakdown products are mutagenic (Gibson et al. 1978). Reaction with ozone or peroxyacetylnitrate yields diones; nitrogen oxide reactions yield intro and dinitro PAHs. Sulfonic acids have also been formed from reaction with sulfur dioxide.

The rates of homogeneous vapor phase chemical reactions are usually faster than heterogeneous chemical reactions of particulate PAHs with sunlight and oxidants in the atmosphere, particularly due to light shielding and stabilizing (toward both oxidation and photolysis) effects in the adsorbed state (Behymer and Hites 1988).

PAHs have a wide range of volatilities and therefore are distributed in the atmosphere between the gas and particle phases. The 24 ring PAHs exist, at least partially, in the gas phase. Atkinson et al. (1991) calculated atmospheric lifetimes (1.44 times the half-life) of several gas-phase PAHs due to reactions with measured or estimated ambient concentrations of OH radicals, NO_3 radicals, N_2O_5, and O_3. Their laboratory studies showed that, for PAHs not containing cyclopenta-fused rings, the major gas-phase process resulting in atmospheric loss will be reaction with the OH radical. Calculated atmospheric lifetimes for acenaphthene, acenaphthylene, phenanthrene, and anthracene were on the order of a few hours. Nighttime reaction with N_2O_5 was estimated to be a minor source of atmospheric loss. The reactions of PAHs, including fluoranthene and pyrene, with the OH radical (in the presence of NO_x) and with N_2O_5 led to the formation of nitroarenes that have been identified in the ambient air. As a class of compounds, the nitrated PAHs have been found to be much more mutagenic than their parent PAHs (Kamens et al. 1993).

Most PAHs in the atmosphere .are associated with particulates (Baek et al.. 1991). Vu-Due and Huynh (1991) describe two types of chemical reactions that appear to be the predominant mode of transformation of these PAHs: (1) reactions between PAHs adsorbed on the particle surfaces and oxidant gases like NO_2, O_3, and SO_3 that do not appear to be influenced by exposure to UV irradiation and (2) photooxidation of PAHs irradiated either under solar radiation or simulated sunlight which produces a variety of oxidized derivatives such as quinones, ketones, or acids. Kamens et al. (1990) estimate that, even in highly polluted air, photolysis is the most important factor in the decay of particle-sorbed PAHs in the atmosphere, followed by reaction with NO_2, N_2O_5, and HNO_3.

The National Research Council (NRC 1983) noted that compounds adsorbed to soot are more resistant to photochemical reactions than pure compounds. Butler and Crossley (1981) estimated half-lives for degradation of the following PAHs adsorbed to soot particles and exposed to sunlight in air containing 10 ppm nitrogen oxides: benzo[a]pyrene-7 days; benzo[g,h,i]perylene-8 days; benz[a]anthracene-11 days; pyrene-14 days; chrysene-26 days; fluoranthene-27 days; and phenanthrene-30 days. However, Thomas et al. (1968) reported that benzo[a]pyrene adsorbed on

soot was readily photooxidized, with 60% of the compound destroyed within the first 40 minutes of exposure to sunlight. The effect of substrate on PAH photolytic half-lives was investigated by Behymer and Hites (1988). Photolysis of 18 PAHs adsorbed to low-carbon fly ash produced a wjde range of half-lives that indicated a relationship between structure and photochemical reactivity. Photolysis of the same compounds adsorbed to fly ash samples containing >5% carbon produced similar half-lives, indicating that for these fly ash samples, photolysis is dependent on the physical and chemical structure of the adsorbent and independent of PAH structure. The investigators postulated that dark (i.e., high carbon content) substrates stabilize PAHs to photolytic breakdown since they absorb more light, making less light available for photolysis. McDow et al. (1993) hypothesized that PAHs in atmospheric particles may be either dissolved in a liquid organic phase or adsorbed at an organic phase-solid elementai carbon interface. Therefore, the reactivity of PAHs might depend, not only on the surface characteristics of the particle's solid core, but also on the chemical composition of the organic phase that surrounds the core. Experiments revealed that photodegradation of PAHs (including benz [a]anthracene, chrysene, benzo[a]pyrene, benzo[b]fluoranthene, and benzo[k]fluoranthene) in a mixture of methoxyphenols, based on relative amounts collected in actual samples from hardwood burning, was 10-30 times faster than in hexane. Their results demonstrated that variations in chemical composition of different types of particles such as diesel exhaust and wood smoke might strongly affect the reactivity of PAHs. Eisenberg and Cunningham (1985) found that the photochemical reaction products of PAHs (anthracene, phenanthrene, fluoranthene, benz[a]anthracene, chrysene, and benzo[a]pyrene) adsorbed on particulates include singlet oxygen, which may be implicated in the formation of mutagenic compounds.

Some PAHs are degraded by oxidation reactions that have been measured in the dark (to eliminate the possibility of photodegradation). Korfmacher et al. (1980) found that, while fhrorene was completely oxidized, fluoranthene and phenanthrene were not oxidized, and benzo[a]pyrene and anthracene underwent minimal oxidation. These compounds were tested adsorbed to coal fly ash; the authors stated that the form of the compound (adsorbed or pure) and the nature of the adsorbent greatly affected the rate and extent of oxidation.

Several studies have been carried out to investigate the reaction of PAHs with ozone at ambient concentrations (Baek et al. 1991). Alebic-Juretic et al. (1990) found degradation of PAHs on particle surfaces by ozone to be an important pathway for their removal from the atmosphere. Half-lives of PAHs obtained under laboratory conditions were used to predict lifetimes in an atmosphere containing

a constant ozone concentration of 0.05 ppm. The predicted lifetimes were 3 hours for benzo[a]pyrene, 12 hours for pyrene, and 6 days for fluoranthene. Lane and Katz (1977) investigated the kinetics of the dark reaction of several PAHs with ozone and found the reaction to be extremely fast under simulated atmospheric conditions, with a reported half-life of 0.62 hours for benzo[a]pyrene exposed to 190 ppb of ozone.

In an attempt to determine the atmospheric oxidation processes that would result in an arene oxide functional group in PAHs, Murray and Kong (1994) studied the reaction of particle-bound PAHs with oxidants derived from the reactions of ozone with alkenes. Phenanthrene and pyrene were converted to arene oxides under these simulated atmospheric conditions. Control experiments indicated that the oxidant responsible for the transformation was not ozone, but a product of the reaction of ozone with tetramethylethylene (TME), probably the carbonyl oxide or the dioxirane derived from TME.

5.3.2.2 Water

The most important processes contributing to the degradation of PAHs in water are photooxidation, chemical oxidation, and biodegradation by aquatic microorganisms (Neff 1979). Hydrolysis is not considered to be an important degradation process for PAHs (Radding et al. 1976). The contribution of the individual processes,to the overall fate of a PAH will depend largely on the temperature, depth, pollution status, flow rate, and oxygen content of the water. As a result, a process that is a major loss/degradation process for a particular PAH in a certain surface water may not be so in another surface water with different water quality.

The rate and extent of photodegradation vary widely among the PAHs (Neff 1979). Unfortunately, there is no easily defined trend in the rates of photolysis that could be correlated with the chemical structure of PAHs. For example, the rate of aquatic photolysis of naphthalene containing two benzene rings is much slower than anthracene which contains three benzene rings (Anderson et al. 1986). Based on half-life data, photolysis in water may be an important fate determining process for acenaphthene, acenaphthylene, anthracene, pyrene, benzo[a]pyrene, and benz[a]anthracene relative to the other PAHs discussed in this document (Behymer and Hites 1988; Anderson et al. 1986; Zepp and Schlotzhauer 1983). A study by Nagata and Kondo (1977) reported that anthracene, phenanthrene, and benz[a]anthracene were susceptible to photodegradation, and that benzo[a]pyrene, chrysene, fluorene, and pyrene were resistant to photodegradation. In the photooxidation of PAHs, the most common

reactions result in the formation of peroxides, quinones, and diones (NAS 1972). The major photoproducts of anthracene, phenanthrene, and benz[a]anthracene are anthraquinone, 9,10-phenanthrequinone, and 7,12-benz[a]anthraquinone, respectively (David and Boule 1993).

The rate of photolysis is accelerated by the presence of certain sensitizers (Zepp and Schlotzhauer 1983). Conversely, the rate of photolysis is decreased by the presence of certain quenchers in water (e.g., certain carbonyl compounds). The importance of photolysis will also decrease with the increase of depth in a body of water, particularly in turbid water, because of light attenuation and scattering (Zepp and Schlotzhauer 1979).

Generally, oxidation with singlet oxygen and peroxy radicals are the two important oxidative processes for environmental pollutants in water. The rate constants for reactions of PAHs with singlet oxygen and peroxy radicals (Mabey et al. 1981) and the typical concentrations of the two oxidants in environmental waters (Mill and Mabey 1985) suggest that these reactions may not be important in controlling the overall fate of PAHs in water.

PAHs in water can be chemically oxidized by chlorination and ozonation. A high efficiency of PAH degradation from chlorination has been reported by Harrison et al. (1976a, 1976b) for both laboratory and waste-water treatment plant conditions. Pyrene was the most rapidly degraded PAH. Benz[a]anthracene, benzo[a]pyrene, and perylene were also highly degraded. Indeno[1,2,3-c,d]pyrene and benzo[g,h,i]pyrene were intermediate with respect to relative degradation. Benzo[k]fluoranthene and fluoranthene were the most slowly degraded of the compounds tested.

The PAH-related by-products resulting from chlorination are not fully known (Neff 1979). Oyler et al. (1978) identified the following products resulting from the chlorination of PAHs: anthraquinone, a chlorohydrin of fluoranthene; and monochloro derivatives of fluorene, phenanthrene, l-methyl-phenanthrene, and 1-methylnaphthalene. Mori et al. (1993) found that treatment of aqueous benz[a]anthracene (B[a]A) solution with chlorine in both the presence and absence of bromide ion produced a variety of halogenated compounds. The main product was the oxygenated compound, B[a]A-7, l2-dione. A variety of mutagenic halogen substituted and halogen additive (polar) compounds also were produced. The oxidation reaction with chlorine of B[a]A in water was accelerated in the presence of bromide ion.

In water, ozonation is generally slower and less efficient than chlorination in degrading PAHs (Neff 1979). Reaction pathways for ozonation of some PAHs include benz[a]anthracene to 7,12-quinone; benzo[a]pyrene to 3,6-, 1,6-, and 4,5diones; and fluorene to fluorenone (NAS 1972).
In general, PAHs can be significantly metabolized by microbes under oxygenated conditions. However, under anoxic conditions, degradation will be extremely slow (Neff 1979). Concentrations of dissolved oxygen >0.7 mg/L is adequate for biotransformation and the presence of a minimal concentration of PAH is required for biodegradation to proceed (Borden et al. 1989). The minimum total PAH concentration below which biotransformation may be inhibited under ambient nutrient conditions may be 30-70 µg/L (Borden et al. 1989). Some other factors that increase the rates of PAH biodegradation are higher water temperature (summer versus winter) and the presence of adapted microorganisms (Aamand et al. 1989; Anderson et al. 1986; Lee and Ryan 1983). Some PAHs are partially or completely degraded by some species of aquatic bacteria and fungi. The bacterial degradation pathway includes an initial dioxygenase attack to form cis-dihydrodiols (via dioxetane intermediates) that are further oxidized to dihydroxy products. In fungi and mammalian systems (which, unlike bacteria, have cytochrome P-450 enzyme systems), truns-dihydrodiol is produced via an arene oxide intermediate (Anderson et al. 1986; Cemiglia and Heitkamp 1989; Neff 1979). This is significant since the arene oxides have been linked to the carcinogenicity of PAHs. Algae were found to transform benzo[a]pyrene to oxides, peroxides, and dihydrodiols (Kirso et al. 1983; Warshawsky et al. 1983).

Microorganisms in stored groundwater samples completely degraded acenaphthene and acenaphthylene within 3 days (Ogawa et al. 1982). When these reactions occurred under aerobic conditions, there was no evidence of anaerobic degradation of PAHs within the aquifer from which the samples were obtained.

Information on the biodegradation of PAHs by fungi is limited compared to the information that is available about bacteria. However, the fungus *Cunninghamella elegans* has been reported to be capable of metabolizing naphthalene (Cemiglia and Gibson 1979), anthracene, benzo[a]pyrene (Cemiglia and Heitkamp 1989), and fluorene (Pothuluri et al. 1993).

No correlation between biodegradability and molecular weight is evident in three- to four-ring PAHs. For example, phenanthrene with three benzene rings biodegraded in an estuarine water from Savannah,

Georgia, with a half-life of 19 days in August, but anthracene, containing the same number of benzene rings, did not biodegrade at all (Lee and Ryan 1983). Based on estimated reaction rates or half-lives, acenaphthylene, acenaphthylene, and fluorene, the three PAHs that have lower molecular weights than phenanthrene, may not readily biodegrade in water (Lee and Ryan 1983; Mabey et al. 1981). While both naphthalene and phenanthrene biodegraded in water, other PAHs, such as anthracene, benz[a]anthracene, chrysene, and fluorene, did not readily biodegrade in water, but degraded readily in sediment water slurries (Lee and Ryan 1983). On the other hand, PAHs with five or more benzene rings, such as benzo[a]pyrene, dibenz[a,h]anthracene, and benzo[g,h,i]perylene, may not biodegrade readily even in sediment-water slurries (Lee and Ryan 1983; Mabey et al. 1981).

Based on theoretical modeling, photolysis would account for 5% and biodegradation 91% of the transformation/removal of anthracene from deep, slow moving, and somewhat turbid water. The corresponding values in a very shallow, fast-moving, clear water were 47 and 12%, respectively (Southworth 1979).

5.3.2.3 Sediment and Soil

Microbial metabolism is the major process for degradation of PAHs in soil environments. Photolysis, hydrolysis, and oxidation generally are not considered to be important processes for the degradation of PAHs in soils (Sims and Overcash 1983). However, in a study of PAH losses from four surface soils amended with PAHs in sewage sludge, losses due to volatilization and photolysis from sterilized soils were considered to be important for PAHs composed of less than four aromatic rings, whereas abiotic losses were insignificant for PAHs containing four or more aromatic rings (Wild and Jones 1993). Another study that assessed the fate of several PAHs, which included naphthalene, anthracene, phenanthrene, fluoranthene, pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthene, dibenz[a,h]anthracene, benzo[a]pyrene, dibenzo[a,i]pyrene and indeno[l,2,3-c,d]pyrene, in two soils concluded that abiotic degradation (photolysis and oxidation) accounted for mean losses of 13, 8.3, and 15.8% loss in case of naphthalene, anthracene, and phenanthrene, respectively. No significant abiotic loss was observed for the other PAHs (Park et al. 1990).

The rate and extent of biodegradation of PAHs in soil are affected by environmental factors; the organic content; structure and particle size of the soil; characteristics of the microbial population; the presence of contaminants such as metals and cyanides that are toxic to microorganisms; and the

physical and chemical properties of the PAHs (Wilson and Jones 1993). Based on experimental results, the estimated half-lives (days) of the PAHs in soil were: naphthalene, 2.1-2.2; anthracene, 50-l34; phenanthrene, 16-35; fluoranthene, 268-377; pyrene, 199-260; chrysene, 371-387; benz[a]anthracene, 162-261; benzo[b]fluoranthene, 211-294; benzo[a]pyrene, 229-309; dibenz[a,h]anthracene, 361-420; dibenzo(a,i)pyrene, 232-361; and indeno[l,2,3-c,d]pyrene, 288-289 (Park et al. 1990). Although there are differences in the biodegradation half-life values estimated by different investigators (Park et al. 1990; Wild and Jones 1993; Symons et al. 1988), their results suggest that the biodegradation half-lives of PAH with more than three rings will be considerably longer (>20 days to hundreds of days) than the PAHs with three or fewer rings. Environmental factors that may influence the rate of PAH degradation in soil include temperature, Ph, oxygen concentration, PAH concentrations and contamination history of soil, soil type, moisture, nutrients, and other substances that may act as substrate co-metabolites (Sims and Overcash 1983). The size and composition of microbial populations in turn can be affected by these factors. For example, in low-Ph soils, fungi are dominant over bacteria, and thereby control microbial degradation in these environments. Sorption of PAHs to organic matter and soil particulates also influences bioavailability, and hence, biotransformation potential. Sorption of PAHs by soil organic matter may limit biodegradation of compounds that would otherwise rapidly undergo metabolism (Manila1 and Alexander 1991; Weissenfels et al. 1992).

Although the pathways of microbial degradation are well known for anthracene, benzo[a]pyrene, and phenanthrene, degradation pathways for other PAHs are largely unknown (Sims and Overcash 1983). Metabolism of PAHs by bacteria includes the formation of cis-dihydrodiols through dioxetane intermediates, whereas in fungi (and mammalian systems) trans-dihydrodiols are produced through arene oxide intermediates (Sims and Overcash 1983). MacGillivray and Shiaris (1994) estimated the relative contribution of prokaryotic (bacteria) and eukaryotic (yeast, fungi) microorganisms to PAH biotransformation using phenanthrene as a model compound. They found that the relative contribution of eukaryotic microorganisms to phenanthrene transformation in inoculated sterile sediment was less than 3% of the total activity.

In laboratory studies, Sims et al. (1988) demonstrated extensive degradation of two-ring PAHs in sandy soils, with half-lives of approximately 2 days. The three-ring PAHs, anthracene, and phenanthrene had half-lives of 16 and 134 days, respectively. Four- to six-ring PAHs generally had half-lives >200 days. Anthracene and fluoranthene showed slightly higher biodegradation rates than

benz[a]anthracene or benzo[a]pyrene in a study with fine and medium sands and marsh sediments (Gardner et al. 1979). Degradation rates expressed as a percentage of the mass removed per week for the four compounds were anthracene-2.0-3.0%, fluoranthene-1.9-2.4%, benz[a]anthracene-1.4-l .8%, and benzo[a]pyrene-0.84-1.4%. The ranges of half-lives of phenanthrene and benzo[g,h,i]perylene in four soils amended with PAHs in sewage sludge were 83-193 days and 282-535 days, respectively. Mean half-lives were found to be positively correlated with log K_{ow} and inversely correlated with log water solubility. Previous exposure of the test soils to PAHs enhanced the rate of biodegradation of low molecular weight PAHs but had little effect on the loss of higher molecular weight compounds (Wild and Jones 1993).

Herbes and Schwall (1978) investigated the rates of microbial transformation of PAHs in freshwater sediments from both pristine and oil-contaminated streams. They found that turnover times (l/k) in the uncontaminated sediment were 10-400 times greater than in contaminated sediment. Absolute rates of PAH transformation (micrograms of PAH per gram of sediment per hour) were 3,000-125,000 times greater in the contaminated sediment. Turnover times in the oil-contaminated sediment increased 30-l00-fold per additional ring from naphthalene through benz[a]anthracene; naphthalene was broken down in hours while the turnover times for benz[a]anthracene and benz[a]pyrene were ~400 days and >3.3 years, respectively. Therefore, four- and five-ring PAHs, including the carcinogenic benz[a]anthracene and benz[a]pyrene, may persist even in sediments that have received chronic PAH inputs.

The rate of biodegradation may be altered by the degree of contamination. At hazardous waste sites, half-lives may be longer since other contaminants at the site may be toxic to degrading . microorganisms. Bossert and Bartha (1986) reported reduced biodegradation of PAHs in soil containing a chemical toxic to microorganisms.

Efroymson and Alexander (1994) investigated the effects of nonaqueous phase-liquids (NAPLs) on the biodegradation of hydrophobic compounds, including phenanthrene, in soil and subsoil. Mineralization of phenanthrene in the subsoil was reduced if the compound was dissolved in a NAPL. However, the suppression of the mineralization of phenanthrene in soil by NAPLs was short-lived, suggesting growth of organisms capable of using phenanthrene.

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

There is a relatively large body of data characterizing PAH air levels at a variety of U.S. sites. Caution must be used in interpreting and comparing results of different studies, however, because of the different sampling methods used. PAHs occur in the atmosphere in both the particle phase and the vapor phase, as discussed in Section 5.2.1. Three-ring PAH compounds are found in the atmosphere primarily in the gaseous phase, whereas, five- and six-ring PAHs are found mainly in the particle phase; four-ring PAH compounds are found in both phases. To fully characterize atmospheric PAH levels, both particle- and vapor-phase samples must be collected. Many of the earlier monitoring studies used filter sampling methods, which provided information on particle-phase PAH concentrations only, and which did not account for losses of some of the lower molecular weight PAHs by volatilization. As a result, the early use of particulate samples may have resulted in an underestimation of total PAH concentrations. More recent monitoring studies often use sampling methods that collect both particle- and vapor-phase PAHs and that prevent or minimize volatilization losses, thus providing more reliable characterization of total atmospheric PAH concentrations (Baek et al. 1991).

Several monitoring studies indicate that there are higher concentrations of PAHs in urban air than in rural air. Pucknat (1981) summarized 1970 data from the U.S. National Air Surveillance Network and reported that benzo[a]pyrene concentrations in 120 U.S. cities were between 0.2 and 19.3 ng/m^3. Ambient benzo[a]pyrene concentrations in nonurban areas ranged between 0.1 and 1.2 ng/m^3. More recently, Greenberg et al. (1985) evaluated atmospheric concentrations of particulate phase PAHs at four New Jersey sites (three urban and one rural) over two summer and winter seasons during 198l-82. Urban PAH concentrations were approximately 3-5 times higher than those at the rural site; in addition, winter concentrations were approximately 5-10 times higher than summer concentrations. Geometric mean concentrations of ten PAHs (benzo[a]pyrene, benzo[e]pyrene, benzo[b]fluoranthene, benzofi]fluoranthene, benzo[k]fluoranthene, benz[a]anthracene, indeno[l,2,3-c,d]pyrene, benzo[g,h,i]perylene, pyrene, and chrysene) ranged from 0.03 to 0.62 ng/m^3 in urban areas and from 0.01 to 0.12 ng/m^3 in the rural area during the summer seasons. During the winter seasons, geometric mean concentrations of these PAHs ranged from 0.40 to 11.15 ng/m^3 in urban areas and from 0.08 to 1.32 ng/m^3 in the rural area. Geometric mean concentrations of benzo[a]pyrene ranged from 0.11 to

0.23 ng/m^3 (urban) and 0.04 to 0.06 ng/m^3 (rural) during the summer seasons, and from 0.69 to 1.63 ng/m^3 (urban) and 0.17 to 0.32 (rural) during the winter seasons. A more extensive study by Harkov and Greenberg (1985) of atmospheric benzo[a]pyrene concentrations at 27 New Jersey sites indicated similar differences in mean urban (0.6 ng/m^3) and rural (0.3 ng/m^3) concentrations. Significant seasonal trends were also observed, with mean benzo[a]pyrene concentrations during the winter more than an order of magnitude greater than during the summer.

Several other studies provide evidence that atmospheric concentrations of particle-phase PAHs are higher in winter than in summer. In a 1981-82 study conducted in the Los Angeles area; atmospheric concentrations of 10 PAHs (anthracene, fluoranthene, pyrene, chrysene, benz[a]anthracene, combined benzo[e]pyrene and perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, and combined benzo[g,h,i]perylene, and indeno[l,2,3-c,d]pyrene) ranged from 0.14 to 1.45 ng/m^3 (with an average of 0.43 ng/m^3) during the summer (August-September), and from 0.40 to 4.46 ng/m^3 (with an average of 1.28 ng/m^3) during the winter (February-March) (Grosjean 1983). A similar seasonal variation in particle-phase PAH concentrations in the Los Angeles atmosphere was seen in an earlier 1974-75 study (Gordon 1976). Quarterly geometric mean concentrations of 11 PAHs (pyrene, fluoranthene, benz[a]anthracene, chrysene, benzo[a]pyrene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, and indeno[1,2,3-c,d]pyrene) ranged from 0.06 to 2.71 ng/m^3 (with an average of 0.45 ng/m^3) during the May-October period, and from 0.26 to 8.25 ng/m^3 (with an average of 1.46 ng/m^3) during the November-April period. The highest and lowest concentrations were observed during the fourth (November-January) and second (May-July) quarters, respectively. Ratios of fourth quarterly and second quarterly geometric mean concentrations ranged from 3.9 for indeno[l,2,3-c,d]pyrene to 7.5 for benzo[a]pyrene and 9.8 for benz[a]anthracene. Possible factors contributing to these seasonal variations in PAH levels include the following: changes in emission patterns; changes in meteorological conditions (i.e., daylight hours and temperature); and changes in space heating emissions, volatilization, and photochemical activity.

Certain monitoring data suggest that ambient levels of some PAHs may be decreasing. Faoro and Manning (1981) analyzed a limited sample of U.S. National Air Surveillance Network data updated through 1977, which indicated that benzo[a]pyrene concentrations have shown consistent, sizable declines during the period from 1967 to 1977 at 26 urban sites and 3 background sites studied (data not provided).

Over the past two decades, the ambient air levels of PAHs in a number of major cities have been characterized. Although data from studies in different areas cannot be used to indicate definitive temporal trends in PAH air levels, a comparison of the results of these studies yields no strong suggestion that the ambient air levels of PAHs may be decreasing, except in traffic tunnels.

In a 1981-82 study that characterized air levels of 13 PAHs in Los Angeles, Grosjean (1983) reported mean ambient particle-phase PAH concentrations ranging from 0.32 ng/m^3 for benzo[k]fluoranthene to 3.04 ng/m^3 for combined benzo[g,h,i]perylene and indeno[1,2,3-c,d]pyrene. Mean concentrations of anthracene, fluoranthene, pyrene, chrysene, benz[a]anthracene, combined perylene and benzo[e]pyrene, benzo[b]fluoranthene, and benzo[a]pyrene were 0.54; 0.94, 1.62, 0.97, 0.48, 0.43, 0.94, and 0.64 ng/m^3, respectively. Similar results were obtained in an earlier (1974-1975) study of atmospheric particle-phase PAHs in the Los Angeles area, where ambient annual geometric mean concentrations ranged from 0.17 ng/m^3 for benzo[j]fluoranthene to 3.27 ng/m^3 for benzo[g,h,i]perylene (Gordon 1976). The annual geometric mean concentration of benzo[a]pyrene was 0.46 ng/m^3; most individual PAHs had annual geometric mean concentrations of <0.6 ng/m^3. The relatively high levels of benzo[g,h,i]perylene found in these studies.have been attributed to high levels of automobile emissions, which are known to contain high levels of benzo[g,h,i]perylene relative to other PAHs (Santodonato et al. 1981). During the same time period, Fox and Staley (1976) reported somewhat higher ambient average concentrations of particle-phase PAHs in College Park, Maryland, ranging from 3.2 ng/m^3 for benzo[a]pyrene to 5.2 ng/m^3 for pyrene.

In a 1985-86 study, reported average ambient concentrations (combined particle- and vapor-phase) of eight PAHs in Denver ranged between 0.83 ng/m^3 for benzo[k]fluoranthene and 39 ng/m^3 for phenanthrene (Foreman and Bidleman 1990). In a study conducted in Hamilton, Ontario, between May 1990 and June 1991, the concentrations of PAHs in respirable air particulate samples were found to range from 0.6 ng/m^3 for phenanthrene to 4.3 ng/m^3 for benzo[g,h,i]perylene, and 5.1 ng/m^3 for combined benzo[b,j,k]fluoranthenes (Legzdins et al. 1994). In a recent limited study, mean concentrations of particle-phase PAHs in New York City air were reported to range from 0.11 ng/m^3 for anthracene to 4.05 ng/m^3 for benzo[g,h,i]perylene (Tan and Ku 1994).

Atmospheric PAH concentrations have been found to be significantly elevated in areas of enclosed traffic tunnels. In a 1985-86 study in the Baltimore Harbor Tunnel the average concentrations of particle-phase PAHs ranged from 2.9 ng/m^3 for anthracene to 27 ng/m^3 for pyrene (Benner and

Gordon, 1989). These values are up to an order of magnitude lower than those obtained in 1975 by Fox and Staley (1976), which ranged from 66 ng/m^3 for benzo[a]pyrene to 120 ng/m^3 for pyrene. Benner and Gordon (1989) postulated that the observed decrease in PAH concentrations over the 1975-85 decade resulted from the increasing use of catalytic converters in U.S. automobiles over that period, These authors also reported concentrations of PAHs in a typical vapor-phase sample from the Boston Harbor Tunnel for four PAHs included in this profile: anthracene (32.3 ng/m^3), fluoranthene (25.6 ng/m^3), phenanthrene (184 ng/m^3), and pyrene (28.3 ng/m^3). They emphasized that the vapor-phase samples included PAHs inherently present in the vapor phase as well as the more volatile 3- and 4-ring PAHs that may be desorbed from particles during sampling. These results underscore the need to evaluate both particle- and vapor-phase samples to obtain more reliable estimates of total atmospheric PAH concentrations.

5.4.2 Water

PAHs have been detected in surface waters of the United States. In an assessment of STORET data covering the period 1980-82, Staples et al. (1985) reported median concentrations in ambient water of <10 µg/L for 15 PAHs (acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, fluoranthene, fluorene, indeno[1,2,3-c,d]pyrene, naphthalene, phenanthrene,. and pyrene). The number of samples ranged from 630 (naphthalene) to 926 (fluoranthene); the percentage of samples in which these PAHs were detected ranged from 1.0 (benzo[g,h,i]perylene) to 5.0 (phenanthrene) and 7.0 (naphthalene).

Basu and Saxena (1978a) reported concentrations of selected PAHs in surface waters used as drinking water sources in four U.S. cities (Huntington, West Virginia; Buffalo, New York; and Pittsburgh and Philadelphia, Pennsylvania). Total concentrations of PAHs ranged from 4.7 ng/L in Buffalo to 600 ng/L in Pittsburgh. Mean concentrations of benzo[a]pyrene in the Great Lakes have been detected at levels between 0.03 and 0.7 ppt (ng/L) (Environment Canada 1991).

DeLeon et al. (1986) analyzed surface water from 11 locations in the Mississippi River. Seventeen PAHs were identified in the samples at levels ranging from 1 ng/L for 6 compounds to a high of 34 ng/L for phenanthrene. The highest concentration of phenanthrene was detected in a sample

collected near New Orleans, Louisiana, near an industrial area, implicating industrial effluent or surface runoff from this area as a possible source.

During April and May 1990, Hall et al. (1993) analyzed 48-hour composite samples from three locations in the Potomac River and three locations in the upper Chesapeake Bay for eight PAHs: perylene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, and chrysene. Pyrene was the.only PAH found (0.42 µg/L) in these samples; it was detected in only one of nine Chesapeake Bay samples and not detected in any of the Potomac River samples (detection limit, 0.04 µg/L).

In a more recent study by Pham et al. (1993), raw water samples from 5 areas in the St. Lawrence River and its tributaries were analyzed for 12 PAHs. The highest mean total PAH concentrations were observed in samples collected in the spring (27.3 ng/L) and autumn (21.03 ng/L), which was attributed to snow melt and increased runoff during these respective seasons. The lowest mean total PAH concentration was observed in summer (14.63 ng/L). High molecular weight PAHs were detected more frequently in the spring and autumn samples. Phenanthrene, benzo[b]fluoranthene, fluoranthene, and pyrene were predominant, comprising on average 33.8%, 17.4%, 17.1%, and 12.8% of the total PAHs, respectively: With the exception of anthracene and benzo[b]fluoranthene, a general decrease in concentration with increasing molecular weight was observed.

PAHs have been detected in urban runoff generally at concentrations much higher than those reported for surface water. Data collected as part of the Nationwide Urban Runoff Program indicate concentrations of individual PAHs in the range of, 300-10,000 ng/L, with the concentrations of most PAHs above 1,000 ng/L (Cole et al. 1984). In a recent study by Pitt et al. (1993) which involved the collection and analysis of approximately 140 urban runoff samples from a number of different source areas in Birmingham, Alabama, and under various rain conditions, fluoranthene was one of two organic compounds detected most frequently (23% of samples). The highest frequencies of detection occurred in roof runoff, urban creeks, and combined sewer overflow samples. The maximum reported concentration of fluoranthene in these samples was 130 µg/L.

Industrial effluents also have elevated PAH levels. Morselli and Zappoli (1988) reported elevated PAH levels in refinery waste waters, with concentrations for most PAHs in the range of 400 ng/L (benzo[b]fluoranthene) to 16,000 ng/L (phenanthrene). In an analysis of STORET data covering the

period 1980-88, Staples et al. (1985) reported median concentrations in industrial effluents of <10 µg/L (10,000 ng/L) for 15 PAHs. The number of samples ranged from 1,182 (benzo-[blfluoranthene) to 1,288 (phenanthrene); the percentage of samples in which PAHs were detected ranged from 1.5 (benzo[g,h,i]perylene) to 7.0 (fluoranthene).

Few data are available on the concentrations of PAHs in U.S. groundwater. Basu and Saxena (1978b) reported total PAH concentrations in groundwater from three sites in Illinois, Indiana, and Ohio to be in the range of 3-20 ng/L. Groundwater levels of PAHs near a coal and oil gasification plant and U.S. wood treatment facilities have been found to be elevated. Groundwater samples from the site of a Seattle coal and oil gasification plant which ceased operation in 1956 were found to contain acenaphthylene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, and chrysene at concentrations ranging from not detected (detection limit 0.005 mg/L) to 0.25, 0.18, 0.14, 0.13, 0.05, 0.08, and 0.01 mg/L, respectively (Tumey and Goerlitz 1990). Individual PAHs in the groundwater from 5 U.S. wood treatment facilities were reported at average concentrations of 57 ppb (0.057 mg/L) for benzo[a]pyrene to 1,825 ppb (1.8 mg/L) for phenanthrene (Rosenfeld and Plumb 1991).

An evaluation of the analytical data from 358 hazardous waste sites with over 5,000 wells indicated that anthracene, fluoranthene, and naphthalene were detected (practical quantitation limit, 10-200 µg/L) in groundwater from at least 0.1% of the sites in three of the ten EPA Regions into which the United States is divided (Garman et al. 1987). A review of groundwater monitoring data from 479 waste disposal sites (178 CERCLA or Super-fund sites, 173 RCRA sites, and 128 sanitary/municipal landfill sites) located throughout the United States indicated that 14 of the PAHs included in this profile were detected at frequencies ranging from 2 detections at one site in one EPA Region for indeno[l,2,3-c,d]pyrene, to 85 detections at 16 sites in 4 EPA Regions for fluorene (Plumb 1991). Benzo[a]pyrene was detected 13 times at 6 sites in 6 EPA Regions. Concentrations were not reported.

Data summarized by Sorrel et al. (1980) indicate low levels of PAHs in finished drinking waters of the United States. Reported maximum concentrations for total PAHs (based on measurement of 15 PAHs) in the drinking water of 10 cities ranged from 4 to 24 ng/L; concentrations in untreated water ranged from 6 to 125 ng/L. The low concentrations of PAHs in finished drinking water were attributed to efficient water treatment processes. Shiraishi et al. (1985) found PAHs in tap water at concentrations of 0.1-1.0 ng/L, primarily as chlorinated derivatives of naphthalene, phenanthrene, fluorene, and fluoranthene. The significance to human health of these compounds is not known (Eisler 1987).

5.4.3 Sediment and Soil

PAHs are ubiquitous in soil. Because anthropogenic combustion processes are a major source of PAHs in soils, soil concentrations have tended to increase over the last 100-150 years, especially in urban areas (Jones et al. 1989a, 1989b). Background concentrations for rural, agricultural, and urban soils (from the United States and other countries) are given in Table 5-3. In general, concentrations ranked as follows: urban > agricultural > rural. Evidence of the global distribution of PAHs was given by Thomas (1986) who detected benzo[g,h,i]perylene and fluoranthene at concentrations above 150 µg/kg in arctic soils. Soil samples collected from remote wooded areas of Wyoming contained total PAH concentrations of up to 210 µg/kg.

Recent data on PAH concentrations in soil at contaminated sites are summarized in Table 5-4. Because of the different sampling methods and locations at each site, this tabulation does not provide a reliable inter-site comparison. Additional studies indicate significantly elevated concentrations of PAHs at contaminated sites. Soil samples collected from the Fountain Avenue Landfill in New York City contained PAH concentrations ranging from 400 to 10,000 µg/kg (Black et al. 1989). In a 1988 study at a hazardous waste land treatment site for refinery process wastes, which had been operative since 1958, average PAH concentrations in surface soils (0-30 cm) ranged from not detected (detection limits 0.1-2.0 mg/kg dry weight) for acenaphthylene, acenaphthene, anthracene, benz[a]anthracene, and benzo[k]fluoranthene to 340 mg/kg dry weight for dibenz[a,h]anthracene (Loehr et al. 1993). In addition to dibenz[a,h]anthracene, the three most prevalent compounds at this depth were benzo[a]pyrene (204 mg/kg), benzo[b]fluoranthene (130 mg/kg), and chrysene (100 mg/kg). PAH concentrations decreased with increasing depth and the majority of PAHs were not detected at depths below 60 cm. At 90-135 cm, only phenanthrene (1.4 mg/kg), pyrene (4.0 mg/kg), chrysene (0.9 mg/kg), and dibenz[a,h]anthracene (0.8 mg/kg) were found.

Sediments are major sinks for PAHs, primarily because of the low solubility of these compounds and their strong affinity for organic carbon in particulate matter. PAH concentrations in sediment are generally much higher than those detected in surface water, i.e., in the range of µg/kg (ppb) rather than ng/kg (ppt) .

In an assessment of STORET data covering the period 1980-1982, Staples et al. (1985) reported median concentrations in sediment of ≤500 µg/kg dry weight for 15 PAHs (acenaphthene,

TABLE 5-3. Background Soil Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs)

Compound	Concentrations (μg/kg)		
	Rural soil	Agricultural Soil	Urban Soil
Acenaphthene	1.7	6	
Acenaphthylene		5	
Anthracene		11–13	
Benzo(a)anthracene	5–20	56–110	169–59,000
Benzo(a)pyrene	2–1,300	4.6–900	165–220
Benzo(b)fluoranthene	20–30	58–220	15,000–62,000
Benzo(e)pyrene		53–130	60–14,000
Benzo(g,h,i)perylene	10–70	66	900–47,000
Benzo(k)fluoranthene	10–110	58–250	300–26,000
Chrysene	38.3	78–120	251–640
Fluoranthene	0.3–40	120–210	200–166,000
Fluorene		9.7	
Ideno(1,2,3-c,d)pyrene	10–15	63–100	8,000–61,000
Phenanthrene	30.0	48–140	
Pyrene	1–19.7	99–150	145–147,000

[a]Derived from:

IARC 1973
White and Vanderslice 1980
Windsor and Hites 1979
Edwards 1983
Butler et al. 1984
Vogt et al. 1987
Jones et al. 1987

TABLE 5-4. Soil Concentrations (mg/kg dry weight) Polycyclic Aromatic Hydrocarbons (PAHs) at Contaminated Sites[a]

Compound	Wood-preserving[b]		Creosote production[c]		Wood treatment[d]	Coking plant[d]	Coking plant[e]	Gas works[f]		Gas works[g]
	Surface-soil	Subsoil	mean	range				mean	range	range
Acenaphthene	7	1,368					29	2	0–11	nd–3.0
Acenaphthylene	5	49	33	6–77			187			nd–3.0
Anthracene	10	3,037	334	15–693	766	6	130	156	57–295	nd–3.1
Benz(*a*)anthracene	12	171			356	16	200	317	155–397	nd–8.6
Benzo(*a*)pyrene	28	82			94	14		92	45–159	nd–15
Benzo(*e*)pyrene										nd–12[i]
Benzo(*b*)fluoranthene	38	140						260	108–552	nd–19
Benzo(*k*)fluoranthene								238	152–446	
Benzo(*j*)fluoranthene										nd–1.2[i]
Benzo(*g,h,i*)perylene										nd–16
Chrysene	38	481	614	8–1,586	321	11	135	345	183–597	nd–12
Dibenz(*a,h*)anthracene					101	2		2,451	950–3,836	nd–2.0
Fluoranthene	35	1,629	682	21–1,464	1,350	34		2,174	614–3,664	nd–2.6
Fluorene	3	1,792	650	49–1,294	620	7	245	225	113–233	nd–6.5
Indeno(1,2,3-*c,d*)pyrene	10	23						207	121–316	nd–13
Naphthalene	1	3,925	1,313	<1–5,769	92	56	59			nd[h]–46
Phenanthrene	11	4,434	1,595	76–3,402	1,440	27	277	379	150–716	nd–26
Pyrene	49	1,016	642	19–1,303	983	28	285	491	170–833	nd–4.3

[a]Modified from Wilson and Jones 1993
[b]Mueller et al. 1991—composite samples
[c]Ellis et al. 1991—samples are 1·5 m or 3·5 m
[d]Weissenfels et al. 1990a—no range or sampling details provided
[e]Werner et al. 1988—no range or sampling details provided
[f]Bewley et al. 1989—samples taken from prototype treatment bed
[g]Turney and Goerlitz 1990—samples taken in 1986 from plant inoperative since 1956.
[h]nd = not detected (no detection limit given)
[i]estimated value

acenaphthylene, anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, fluoranthene, fluorene, indenopyrene, naphthalene, phenanthrene, and pyrene). The number of samples ranged from 236 (anthracene) to 360 (benzo-[alpyrene, fluoranthene); the percentage of samples in which these PAHs were detected ranged from 6.0 (acenaphthene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene) to 22.0 (fluoranthene, pyrene).

Eadie et al. (1982) analyzed surficial sediments in southwestern Lake Erie near a large coal-fired power plant. Sediment concentrations for total PAHs were generally in the range of 530-700 µg/kg, although concentrations in river and near-shore sediments reached nearly 4,000 µg/kg (4 ppm). Heit et al. (1981) reported total concentrations of PAHs (3-7 ring PAHs) from two lakes in the Adirondack acid lake region of 2,660 µg/kg and 770 µg/kg (calculated from data presented). Average concentrations of total PAHs in sediments from three coastal South Carolina marinas were reported to range from 35.6 to 352.3 µg/kg (Marcus et al. 1988). Benzo[a]pyrene levels in bottom sediments of the Great Lakes have been reported to range from 34 to 490 ppb (µg/kg) (Environment Canada 1991). Concentrations of PAHs in sediments from Cape Cod and Buzzards Bay in Massachusetts and the Gulf of Maine have been reported to be in the range of 540-1,300 µg/kg (Hites et al. 1980). Concentrations of low molecular weight PAHs (naphthalene, acenaphthylene, fluorene, phenanthrene, anthracene, and 2-methylnaphthalene) and high molecular weight PAHs (fluoranthene, pyrene, benz[a]anthracene, chrysene, benzofluoranthenes, benzo[a]pyrene, indeno[l,2,3-c,d]pyrene, dibenz[a,h]anthracene, and benzo[g,h,i]perylene) in sediment from the highly polluted Boston Harbor have been reported to range from approximately 100 to 11,000 µg/kg dry wt, and 800 to 23,000 µg/kg dry wt, respectively (Demuth et al. 1993).

Total PAH concentrations in bottom sediments from the main stem of the Chesapeake Bay were reported to range from 45 to 8,920 µg/kg for samples collected from 16 stations in 1986 (Huggett et al. 1988). At least 14 PAHs were found to be dominant among pollutants of surface sediments from the Elizabeth River, a subestuary of the James River in Virginia, with a maximum total PAH concentration of 170,000 µg/g (ppm) observed in one sample from a site of two large wood preservative spills (Bieri et al. 1986). In a more recent study, surface sediment samples from the highly contaminated Elizabeth River were found to contain total concentrations of 14 PAHs ranging from 1.5 to 4,230 µg/g (ppm) dry weight (Halbrook et al. 1992). Significantly lower concentrations,

ranging from 0.34 to 0.95 µg/g (340-950 µg/kg) dry weight, were found in sediment samples from the nearby Nansemond River which served as a clean reference site.

Two-thirds of 105 sediment samples collected throughout Florida during the summers of 1989 and 1990 from sites known or suspected to be contaminated with priority pollutants were found to contain at least one of 15 PAH target analytes (Jacobs et al. 1993). Pyrene was detected most frequently (61% of samples); dibenz[a,h]anthracene and naphthalene were detected least frequently (4% of samples). Total PAH concentrations ranged from below the detection limit to 1,090 mg/kg. Mean concentrations for individual PAHs ranged from 0.87 mg/kg (dibenz[a,h]anthracene and naphthalene) to 30.8 mg/kg (acenaphthene).

Drainage stream sediments from a wood-preserving facility near Pensacola, Florida, were found to be highly contaminated with creosote-derived PAHs, with maximum concentrations from two sampling sites ranging from 300 µg/kg for naphthalene to 12,000 µg/kg for phenanthrene and 140,000 µg/kg for anthracene (Elder and Dresler 1988). Fluoranthene, pyrene, benz[a]anthracene, chrysene, acenaphthene, and fluorene were other dominant PAHs. PAHs were not detected in water samples from the drainage stream. Furthermore, no significant PAH contamination was found in surface sediments from estuarine sites adjacent to the drainage stream; PAHs were detected in sediment samples from only one of seven estuarine sites at concentrations ranging from 75 µg/kg for benz[a]anthracene to 190 µg/kg for fluoranthene.

In 1991, Kennicutt et al. (1994) found that sediment samples from Casco Bay in Maine contained total PAH concentrations ranging from 16 to 20,800 µg/kg dry weight. PAHs were found at all 65 locations sampled. PAHs with four or more rings accounted for more than 60% of Casco Bay sedimentary PAHs. The predominance of PAHs with highly condensed ring structures with few alkylations indicated a pyrogenic or combustion source as the major contributor.

Mean total PAH concentrations of sediments collected in 1985-87 from Moss Landing Harbor, Elkhom Slough, and nearshore Monterey Bay, California, were found to range from 1,470 to 3,080, 157 to 375, and 24 to 114 µg/kg dry weight, respectively (Rice et al. 1993). The Moss Landing Harbor and nearshore Monterey Bay ecosystems are subject to PAH contamination from various local industries, harbor-related activities, power generation, municipal waste treatment, and agricultural runoff. The largest Pacific Coast fossil-fueled power plant is located at Moss Landing. Elkhom

Slough is a seasonal estuary which receives freshwater runoff. Combustion PAHs (i.e., benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, benzo[e]pyrene, chrysene, fluoranthene, and pyrene) were predominant, with mean total concentration at these 3 sites ranging from 1,250 to 2,710, to 335, and 11 to 59 ug/kg dry weight, respectively.

Median concentrations of PAHs in sediment coves collected in 1991 from three northern New Jersey waterways (Arthur Kill, Hackensack River, and Passaic River) highly contaminated with petroleum hydrocarbons ranged from 0.47 mg (470 ug/kg) (acenaphthylene) to 5.10 mg (5,100 µg/kg) (pyrene) (Huntley et al. 1993). In addition to pyrene, fluoranthene, chrysene, and benzo[a]pyrene were the most frequently detected PAHs, with median concentrations at the three sites ranging from 2.40 to 4.10, 1.35 to 2.85, and 0.86 to 2.30 mg/kg, respectively. Mean total PAH concentrations at the 29 sampling stations ranged from 0 to 161 mg/kg. A mean total PAH concentration of 139 mg/kg was found at a sampling station downstream from a chemical control Superftmd site. At most sampling stations, PAH concentrations increased with sample depth up to approximately 45-50 cm, indicating a decline in recent loadings relative to historic inputs.

5.4.4 Other Environmental Media

PAHs have been detected in many food products including cereal, potatoes, grain, flour, bread, vegetables, fruits, oils, and smoked or broiled meat and fish. The concentrations in uncooked foods largely depend on the source of the food. For example, vegetables and fruits obtained from a polluted environment may contain higher PAH concentrations than those obtained from nonpolluted environments. Benzo[a]pyrene, dibenz[a,h]anthracene, and chrysene have been detected in vegetables grown near a heavily traveled road (Wang and Meresz 1982). The method of cooking can also influence the PAH content of food; the time of cooking, the distance from the heat source, and the drainage of fat during cooking (e.g., cooking in a pan versus on a grill) all influence PAH content. For example, charcoal broiling increases the amounts of PAHs in meat. In a composite sample characterized to be typical of the U.S. diet, Howard (1979) found that PAH concentrations in all food groups were less than 2 ppb (µg/g). The following ranges of benzo[a]pyrene concentrations (wet or dry weight not specified) were summarized by Santodonato et al. (1981) from studies conducted in many countries:

- cooking oils: 0.5-S ppb (µg/g)
- margarine: 0.2-6.8 ppb

- smoked fish: trace-6.6 ppb
- smoked or broiled meats: trace-105 ppb
- grains and cereals: not detected-60 ppb
- fruits: not detected-29.7 ppb
- vegetables: not detected-24.3 ppb

These data include samples from areas identified as “polluted.”

Gomaa et al. (1993) recently reported the results of a study to screen smoked foods, including turkey, pork, chicken, beef, and fish products, for carcinogenic and noncarcinogenic PAHs. Eighteen commercially available liquid smoke seasonings and flavorings were also evaluated. All smoked meat products and liquid smoke seasonings were purchased from local supermarkets in Michigan. Total PAH concentrations in smoked red meat products ranged from 2.6 μg/kg in cooked ham to 29.8 μg/kg in.grilled pork chops, while those in smoked poultry products ranged from 2.8 μg/kg in smoked turkey breast to 22.4 μg/kg in barbecued chicken wings. Total PAH concentrations in smoked fish products ranged from 9.3 μg/kg in smoked shrimp to 86.6 μg/kg in smoked salmon. Total concentrations of carcinogenic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, dibenz[a,h]anthracene, and indeno[l,2,3,-c,d]pyrene) ranged from not detected in several red meat products to 7.4 μg/kg in grilled pork chops; from not detected in several poultry products to 5.5 μg/kg in barbecued chicken wings; and from 0.2 μg/kg in smoked trout and shrimp to 14.9 and 16.1 μg/kg in smoked oysters and salmon, respectively. Total PAH concentrations in liquid smoke flavorings and seasonings ranged from 6.3 to 43.7 μg/kg, while total carcinogenic PAH concentrations ranged from 0.3 to 10.2 μg/kg. Smoked meat products processed with natural wood smoke had higher total PAH and total carcinogenic PAH concentrations than those processed with liquid smoke flavorings. Carcinogenic PAHs were not detected in 10% of the smoked food samples and 24% of the samples had concentrations of carcinogenic PAHs <I μg/kg. Benzo[a]pyrene was not detected in 31% of the samples; 45% of the samples had concentrations <l μg/kg. Benzo[a]pyrene was found at concentrations >l μg/kg in 24% of the samples, which included pork sausage (1.8-2.3 μg/kg), grilled pork chops (2.5 μg/kg), whole ham (1.1 μg/kg), beef sausage (1.1 μg/kg), salmon (3.9 μg/kg), and oysters (3.0 μg/kg). Benzo[a]pyrene was detected in 92% (12/13) of liquid smoke flavorings and seasoning samples, with concentrations ranging from 0.1 to 3.4 μg/kg.

Similar results have been obtained in recent investigations of benzo[a]pyrene concentrations in smoked foods in other countries. In Brazil, benzo[a]pyrene was detected in 52% (23/44) of smoked meat

samples; concentrations ranged from 0.1 to 5.9 µg/kg and were generally <1.0 µg/kg (Yabiku et al. 1993). In France, benzo[a]pyrene concentrations in smoked fish, poultry, and pork products were found to range from <0.2 to 1.9, 0.3 to 1.9, and <0.2 to 7.2 µg/kg, respectively; 36% (26/71) of the samples analyzed had benzo[a]pyrene concentrations >1 µg/kg (Moll et al. 1993). Because many imported food products are included in the U.S. food supply, these data may be relevant to estimating dietary PAH exposures of the general U.S. population.

In data summarized by Edwards (1983) the maximum total concentration of PAHs in vegetation near a source was 25,000 ppb (25 µg/g) (dry weight), while concentrations in nonsource areas ranged from 20 to 1,000 ppb (0.02-l .0 µg/g). In general, concentrations in leaves, stems, and fruits were higher than those in roots. Fluoranthene, pyrene, and chrysene/triphenylene were found in concentrations of 1.2, 2.0, and 2.9 µg/g, respectively, in composite samples of green leaves from 62 plant species in the Los Angeles area; corresponding values for dried leaf samples were 0.47, 1.l, and 1.9 µg/g (Rogge et al. 1993d). Edwards (1983) reported that washing removed a maximum of 25% of PAHs on the leaves of plants.

PAHs have been found in the tissues of aquatic organisms. In an assessment of STORET data covering the period 1980-1982, Staples et al. (1985) reported median concentrations in biota of <2.0 mg/kg (ppm) wet weight for 8 PAHs (acenaphthene, acenaphthylene, benz[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene, fluorene, and pyrene) and <2.5 mg/kg wet weight for seven PAHs (anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, indenopyrene, naphthalene, and phenanthrene). The number of samples ranged from 83 (naphthalene) to 140 (acenaphthylene); only benzo[g,h,i]perylene (1 sample, 0.8%) and indenopyrene (1 sample, 0.8%) were found in detectable concentrations.

In summary of data on tissue contamination in mussels and oysters from the first 3 years (1986-1988) of the National Oceanic and Atmospheric Administration (NOAA) Mussel Watch Project, which involved the analysis of samples from 177 coastal and estuarine U.S. sites, overall mean concentrations of low molecular weight PAHs ranged from not detected (detection limits 3.3-67 ng/g dry weight) to 4,200 ng/g dry weight (NOAA 1989). Mean concentrations of low molecular weight PAHs for individual years 1986, 1987, and 1988 ranged up to 9,600, 3,200, and 4,300 ng/g dry weight, respectively. Overall mean concentrations of high molecular weight PAHs ranged from not detected (detection limits 3.9-47 ng/g dry weight) to 11,000 ng/g dry weight. Mean concentrations of high

molecular weight PAHs for 1986, 1987, and 1988 ranged up to 15,000, 10,000, and 11,000 ng/g dry weight, respectively. States with sites ranked among the highest five for concentrations of low molecular weight PAHs in 1986, 1987, 1988, and overall in 1986-1988, were California, Florida, Hawaii, Massachusetts, Mississippi, New York, Oregon, and Washington; for high molecular weight PAHs these states were California, Florida, Hawaii, Massachusetts, New York, and Washington. No consistent trends over the 1986-88 period were observed in the data; significant increases and decreases in concentrations of low and high molecular weight PAHs were observed with almost equal frequency. Low molecular weight PAH concentrations showed significant increasing trends at a single site each in New York, New Jersey, Florida, Texas, California, and Oregon; significant decreasing trends were observed at a single site each in Massachusetts, Maryland, and Mississippi, and at two sites in Texas. High molecular weight PAH concentrations showed significant increasing trends at a single site each in New York and Washington, and at two sites in Florida; significant decreasing trends were observed at a single site each in Connecticut, Maryland, and Florida.

Concentrations of phenanthrene and total PAHs ranged from 2 to 296 and 63 to 2,328 µg/kg (ng/g) wet weight, respectively, in caged mussels *(Elliptio complanata)* after 3 weeks' exposure at various locations in St. Mary's River, which is heavily contaminated from industrial and municipal discharges in the Sault Ste. Marie, Ontario, area (Kauss 1991). PAH concentrations ranging from approximately 50 ng/g wet weight for acenaphthylene to 4,660 nglg wet weight for fluoranthene were found in the digestive glands of the American lobster *(Homerus americancus)* collected in the proximity of a coal-coking plant that had been closed for a decade (King et al. 1993). Benzo[a]pyrene concentration was reported to be 720 nglg wet weight.

In a study to evaluate the concentrations of PAHs in various fish and shellfish species from Prince William Sound, Alaska, following the 1989 Exxon Valdez spill of more than 10 million gallons of crude oil, PAHs were not detected in 18% (72/402) of the samples; trace levels were found in 78% (312/402) of the samples; and individual PAH concentrations ranging from 5 to 12 µg/kg (wet or dry weight not specified) were found in 4% (18/402) of the samples. There was no apparent difference between PAH concentrations in salmon collected from impacted areas and those collected from control areas; however, there was a suggestion that contamination may be increasing with time. No PAHs were detected in 14% (31/221) of samples collected in 1989, trace levels were found in 85% of these samples, and only 1% (3 samples) had individual PAH concentration >5 µg/kg; whereas in the 1990

samples, PAHs were detected in all of the 41 samples, trace levels were found in 87% of the samples, and 13% (6 samples) had individual PAH concentrations >5 µg/kg.

PAHs are present at 1–2 weight percent in crude oils (Guerin 1978). Actual PAH concentrations in crude oil depend on the geological source of the oil (IARC 1989). For example, the NRC (1985) has reported concentrations of seven individual carcinogenic PAHs ranging from 1.2 µg/g for benzo[a]pyrene to 23 µg/g for chrysene in a South Louisiana crude oil and from 0.5 µg/g for benzo[e]pyrene to 6.9 µg/g for chrysene in a Kuwaiti crude oil. PAHs are also found in refined petroleum products including gasoline, kerosene, diesel fuel, some heating oils, and motor oil (Guerin 1978).

PAHs have also been detected in used motor oils. The following concentrations of benzo[a]pyrene and benz[a]anthracene measured in 1,071 samples of used motor oils were reported by Franklin Associates (1984):

Positive	Samples(%)	Mean (mg/kg)	Median (mg/kg)	Range (mg/kg)
Benzo[a]pyrene	58	24.5	10	<1–405
Benz[a]anthracene	74	71.3	12	<5–660

The levels, either in concentration or percent weight, in which several PAHs appear in various other substances are given below. A coal tar sample has been found to contain approximately 0.007 mg/kg benz[a]anthracene, 3 mg/kg benzo[b]fluoranthene, 4 g/kg chrysene, and 30 mg/kg benzo[a]pyrene (Perwak et al. 1982). High-temperature coal tar contains 1,000 mg/kg dibenz[a,h]anthracene (IARC 1985). A sample of coal tar pitch was found to contain <10 mg/kg benz[a]anthracene, <10 mg/kg chrysene, and approximately 10 mg/kg benzo[a]pyrene; creosote oil contains <3 mg/kg benz[a]anthracene, <1 mg/kg chrysene, and <10 mg/kg benzo[a]pyrene (Perwak et al. 1982). Creosote has been reported to contain 21% phenanthrene, 10% fluorene, 10% fluoranthene, 9% acenaphthene, 8.5% pyrene, 3% chrysene, 3% naphthalene, and 2% anthracene (Lorenz and Gjovik 1972).

PAHs have also been reported to occur in chewing tobacco, snuff, and in mainstream and sidestream tobacco smoke. Reported concentrations of some PAHs in various types of tobacco smoke are shown in Table 5-5 (IARC 1983). These data show concentrations of benzo[a]pyrene in cigarette mainstream smoke ranging between 5 and 78 ng/cigarette (IARC 1983). Other studies indicate that concentrations of carcinogenic PAHs in mainstream smoke from unfiltered cigarettes may range from 0.1 to 0.25 µg

per cigarette (Hoffmann and Hecht 1990). Concentrations of PAHs in sidestream smoke are significantly higher than in mainstream smoke with sidestreammainstream concentration ratios for benzo[a]pyrene ranging from 2.5 to 20 (Adams et al. 1987; Evans et al. 1993; Grimmer et al. 1987; Hoffmann and Hoffmann 1993; IARC 1983). Benzo[a]pyrene concentrations of 0.42-63 ppb (ng/g) have been reported in snuff (Brunnemann et al. 1986).

PAH concentrations in a variety of other media have been evaluated. PAH concentrations in fly ash and bottom ash samples from domestic municipal incinerators ranged from not detected to 7,400 µg/kg, with phenanthrene the most abundant and frequently detected compound (Shane et al. 1990). Machado et al. (1993) reported the total concentrations of 16 PAHs (all PAHs in this profile except benzo[e]pyrene) in asphalt and coal tar pitch to be 50, 122 and 294, 300 ppm µg/g), respectively; benzo[a]pyrene concentrations were <6 and 18,100 ppm, respectively. The concentrations of benzo[a]pyrene (250-480 ppm) and several other PAHs in coal tar fumes were higher than those in asphalt fumes by two to three orders of magnitude. The PAH content of asphalt and coal tar pitch fumes increased with increasing generation temperature.

Tire wear particles, brake lining particles, and paved road dust from a residential area had total PAH concentrations of 226.1, 16.2, and 58.7 µg/g, with maximum concentrations of individual PAHs of 54.1 µg/g (pyrene), 2.6 µg/g (benzo[g,h,i]perylene), and 9.4 µg/g (pyrene), respectively (Rogge et al. 1993c). Benzo[a]pyrene concentrations in these media were 3.9, 0.74, and 2.3 µg/g, respectively. Combined particle- and vapor-phase emissions from scrap tire fires have been reported to contain average total PAH concentrations of 3.2 mg/m^3, with average benzo[a]pyrene concentrations ranging from 0.07 to 0.08 mg/m^3 (Lemieux and Ryan 1993). Tire pyrolysis oil, which may be used as a fuel, contains high levels of PAHs, with average total PAH concentrations ranging from 14,540 ppm (µg/g) to over 100,000 ppm (10%); benzo[a]pyrene concentrations ranged from <10 to 600 ppm (Williams and Taylor 1993).

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

The greatest sources of exposure to PAHs for most of the U.S. population are active or passive inhalation of the compounds in tobacco smoke, wood smoke, and contaminated air, and ingestion of these compounds in foodstuffs. Smoking one pack of cigarettes a day has been estimated to result in exposure to carcinogenic PAHs of up to 5 µg/day (Menzie et al. 1992) and in exposure to

TABLE 5-6. Average Indoor Concentrations (μg/m^3) of Polycyclic Aromatic Hydrocarbons (PAHs) in Different Categories of Sample Homes Occupied by Smokers and Non-smokers[a]

	E/E		Home-type G/E		G/G		
Compound	Smokers	Non-smokers	Smokers	Non-smokers	Smokers	Non-smokers	Outdoor Air
Acenaphthylene	18	11	71	15	33	17	4.2
Anthracene	3.5	1.8	8.3	3.4	8.9	2.2	0.96
Benz[a]anthracene	0.32	0.25	1.7	0.34	1.1	0.55	0.42
Benzo[a]pyrene	0.37	0.30	1.7	0.27	0.96	0.58	0.23
Benzo[e]pyrene	1.4	0.67	5.5	0.52	2.4	1.0	0.46
Benzofluoranthenes	0.79	0.68	1.1	0.97	2.0	2.0	1.1
Benzo[g,h,i]perylene	0.53	0.44	1.4	0.59	1.2	0.75	0.50
Chrysene	0.91	0.76	3.6	0.81	2.3	1.6	1.1
Fluorothene	7.2	7.7	13	7.5	13	16	5.6
Indeno[1,2,3-c,d]pyrene	0.35	0.28	1.1	0.40	0.84	0.64	0.35
Phenanthrene	79	57	130	63	130	110	31
Pyrene	4.3	4.6	11	4.8	5.0	9.3	4.4

[a]Adapted from Chuang et al. (1991)
[b]E/E denotes electric heating and cooking systems; G/E denotes gas heating and electric cooking systems; G/G denotes gas heating and cooking systems

benzo[a]pyrene of 0.4 µg/day (Santodonato et al. 1981). Other potential routes of human exposure are ingestion of contaminated drinking water and food products, and skin contact with soot and tars. PAHs are ubiquitous in the environment, resulting from the incomplete combustion of organic materials, whether natural (forest fires or volcanoes) or synthetic (combustion of fuels for heating and transportation). The amount of PAHs found in food products depends as much on the method of preparation (especially grilling or smoking) as on the origin of the food. Disinfection of public water supplies with chlorine can result in the presence of chlorinated and oxygen substituted PAHs (Shiraishi et al. 1985). Coal tar preparations have been used in the clinical treatment of skin disorders. Contamination of the ambient air can be derived from industrial and construction sources. Eldridge et al. (1983) measured substantial levels of PAHs emitted from freshly laid petroleum road asphalt.

Estimates of general population exposure to total PAHs (µg/day) and carcinogenic PAHs in comparison to readily measured benzo[a]pyrene concentrations were presented by Santodonato et al. (1981), as follows:

Source	Benzo[a]pyrene	Select Carcinogenic PAHs[a]	Total PAHs
Air	0.0095–0.0435	0.038	0.207
Water	0.0011	0.0042	0.027
Food	0.16–1.6	–	1.6–16

[a]Total of benzo[a]pyrene, benzo[j]fluoranthene, and indeno[1,2,3-c,d]pyrene.

The most noteworthy of these estimates are the relatively high exposures from ingestion of contaminate food; however, it was noted that because of the lack of reliable monitoring data for PAHs in food, the uncertainty of the food estimates was greater than the uncertainty of the estimates for air or water. Nevertheless, the authors concluded that estimates from all three exposure sources were probably accurate within one order of magnitude, so that food was predominant among the sources of exposure.

More recent estimates of the potential exposures of American adult males to carcinogenic PAHs were provided by Menzie et al. (1992). The estimates provided by these investigators do not include potential exposures experienced in occupational settings or those resulting from use of consumer products (e.g., cosmetics or asphaltic materials added to roofs or driveways). From the average American diet, the intake of carcinogenic PAHs was estimated to be 1–5 µg/day, mostly from

ingestion of unprocessed grains and cooked meats. This dietary intake estimate was increased to 6-9 µg/day for individuals consuming diets with a large meat content as a result of the additional contribution from charcoal-cooked or smoked meats and fish. Exposure via inhalation of ambient air was estimated to be 0.16 µg/day (median), with a range of 0.02-3 µg/day, assuming an inhalation rate of 20 m^3/day. Smoking one pack of unfiltered cigarettes per day increases this estimate by an additional 2-5 µg/day; chain smokers consuming three packs per day increase their exposure by an estimated 6-15 µg/day. Exposure to carcinogenic PAHs for the typical adult male from ingestion of drinking water and incidental ingestion of soil is minor compared to other potential routes of exposure. Drinking water exposure was estimated to be 0.006 µg/day (median), with a range of 0.0002-0.12 µg/day, assuming a consumption rate of 2 L/day. Assuming incidental ingestion of 50 mg soil/day, which may be more typical for small children than for most adults, the estimated median soil intake of carcinogenic PAHs was 0.06 µg/day (range, 0.003-0.3 µg/day). Therefore, the total potential exposure of carcinogenic PAHs for adult males was estimated to be 3 µg/day (median), with a maximum value of 15 µg/day. Smokers of nonfiltered cigarettes may experience exposures twice as high as these estimates. Ingestion of food appears to be the main source of exposure to PAHs for nonsmokers, although inhalation of ambient air is also an important route.

In a Dutch market-basket survey conducted from 1984 to 1986, the mean daily dietary intake of PAHs by 18-year-old males in composites of 221 different foods from 23 commodity groups was estimated to range from 5 to 17 µg/day. The most frequently detected PAHs were benzo[b]fluoranthene (59% of samples), fluoranthene (48%), and benzo[k]fluoranthene (46%). The largest contribution of PAHs to the total diet came from the sugar and sweets, cereal products, and oils, fats, and nuts commodity groups (de Vos et al. 1990).

Consumption of Great Lakes fish is not expected to contribute significantly to dietary intake unless the fish are smoked (Environment Canada 1991). The estimated exposure from consuming 114 g fish containing 50 ppt (ng/g) benzo[a]pyrene once a week would be 5.7 ng/person/week, or 11.6 pg/kg of body weight per day for a 70-kg individual. However, in some areas of the United States, fish consumption advisories have been issued based on elevated concentrations of PAHs found in locally caught fish or shell fish (see Section 5.6) (RTI 1993).

The average intake of benzo[g,h,i]perylene by adults from drinking water sources has been estimated to be 2 ng/day (assuming a drinking water ingestion rate of 2 L/day), inhalation exposure to the

compound has been estimated to be 10 ng/day (assuming an air intake rate of 20 m^3/day) (EPA 1989a).

Indoor air can be an important source of human exposure to PAHs. Potential indoor combustion sources of PAHs include tobacco smoke, unvented space heaters, and food preparation (Lioy and Greenberg et al. 1990). PAHs are among the major carcinogenic agents in environmental tobacco smoke (ETS), which is comprised primarily of diluted sidestream smoke, with a much smaller contribution from exhaled mainstream smoke (Hoffmann and Hoffmann 1993). Exposure to ETS is of particular concern because it has recently been declared a human lung carcinogen by the U.S. EPA. Concentrations of some PAHs in cigarette smoke-polluted environments are listed in Table 5-5. Chuang et al. (1991) monitored the concentrations of PAHs in the indoor and outdoor air of eight homes in Columbus, Ohio, in the winter of 1986-87 and obtained the indoor air results shown in Table 5-6.

Environmental tobacco smoke was the most significant influence on indoor air PAH levels; homes occupied by smokers had higher average concentrations of most PAHs than homes occupied by nonsmokers. In homes occupied by nonsmokers, the.highest average concentrations of most PAHs were found in homes that had gas cooking and heating appliances, followed by homes with gas heating and electric cooking appliances. Homes equipped with electric cooking and heating had the lowest average concentrations of most PAHs.

The Total Human Environmental Exposure Study (THEES), a multimedia study of human exposure to benzo[a]pyrene, was conducted in a rural town, Phillipsburg, New Jersey, where the major industry was a grey-iron pipe manufacturing plant that contributed to high levels of benzo[a]pyrene in the ambient atmosphere (Butler et al. 1993; Lioy 1990; Lioy et al. 1988; Waldeman et al. 1991). Benzo[a]pyrene concentrations in respirable particulate personal samples from 10 homes in areas near the foundry were measured in the range of 0.1 to 8.1 ng/m^3, depending on personal habits (whether the windows were kept open, how frequently the doors were opened, cooking methods, hobbies, whether home improvements were being made) and sources of home heating. The mean outdoor air concentration of benzo[a]pyrene was 0.9 ng/m^3. In samples of food collected from family meals over a 2-week period, the concentration level of benzo[a]pyrene ranged from 0.004 to 1.2 ng/g (wet weight)., No detectable amounts of benzo[a]pyrene were observed in the drinking water supply (detection limit, 0.1 ng/L). In comparing the inhalation and ingestion pathways in each home, Lioy et

TABLE 5-5. Concentrations of Some Polycyclic Aromatic Hydrocarbons (PAHs) in Tobacco Smoke[a]

Compound	Cigarette main stream smoke (µg/100 cigarettes)	Cigarette side stream smoke (µg/100 cigarettes)	Cigarette smoke-polluted environments (µg/m^3)	Cigar smoke (µg/100 g)	Pipe smoke (µg/100 g)
Anthracene	2.3–23.5			11.9	110.0
Benz(*a*)anthracene	0.4–7.6	4–20	0.1–100	2.5–3.9	
Benzo(*b*)fluoranthene	0.4–2.2		0.1–35[b]		
Benzo(*j*)fluoranthene	0.6–2.1				
Benzo(*k*)fluoranthene	0.6–1.2				
Benzo(*g,h,i*)fluoranthene	0.1–0.4				
Benzo(*g,h,i*)perylene	0.3–3.9	9.8	0.4–17		
Benzo(*a*)pyrene	0.5–7.8	2.5–19.9	0.4–760	1.8–5.1	8.5
Benzo(*e*)pyrene	0.2–2.5	13.5	0.4–18		
Chrysene	0.6–9.6		2.6–16		
Dibenz(*a,h*)anthracene	0.4		<0.1–13		
Fluoranthene	1–27.2	126	0.2–99	20.1	
Fluorene	present				
Indeno(1,2,3-*c,d*)pyrene	0.4–2.0		0.6–1		
Phenanthrene	8.5–62.4		4–87	115	
Pyrene	5–27	39–101	0.8–66	17.6	75.5

[a]Adapted from a tabulation of data from several studies in IARC (1983) and Guerin et al. (1992)
[b]Benzofluoranthenes

al. (1988) found that potential intake could be similar in each medium. Of the 20 weeks of exposure (10 homes over a 2-week exposure period), 10 had higher food benzo[a]pyrene exposures and 10 had higher inhalation benzo[a]pyrene exposures. The range of estimated food exposures (l0-4,005 ng/week) was much greater than the range of estimated air exposures (78-385 ng/week). The dominance of one pathway or the other seemed to depend on indoor combustion sources (e.g., cigarette smoke or coal-burning stoves) and personal eating habits. For smokers, inhalation of tobacco smoke was the main source of benzo[a]pyrene exposure; intake from this source was much higher than inhalation of ambient and indoor air or ingestion of food. Smokers also had higher exposure through food intake than nonsmokers. For the average nonsmoker, ingestion of food was the most important route of exposure (Lioy 1990).

Occupational exposures to PAHs can result from processes such as petroleum refining, metalworking, the production of coke, the manufacture of anodes, and the production of aluminum. In reviewing the available data on occupational exposures, it is important to understand that it cannot be implied that the results of a study at one industrial site would be valid for another site or for the same site at another time.

Occupational exposures to PAHs are possible in all operations involved in extraction and processing of crude oil, including drilling, pumping and treating, transport, storage, and refinement (Suess et al. 1985). The main route of exposure is inhalation, although there is also potential for significant dermal exposure (IARC 1989). Workers in petroleum refineries are exposed to PAHs from a variety of sources, including atmospheric distillation, catalytic cracking, residual fuel oil, lubricant oil processing, bitumen processing and loading, coking, and waste-water treatment (IARC 1989). In a study of nine US refineries, total PAH concentrations of 10 $\mu g/m^3$ were reported in personal samples taken in the fluid catalytic cracking and delayed coker units (Futagaki 1983). Total PAH concentrations ranging from approximately 1 to 40 $\mu g/m^3$ were observed in area samples from bitumen processing units. Total PAH concentrations in personal samples from the de-asphalting unit in one refinery were found to range from 2.5 to 49.8 $\mu g/m^3$. At least 85% of the total PAH in these samples was comprised of two-ring compounds (i.e., naphthalene and its derivatives) and 94% of two- or three-ring compounds. PAHs with five or more rings were found to contribute from <0.1% at the catalytic cracker unit to 2.5% at the delayed coker unit. The highest combined concentration of benzo[a]pyrene and benzo[e]pyrene was 9.3 $\mu g/g^3$ in a personal sample from a coker cutter; however, these two PAHs were not detected in most samples (detection limit, 0.01 μg/m3). Exposures to four- to six-ring PAHs

of <0.1 μg/m^3 have been associated with loading road tankers with bitumen in refineries (Brandt and Molyneux 1985). In an evaluation of turn-around operations on reaction and fractionator towers, concentrations of anthracene, benzo[a]pyrene, chrysene, and pyrene in personal samples were either too low to be detected or ≤1 μg/m^3; naphthalene and its methyl derivatives accounted for >99% of the total PAH measured in personal samples (Dynamac Corp. 1985). Area samples taken at various sites during shut-down, leak testing and start-up operations after turn-arounds showed the same distribution pattern of individual PAHs with total PAH concentrations generally ≤100 μg/m^3 (maximum 400 μg/m^3).

Metalworkers may also be exposed to PAHs from refined mineral oils used in machining operations, with the level of exposure depending on the type of oil refinement procedure used (IARC 1984). Acid refined mineral oils have a significant PAH content and have been shown to cause skin cancer in workers exposed to them (Jarvholm and Easton, 1990). Solvent refining procedures almost completely remove PAHs from mineral oils and, therefore, should almost completely eliminate the risks of exposure to carcinogenic PAHs (Bingham et al. 1965; Doak et al. 1983; IARC 1984). There is evidence, however, that the concentration of carcinogenic PAHs in solvent-refined cutting oils may increase during use, particularly during operations such as quenching where the oil is severely heated (Agarwal et al. 1986; Apostoli et al. 1993; IARC 1984; La Fontaine 1978; Thony et al. 1976). Total PAH concentrations in air samples from work areas related to the use of cutting, hardening, and extruding oilshave been reported to be 66, 90, and 106 ng/m^3, respectively (Apostoli et al. 1993).

In a summary of data on industrial exposures in IARC (1984), concentrations of airborne benzo[a]pyrene in aluminum production facilities from 1959 to 1982 in several countries ranged from not detected to 975 μg/m^3; concentrations in a U.S. aluminum reduction plant ranged from 0.03 to 53.0 μg/m^3, depending on the work site. Concentrations of airborne benzo[a]pyrene in coke oven operations ranged from 0 to 383 μg/m^3 depending on the work area; average concentrations in a U.S. plant were reported to range from 0.15 to 6.72 μg/m^3. More recently, inhalation exposures to phenanthrene, pyrene, and benzo[a]pyrene of 485, 108, and 48 μg/8 hours, respectively, have been reported for workers in a German coke plant (Grimmer et al. 1994). However, Van Rooij et al. (1993b) has recently concluded that among coke oven workers dermal absorption is a major route of exposure to PAHs, accounting for an average of 75% and 51% of total absorbed pyrene and benzo[a]pyrene, respectively; the mean dermal and respiratory uptakes of pyrene in 12 workers were reported to range from 4 to 34 and 0.5 to 32 μg/day, respectively.

The use of coal tar, pitch, asphalt, creosote, soot, and anthracene oil is widespread in the manufacture of fuel, dyes, plastics, paints, insulating materials, impregnating materials, building materials, road-building materials, embedding material, rubber, inks, and brushes (Hueper 1949). Faulds et al. (1981) faund that PAHs in diesel engine exhaust attach to respirable dust particles and travel long distances in underground mines, resulting in exposure of mine workers far removed from engine sites. Mechanics may also be exposed to PAHs resulting from the pyrolytic decomposition of the organic fractions of abraded particles from clutch and brake linings (Knecht et al. 1987). Potential exposure to PAHs in road sealing work involving coal tar and bitumen was discussed by Darby et al. (1986). In a study to evaluate inhalation and dermal exposures of 10 roofers removing an old coal tar pitch roof and applying a new asphalt roof, the PAH content of forehead skin wipes taken at the end of the workshift (0.097 μg/cm^2; equivalent to an estimated daily skin exposure of 19.4 μg/day) was found to correlate with the PAH concentrations in personal air samples (10.2 μg/m^3) (Wolff et al. 1989c). Relative concentrations of PAHs in air and wipe samples were: fluoranthene > pyrene > benz[a]anthracene > benzo[a]pyrene > benzo[b]fluoranthene > benzo[g,h,i]perylene > benzo[k]fluoranthene. Anthracene was found in the air samples but was not detected in the wipe samples.

Data on PAH exposures in the United States for many other occupations are limited. Most of the recent studies have been conducted in other countries. PAH concentrations (combined particle- and vapor-phase) in two work areas in a silicon carbide plant ranged from not detected (detection limit, 0.01 mg/m^3) for benzo[a]pyrene and benzo[e]pyrene, to 0.99 mg/m^3 for fluoranthene and 3.46 mg/m^3 for naphthalene (Dufresne et al. 1987). Higher ambient concentrations were observed in the furnace area, ranging from 0.04 mg/m^3 for benzo[a]pyrene and benzo[e]pyrene to 3.85 mg/m^3 for fluoranthene and 58.0 mg/m^3 for naphthalene. Total PAH concentrations in areas near cooking fume sources in the food and catering industries in Finland have been reported to range from 0.2 to 31.8 μg/m^3 (Vainiotalo and Matveinen 1993). Benzo[a]pyrene concentrations of <l-44 ng/m^3 in the breathing zone of urban bus drivers in France have been reported (Limasset et al. 1993). The mean particulate total PAH exposure level in a Swedish electrode paste plant was found to vary from 4.3 to 84.6 μg/m^3 over various work operations, with an overall mean particulate PAH exposure level in the plant of 14.4 μg/m^3 (Ovrebo et al. 1994). The mean PAH exposure level in a Belgian graphite electrode plant was reported to be 19.7 μg/m^3 (Van Hummelen et al. 1993). Drivers of large diesel-powered trucks in Switzerland were not found to have exposures to total PAHs or benzo[a]pyrene that were significantly different from controls (Guilleman et al. 1992).

Preliminary data from the National Occupational Exposure Survey (NOES), conducted by NIOSH from 1980 to 1983, estimated the number of workers potentially exposed to various chemicals in the workplace from 1981 to 1983 (NIOSH 1990). Data for the seven PAHs included in the survey are summarized below:

Chemical	Number of industry/ occupation categories	Number of workers potentially exposed
Anthracene	5	2,303
Benz[a]anthracene	4	2,310
Benzo[a]pyrene	1	896
Chrysene	2	9,358
Fluoranthene	36	21,339
Fluorene	6	2,912
Pyrene	3	9,368

The NOES database does not contain information on the frequency, level, or duration of exposure of workers to any of the chemicals listed. It provides only estimates of workers potentially exposed to the chemicals.

PAHs have generally not been detected in surveys of human tissue, presumably because the compounds are fairly rapidly metabolized. Phenanthrene was the only PAH detected in the 1982 National Human Adipose Tissue Survey; it was found in trace concentrations in 13% of the samples (EPA 1986). Acenaphthylene, acenaphthene, fluorene, and chrysene were not found at levels below the detection limit (0.010 µg/g; 10 ppt). However, autopsies performed on cancer-free corpses found PAH levels of 11–2,700 ppt (ng/g) in fat samples (Obana et al. 1981). Several PAHs were detected, including anthracene, pyrene, benzo[e]pyrene, benzo[k]fluoranthene, benzo[a]pyrene, and benzo[g,h,i]perylene, with pyrene being detected in the highest concentrations. A similar study done on livers from autopsied cancer-free corpses found levels of 6–500 ppt (ng/g) of all of the same PAHs except benzo[e]pyrene, which was not detected (Obana et al. 1981). As in the fat sample studies, pyrene appeared in the highest concentrations in the liver, but the overall levels were less than in fat.

Human exposure to PAHs can be monitored through analytical determination of PAHs and metabolites (e.g., 1-hydroxypyrene) in the urine of exposed individuals (Jongeneelen et al. 1985, 1987; Tolos et al. 1991; Weston et al. 1994). For example, Clonfero et al. (1990) detected increased levels of PAH metabolites in the urine of individuals occupationally (i.e., aluminum plant workers) and

therapeutically (i.e., psoriatic patients) exposed to coal tar, as compared to unexposed subjects. Weston et al. (1994) reported similar results for coal-tar treated psoriasis patients. Tolos et al. (1991) and Van Rooij et al. (1994) reported significant increases in the average 1-hydroxypyrene concentrations in the urine of smokers over nonsmokers. Significant increases in urinary 1-hydroxypyrene levels have also been observed in children living in areas of high density automobile traffic over those of children in suburban areas (Kanoh et al. 1993). Several researchers have reported substantial increases in the urinary concentrations of 1-Hydroxypyrene and other PAH metabolites among workers exposed to PAHs in a variety of occupational settings, including coke plants (Grimmer et al. 1994; Jongeneelen et al. 1990; Van Hummelen et al. 1993), graphite electrode plants (Van Hummelen et al. 1993), foundries (Santella et al. 1993), and creosote wood treatment plants (Viau et al. 1993) and during clean-up of dump sites contaminated with coal tars (Viau et al. 1993), handling of petroleum coke (Jongeneelen et al. 1989), and road surfacing operations (Jongeneelen et al. 1988). Most of these increases were statistically significant over controls. There is conflicting evidence regarding an exposure-response relationship between PAH exposures levels and urinary PAH metabolite concentrations. For example, Grimmer et al. (1994) reported a good correlation between PAH inhalation exposures and levels of urinary metabolites of benzo[a]pyrene, phenanthrene, and pyrene, whereas Jongeneelen et al. (1990) did not find a strong relationship between air monitoring data and urinary levels of 1-hydroxypyrene. In a study of PAH inhalation exposures of aluminum plant workers, Becher and Bjorseth (1983) found that the high concentrations in the occupational setting did not correspond to the measured concentrations of urinary PAH metabolites. The authors suggested that PAHs adsorbed to airborne particulate matter may not be bioavailable and that the exposure-uptake relationship may not be linear over the entire PAH concentration range. When urinary 1-hydroxypyrene excretion is used in the assessment of PAH exposure, the contributions of alternative routes of exposure (i.e., inhalation and dermal) and the variability in the baseline excretion among individual PAH metabolites due to tobacco smoking and dietary PAH intake should be taken into account (Van Rooij et al. 1993b, 1994). Assays for other biomarkers of PAH exposure are currently being developed in animal models (Singh and Weyard 1994), but have not been evaluated in humans.

The detection of PAH-DNA adducts in urine, blood and other tissues by immunoassay and ^{32}P-postlabelling has also been used as an indicator of exposure (Harris et al. 1985; Herikstad et al. 1993; Ovrebo et al. 1994; Perera et al. 1993; Santella et al. 1993).

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Human exposure to PAHs is expected to be highest among certain occupational groups (e.g., individuals working with coal tar and its products, foundry workers, miners, chimney sweeps), smokers and nonsmokers living or working in close proximity to smokers, members of the general population who heat their homes with wood-burning stoves, individuals living in the vicinity of emission sources or using products containing PAHs, and people living in the vicinity of NPL sites where PAHs have been detected above background levels. People who consume grilled or smoked food may ingest high levels of these compounds. Anyone who works extensively with products such as roofing materials, asphalt, and other PAH-containing substances may be exposed through inhalation or skin contact.

Recreational and subsistence fishers that consume appreciably higher amounts of locally caught fish from contaminated waterbodies may be exposed to higher levels of PAHs associated with dietary intake (EPA 1993b). PAH contamination has triggered the issuance of several human health advisories. As of September 30, 1993, PAHs were identified as the causative pollutants in five fish consumption advisories in three different states. This information is summarized in Table 5-7 (RTI 1993). EPA is considering including PAHs as target analytes and has recommended that these chemicals be monitored in fish and shellfish tissue samples collected as part of state toxics monitoring programs. EPA recommends that residue data obtained from these monitoring programs be used by states to conduct risk assessments to determine the need for issuing fish and shellfish consumption advisories for the protection of the general public as well as recreational and subsistence fishers (EPA 1993b).

5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of PAHs is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of PAHs.

Table 5-7. Fish Consumption Advisories

State	Waterbody	Extent
Massachusetts	Hocomoco Pond	Entire pond
Michigan	Hersey River	Downstream from Reed City
Ohio	Black River	6.2 miles from the 31st Street Bridge (Loraine) to the harbor (includes confined disposed facility)
Ohio	Little Scioto River	3.9 miles from Holland Road (Marion) south to St. Rt. 739
Ohio	Mahoning River	29.24 miles from Northwest Bridge Street (Warren) to Pennsylvania border

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.7.1 Identification of Data Needs

Physical and Chemical Properties. The physical and chemical properties (K_{ow}, K_{oc}, vapor pressure, Henry's law constant, etc.) have been sufficiently characterized for most of the 17 PAHs and allow prediction of their environmental fate.

Production, Import/Export, Use, Release, and Disposal. According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit chemical release and off-site transfer information to the EPA. The Toxics Release Inventory (TRI), which contains this information for 1992, .became available in May of 1994. This database will be updated yearly and should provide a list of industrial production facilities and emissions.

PAHs are produced primarily as a result of combustion processes both from anthropogenic and natural sources (HSDB 1994; IARC 1982). Of the 17 PAH compounds discussed in this profile, only acenaphthene, acenaphthylene, and anthracene are produced commercially. However, several other PAH compounds were imported into the United States in 1984 and 1985 (see Section 4.2).

There is no known commercial use for most of the 17 PAHs discussed in this profile. Anthracene, acenaphthene, fluorene, and phenanthrene are chemical intermediates used in the manufacture of dyes, plastics, pesticides, explosives, and chemotherapeutic agents (Hawley 1987; HSDB 1992; Windholz 1983). Fluoranthene is used as a lining material to protect the interior of steel and ductile iron drinking water pipes and storage tanks (NRC 1983).

PAHs are most likely to be released directly in the atmosphere. Other contaminated media of relevance to human exposure include foods and drinking water.

Rules governing the disposal of PAHs have been promulgated by EPA. Although information regarding recommended remedial techniques is available for most of the 17 PAHs discussed in this profile (EPA 1980, 1981a; HSDB 1992; IARC 1985), additional information about the amounts of these compounds disposed of by these remediation methods would be helpful in determining important routes of human exposure.

Environmental Fate. The environmental fate of PAHs is well characterized. No further studies are needed. PAHs are transported in and partitioned to the air, water, and soil. Transformation and degradation processes of PAHs in the air, water, and soil have been well studied. Atmospheric halflives of PAHs are generally less than 30 days. Photochemical oxidation of a number of PAHs has been reported (EPA 1988a). The National Research Council (NRC 1983) noted that compounds adsorbed to soot are more resistant to photochemical reactions than pure compounds. In surface water, PAHs can volatilize, photodegrade, oxidize, biodegrade, bind to particulates, or accumulate in aquatic organisms (with bioconcentration factors often in the 100-2,000 range). Half-lives for volatilization of benz[a]anthracene and benzo[a]pyrene (high molecular weight PAHs) from water have been estimated to be greater than 100 hours (Southworth 1979), and the half-life for volatilization of anthracene (a low molecular weight PAH) was estimated to be 18 hours (Southworth et al. 1978). Hydrolysis is not considered to be an important degradation process for PAHs (Radding et al. 1976). The rate and extent of photodegradation varies widely among the PAHs (Neff 1979). PAHs in soil can biodegrade or accumulate in plants. Microbial metabolism is the major process for degradation of PAHs in soil environments. Photolysis, hydrolysis, and chemical oxidation are not considered important processes for the degradation of PAHs in soils (Sims and Overcash 1983).

Bioavailability from Environmental Media. Limited information is available regarding the bioavailability of PAHs from plants grown in contaminated soils. PAHs can be absorbed following inhalation, oral, or dermal exposure. All of these routes are of concern to humans because PAHs have been shown to contaminate the air, drinking water, soil, and food. There is a need to conduct additional studies on the bioavailability of PAHs from plants grown in contaminated soils and from contaminated soils. However, bioavailability of PAHs from contaminated air, water, and food is of primary concern, and some information is available concerning bioavailability following exposure by these routes. Indirect evidence indicates that PAHs are absorbed by humans following inhalation exposure (Becher and Bjorseth 1983). Furthermore, indirect evidence suggests that benzo[a]pyrene may be absorbed following oral exposure in humans. The concentration of benzo[a]pyrene in human

feces was studied after eight volunteers ingested broiled meat that contained approximately 9 μg of benzo[a]pyrene (Hecht et al. 1979). Less than 0.1 μg/person of benzo[a]pyrene was measured in the feces of these individuals, suggesting absorption and perhaps metabolism of the compound. More direct data are needed on the extent of bioavailability of PAHs, particularly those that are particlebound, following the three major routes of exposure.

Food Chain Bioaccumulation. PAHs can bioaccumulate in plants, aquatic organisms, and animals from intake of contaminated water, soil, and food. Extensive metabolism of the compounds by high-trophic-level consumers, including humans, has been demonstrated; therefore, food chain biomagnification of the compounds does not appear to be significant (Edwards 1983; Eisler 1983; Gile et al. 1982; Wild et al. 1992). However, in some areas of the United States, fish consumption advisories have been issued based on elevated concentrations of PAHs found in locally caught fish or shellfish (see Section 5.6) (RTI 1993). Additional information is needed on levels of PAHs in aquatic organisms that are of concern for human health.

Exposure Levels in Environmental Media. PAHs have been produced and used in large volumes in the environment, home, and industry and. are widely distributed in the environment. They have been detected in air, water, sediment, soil, and food. Although some studies of background levels in different media have been conducted, additional site-specific concentration data in the vicinity of hazardous waste sites are needed. Studies should focus particularly on ambient air, in order to estimate exposure of the general population through inhalation of contaminated air as well as ingestion of or dermal contact with contaminated water or soil. Levels of PAHs tend to be higher in urban air than in rural air (Greenberg et al. 1985; Pucknat 1981). One study reported benzo[a]pyrene air levels of 0.2-19.3 ng/m^3 for urban air and 0.1-0.2 ng/m^3 in rural air (Pucknat 1981). Higher levels of other PAHs have been measured in urban areas. Basu and Saxena (1978a) reported concentrations of selected PAHs in surface waters used as drinking water sources in four U.S. cities (Huntington, West Virginia; Buffalo, New York; and Pittsburgh and Philadelphia, Pennsylvania) as ranging from 4.7 ng/L in Buffalo to 600 ng/L in Pittsburgh. Data collected as part of the Nationwide Urban Runoff Program indicate concentrations of individual PAHs in the range of 300-10,000 ng/L, with the concentrations of most PAHs above 1,000 ng/L (Cole et al. 1984). Few data are available on the concentrations of PAHs in U.S. groundwater. Basu and Saxena (1978b) reported total PAH concentrations in groundwater from three sites in Illinois, Indiana, and Ohio to be in the range of 3-20 ng/L. Data summarized by Sorrel et al. (1980) indicate low levels of PAHs in finished drinking waters of the

United States. Reported maximum concentrations for total PAHs (based on measurement of 1.5 PAHs) in the drinking water of 10 cities ranged from 4 to 24 ng/L. PAHs have been detected in unprocessed cereal, potatoes , grain, flour, bread, vegetables, fruits, and refined fats and oils. The concentrations in uncooked foods largely depend on the source of the food. The amount of PAHs found in food products depends as much on the method of preparation (especially grilling, smoking, or pickling) as on the origin of the food.

Reliable monitoring data for the levels of PAHs in contaminated media at hazardous waste sites and associated background sites are needed so that the information obtained on levels of PAHs in the environment can be used in combination with the known body burden of PAHs to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Exposure Levels in Humans. No data are available regarding the levels of PAHs in body tissues or fluids for populations living near hazardous waste sites. PAHs and their metabolites can be measured in the urine of exposed individuals. In workers exposed to PAHs, the PAH metabolite 1-hydroxypyrene has been detected in the urine at concentrations of 0-40 µg/g creatinine (Jongeneelen et al. 1985). No correlation was found between occupational exposure levels and urine levels, so it is not known whether-urine metabolites could be detected following exposure to low levels of PAHs (as might be expected to occur in individuals living in the vicinity of hazardous waste sites).

PAHs have generally not been detected in surveys of human tissue, presumably because the compounds are fairly rapidly metabolized. Phenanthrene was the only PAH detected in the 1982 National Human Adipose Tissue Survey; it was found in trace concentrations in 13% of the samples (EPA 1986). Acenaphthylene, acenaphthene, fluorene, and chrysene were not found at levels below the detection limit (0.010 µg/g; 10 ppt). However, autopsies performed on cancer-free corpses found PAH levels of 11-2,700 ppt (ng/g) in fat samples (Obana et al. 1981). Several PAHs were detected, including anthracene, pyrene, benzo[e]pyrene, benzo[k]fluoranthene, benzo[a]pyrene, and benzo[g,h,i]perylene, with pyrene being detected in the highest concentrations. A similar study done on livers from cancer-free patients found levels of 6-500 ppt of all of the same PAHs except benzo[e]pyrene, which was not detected (Obana et al. 1981). As in the fat sample studies, pyrene appeared in the highest concentrations in the liver, but the overall levels were less than in fat.

A few exposure estimates for the general population have been made from inhalation of ambient air and ingestion of contaminated drinking water and food, but sparse monitoring data limit the reliability of these estimates. Relatively recent estimates of the size of the workforce exposed to a few of the PAHs (such as benzo[a]pyrene) are available from NIOSH. However, monitoring data on workplace exposure levels are generally inadequate, partially because of the complexity of air emissions in terms of number of compounds detected. Information on exposure levels in humans is needed to better define exposure estimates in the general population and workforce, and to examine the relationship between levels of PAHs in the environment, human tissue levels, and the subsequent development of health effects. These data should be collected simultaneously with data on levels of PAHs air, water, and soil. For a sound database to serve as a foundation for higher level environmental or toxicological research, it should contain information on human exposure levels to PAHs, particularly for individuals living near hazardous waste sites.

This information is necessary for assessing the need to conduct health studies on these populations.

Exposure Registries. No exposure registries for PAHs were located. These substances are not currently compounds for which a subregistry has been established in the National Exposure Registry. The substances will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

5.7.2 Ongoing Studies

The National Institute of Environmental Health Sciences is funding research at Miami University, Oxford, Ohio, to evaluate the transfer of benzo[a]pyrene from sediments directly to a sediment-feeding fish. Specific objectives are to (1) to examine the effects of seasonal parameters (i.e., temperature, body lipids, gonadal development) on the rate and pattern of metabolism of benzo[a]pyrene in a range of size, age, and sexual maturity classes; and (2) evaluate the relative importance of sediment and water as vectors of uptake of benzo[a]pyrene.

The National Institute of Environmental Health Sciences is funding research at the State University of New York at Albany to determine the aquatic bioavailability of PAHs from sediments collected near

discharge points from two aluminum manufacturing plants in the Massena area of the St. Lawrence River. The results of this study should provide a better understanding of the relative contributions of individual industries to pollution of fish and wildlife consumed by area residents.

The National Institute of Environmental Health Sciences is funding research at the State University of New York at Albany to conduct an epidemiologic study of Mohawk women and infants to test the hypotheses that exposure to PAHs, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-pdioxins and dibenzofurans (PCDD/Fs) from a nearby Superfund hazardous waste site elevates body burdens and affects the cytochrome P-450-dependent mixed function monooxygenase system. Determination of 15 PAHs in breast milk will be among the analyses included in this study. The results of the study should enhance our understanding of how these important classes of chemicals arising from hazardous waste bioaccumulate in human adults and infants and whether P-450IA2 induction is a sensitive biomarker of their early biologic effect.

The National Institute of Environmental Health Sciences is funding research at Johns Hopkins University to investigate the molecular dosimetry of ingested PAHs from cooked meats in humans, and identify susceptibility factors that modulate the formation of DNA and protein adducts with these dietary carcinogens. Ultimately, molecular biomonitoring may allow quantitation of biological dose from ingested PAHs, thus accounting for variation in exposure, cooking processes, and metabolism.

The National Institute of Environmental Health Sciences is funding the Massachusetts Institute of Technology to continue studies with fluoranthene by using a modification of a ^{32}P-postlabelling assay to detect and quantify DNA adducts in mice and human lymphoblast cell lines from eventual application as a dosimeter to monitor DNA damage in tissues from occupationally or environmentally exposed human populations.

6. ANALYTICAL METHODS

The purpose of this chapter is to describe the analytical methods that are available for detecting, and/or measuring, and/or monitoring PAHs, its metabolites, and other biomarkers of exposure and effect to PAHs. The intent is not to provide an exhaustive list of analytical methods. Rather, the intention is to identify well-established methods that are used as the standard methods of analysis. Many of the analytical methods used for environmental samples are the methods approved by federal agencies and organizations such as EPA and the National Institute for Occupational Safety and Health (NIOSH). Other methods presented in this chapter are those that are approved by groups such as the Association of Official Analytical Chemists (AOAC) and the American Public Health Association (APHA). Additionally, analytical methods are included that modify previously used methods to obtain lower detection limits, and/or to improve accuracy and precision.

6.1 BIOLOGICAL SAMPLES

Several analytical techniques have been used to determine trace levels of PAHs in biological tissues and fluids including adipose tissue, lungs, liver, skin, hair, blood, urine, and feces (Table 6-l). These include gas chromatography coupled with flame ionization detection (GC/FID), gas chromatography coupled with a mass spectrometry (GC/MS), high-performance liquid chromatography (HPLC) coupled with an ultraviolet (UV) or fluorescence detector, and thin-layer chromatography (TLC) with fluorescence detection.

Recently, Liao et al. (1988) developed a relatively simple and rapid procedure for purifying human and bovine adipose tissue extracts so that trace levels of complex mixture of target analytes (including PAHs) could be detected and quantified by capillary GC/MS. By employing an activated Florisil column, Liao and co-workers showed that lipid contaminants bind effectively (more than 99.75%) with Florisil, thereby producing a relatively clean sample extract. A detection limit at a low ng/g level and an average sample recovery of 85% were achieved (Gay et al. 1980; Liao et al. 1988; Modica et al. 1982).

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Biological tissues (adipose)	Homogenization in 8% benzene in hexane; clean-up on Florisil column	GC/MS	5–50 ng/g	52–95	Liao et al. 1988
	Extraction into pentane; clean-up on Florisil and silica column	GC/MS	0.05 ng/sample	27–100	Gay et al. 1980
	Extraction into cyclohexane; clean-up on alumina column; concentration	GC/FID	50 ng/sample	83–95	Modica et al. 1982
Lungs	Homogenization in hexane; extraction with 25% DMSO in water (discarding aqueous phase); washing with water; concentration	SF	No data	95	Mitchell 1979
	Extraction into cyclohexane; centrifugation; dry with Na_2SO_4; concentration; analysis in acetonitrile	HPLC/UV	20 ng/g	93.7 (fluoranthene); 65.3 (pyrene); 65 (benzo[a]-anthracene)	Brandys et al. 1989

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Lungs (cont.)	Tissue digestion; extraction and precipitation of DNA with spermine; hydrolysis of DNA in 0.1 M HCl	HPLC/radioisotope counting	13.3–32.7x10^{-15} mol BPDE bound/mg DNA	No data	Weyand and Bevan 1987a
	Tissue digestion; extraction of DNA; isolation of BPDE-DNA adducts (immunoaffinity chromatography); hydrolysis to tetrahydrotetrols	HPLC/fluorescence detector	6 pg B[a]P-tetrol/mL	26–66	Weston and Bowman 1991
Human lymphocytes	Isolation and hydrolysis of DNA to tetrahydrotetral; oxidization to dicarboxylic acid with potassium superoxide; derivatization and clean up on silica	GC/NIEC-MS (BaP adduct)	5 adduct/ 10^7 nucleotide	47	Allan et al. 1993
Liver	Homogenization with DMSO; incubation with S-9 mixture at 37 °C; extraction with ethyl acetate; concentration; analysis for metabolites of indeno[1,2,3-c,d]pyrene	HPLC/UV-VIS	No data	No data	Rice et al. 1985b

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Liver (cont.)	Homogenization with DMSO; incubation with S-9 mixture at 37 °C; extraction with ethyl acetate; concentration and analysis for metabolites of indeno[1,2,3-c,d]pyrene and benzo[b]fluoranthene	HPLC/UV-VIS	No data	No data	Amin et al. 1982
	Homogenization; saponification; extraction into hexane; clean-up on silica or alumina column	HPLC/fluorescence detector	0.006–0.46 ng/g range	No data	Obana et al. 1981
Skin	Digestion and deproteinization of PAH-treated skin tissue; extraction and precipitation of DNA; hydrolysis with 1.2 M HCl	HPLC/fluorescence detector	10^{-15} mol BPDE/sample	No data	Shugart et al. 1983
	Modification of PAH-treated skin DNA *in vitro*; labelling of PAH-DNA adduct by ^{32}P-postlabeling technique	TLC/ autoradiography	90–1,210x10^{-15} mol PAH adduct/ mg DNA	No data	Phillips et al. 1987

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Fish bile	Hydrolysis of the conjugated PAH metabolite; extraction of the free metabolite into n-hexane; concentration and methylation with methyl iodide; extraction of methylated product	LESS (3-hydroxy-BaP)	0.005 ng/mL	No data	Ariese et al. 1993b
Blood	Hydrolysis of BPDE-DNA adduct with 0.1 M HCl; analysis of hydrolysis products (benzo[a]pyrene-tetrols and triols)	SLS	No data	No data	Haugen et al. 1986
	Extraction into cyclohexane; centrifugation; drying with Na_2SO_4; concentration; analysis in acetonitrile solution	HPLC/UV	20 ng/mL	107 (fluoranthene); 108.6 (pyrene); 101 (benzo[a]-anthracene)	Brandys et al. 1989

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Blood (cont.)	Treatment with 2% horse serum; incubation with rabbit anti-BPDE-DNA antiserum; incubation with alkaline phosphatase-conjugated goat anti-rabbit IgG, PNPP, radiolabeled PNPP, and $MgCl_2$; separation of hydrolyzed radiolabeled PNPP; measurement of radioactivity	USERIA	$0.38–2.2x10^{-15}$ mol/μg DNA	No data	Haugen et al. 1986
	Incubation of equal volumes rabbit anti-serum and sample; wash; incubation with reconstituted biotinylated anti-rabbit IgG; wash; incubation with buffered europium-labeled streptovidin; shaking with enhancement solution at room temperature	Time-related fluorometry (PAH-DNA adduct)	<1 adduct/10^8 nucleotides	No data	Schoket et al. 1993
Blood	Incubation of BPDE-DNA adduct sample with goat antihuman IgG reagent, horseradish peroxidase and substrate solution	ELISA	$0.38–2.2x10^{-15}$ mol BPDE/μg DNA	No data	Haugen et al. 1986

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Blood (cont.)	Separation and isolation of white blood cell DNA by standard RNase and phenol treatment	ELISA	$1x10^{-15}$ mol BPDE/0.001 mg DNA	No data	Perera et al. 1988
			$2–120x10^{-15}$ BPDE/50 µg DNA	No data	Shamsuddin et al. 1985
	Separation of hemoglobin (hb) by lysis and centrifugation; isolation of BPDE-hb adduct by acid hydrolysis; clean-up on Sep-Pak and cellulose column	HPLC/fluorescence detector	$5x10^{-12}$ g BPDE/sample	No data	Shugart 1986
	Isolation of PAH-DNA adduct from white blood cells; digestion of adduct with [gamma ^{32}P] ATP; resolution and quantitation of the ^{32}P-labelled adduct by TLC;	TLC and auto-radiography	$0.3x10^{-15}$ mols adduct/µg DNA	No data	Phillips et al. 1988
	Collection of lymphocyte cells; isolation of BPDE-DNA adduct by standard treatment; assay of BPDE-DNA adduct by immunoassay; analyses by SLS	ELISA/USERIA; SLS	$0.06–0.23x10^{-15}$ mol BPDE/µg DNA	No data	Harris et al. 1985

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Feces	Extraction with benzene:MeOH (4:1); add MeOH:H_2O (4:1); clean-up on silica gel column	HPLC/UV	0.05 µg/g	No data	Hecht et al. 1979
Urine	Acidify to pH 3 with HCl; clean-up on activated Sep-Pak C_{18} cartridge column; reduction with hydriodic acid	HPLC/fluorescence detector	<1 µg PAH/mmol creatinine	10–85	Becher and Bjorseth 1983
	Extraction into cyclohexane; concentration; reduction with hot acid	GC/FID	1.2–6.48 µg PAH/mmol creatinine	No data	Becher and Bjorseth 1985
	Hydrolysis; isolation of tetrol by Sep-Pak chromatography; clean up by immunoaffinity chromatography (anti BP-tetrol-modified guanosine column)	HPLC/SFS (7,8,9,10-BaP tetrol)	0.01 pmol/mL	>30	Weston et al. 1993a
	Isolation on a Sep-Pak column, washing with water followed by 10% MeOH; elution with 100% MeOH; concentration; addition of 0.1 M HCl with heating	SLS	25 pg metabolite/mL	No data	Uziel et al. 1987

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Urine (cont.)	Collection of radiolabeled benzo[a]pyrene urine sample; addition of MeOH; isolation on C_{18} Sep-Pak column; elution with aqueous MeOH	HPLC/UV	$5x10^{-12}$ mol 7-BPDE-Gua/10 µg of labelled benzo[a]-pyrene	No data	Autrup and Seremet 1986
	Buffer to pH=5.5; enzymatic hydrolysis with β-glucuronidase/sulfatase (4 hours at 37.5 °C); clean-up using Sep-Pak C_{18} cartridge; isolation of 1-pyrenol	HPLC/fluorescence detector	0.45 nmol/L (1-pyrenol)	No data	Tolos et al. 1990
	Dilution; extraction into $CHCl_3$; precipitation of protein; wash extract with CH_3OH; evaporation and analysis of residue	HPLC/UV; FLNS	~1 fmol (BP tetrol)	No data	Rogan et al. 1990
Feces	Homogenization and drying; extraction with $CHCl_3$; evaporation and analysis of residue	HPLC/UV; FLNS	~1 fmol (BP tetrol)	No data	Rogan et al. 1990
Hair	Incubation of hair follicle with (-)-B[a]P-7,8-diol for 24 hours; addition of acetone; centrifugation; analysis of supernatant	HPLC/fluorescence detector	~0.3 fmol of tetrols	No data	Alexandrov et al. 1990

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Thymus and liver	Preparation of fluoranthene-modified DNA *in vitro*; digestion with enzyme; isolation of adducts using disposable C_{18} cartridge; nuclease P1 pretreatment to remove residual unmodified nucleotides; labelling of fluoranthene-DNA adduct by ^{32}P-postlabelling technique; nuclease P1 digestion	HPLC/radioisotope counting	0.1 fmol adduct (3 adducts/10^8 nucleotides in 1 µg DNA)	10–15	Gorelick and Wogan 1989
Thymus	Preparation of B[a]P-DNA adduct; digestion; labelling of adduct by ^{35}S-postlabelling technique	HPLC/radioisotope counting	1 adduct/10^8 nucleotides for 60 µg DNA	20	Lau and Baird 1991
Embryo and thymus	Preparation of PAH-DNA adduct; digestion; labelling of adduct by ^{35}P-postlabelling; separation of steroisomers by immobilized boronate chromatography	IP-RP-HPLC/radioisotope flow detects (+) and (–) enantiomers of anti- and syn- PAH-DE-DNA adduct	No data	No data	Baird et al. 1993

TABLE 6-1. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Biological Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Placenta	Hydrolysis of DNA; addition of phosphate-buffered saline; neutralization with NaOH; incubation of sensor in sample	FIS	$14x10^{-18}$ mol BPT	No data	Vo-Dinh et al. 1991

ATP = adenosine triphosphate; B[a]P = benzo[a]pyrene; BPDE = 7_{β},8α-dihydroxy-[9α, 10α]-epoxy-7,8,9,10-tetrahydrobenzo[a]pyrene; BPT = benzo[a]pyrene tetrol; $CHCl_3$ = chloroform; CH_3OH = methanol; DMSO = dimethyl sulfoxide; DNA = deoxyribonucleic acid; ELISA = enzyme linked immunosorbent assay; FIS = fluoroimmunosensor; FLNS = fluorescence line narrowing spectrometry; fmol = femtomole; GC/FID = gas chromatography/flame ionization detector; GC/MS = gas chromatography/mass spectrometry; Gua = Guanosine; H_2O = water; HCl = hydrogen chloride; HPLC = high performance liquid chromatography; IgG = immunoglobin; IP-RP-FPLC = ion-paired reverse phase high pressure liquid chromatography; KOH = potassium hydroxide; LESS = laser-excited Stepol'skii spectroscopy; M = molar; MeOH = methanol; $MgCl_2$ = magnesium chloride; mmol = millimole; $NADP^+$ = oxidized nicotinamide adenosine dinucleotide; NaOH = sodium hydroxide; Na_2SO_4 = sodium sulfate; ng = nanogram; NIEC-MS = negative ionization electron capture mass spectrometry; nmol = nanomole; PAHs = polycyclic aromatic hydrocarbons; pg = picogram; pmol = picomole; PNPP = para nitrophenyl phosphate; SF = spectrofluorometry; SFS = synchronous fluorescence spectroscopy; SLS = synchronous luminescence spectroscopy; TLC = thin-layer chromatography; USERIA = ultra sensitive enzyme radioimmuno assay; UV = ultraviolet; UV-VIS = UV-visible detector.

Obana et al. (1981) reported the identification and quantification of six PAHs on EPA's priority pollutant list: anthracene, pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, and benzo[g,h,i]perylene using the HPLC/fluorescence detector technique. Levels measured in human. tissue ranged from 0.006 to 0.460 ng/g. Following extraction of the PAHs from the sample matrices by saponification with KOH, the extract was cleaned on alumina and silica gel columns, prior to quantitation. The known carcinogens, benz[a]anthracene and dibenz[a,h]anthracene, were not detected (detection limit <0.005 ng/g). The HPLC/UV detection technique has also been used to simultaneously determine fluoranthene, benz[a]anthracene, and pyrene in blood and lung tissues (Brandys et al. 1989). A detection limit of ppb (ng/g or ng/mL), satisfactory recoveries (65-109%), and adequate precision (119% relative standard deviation [RSD]) were achieved (Brandys et al. 1989).

In addition to direct measurement of PAHs in biological tissues, it is also possible to determine the concentration of metabolites in biological fluids. Pyrene is predominantly excreted as a 1-hydroxypyrene conjugate (glucoronate and sulfate), although 1,2-dihydroxy- 1,2-dihydropyrene conjugates are .also excreted in urine (Grimmer et al. 1993). Phenanthrene, on the other hand, is mainly excreted as dihydrodiol conjugates. The metabolites of phenanthrene that have been detected in human urine are 1-hydroxyphenanthrene, 2-hydroxyphenanthrene, 3-hydroxyphenanthrene, 4-hydroxyphenanthrene, 9-hydroxyphenanthrene, 1,2-dihydroxy-1,2-dihydrophenanthrene, 3,4-dihydroxy-3,4-dihydro-phenanthrene, and 9,10-dihydroxy-9,10-dihydrophenanthrene (Grimmer et al. 1993). There are apparently individual variations in the phenanthrol (hydroxyphenanthrene) and phenanthrene dihydrodiol conjugates excreted in the 24-hour urine sample (Grimmer et al. 1993). The major metabolite of benzo[a]pyrene in human tissue and body fluid is 7,8,9,10-tetrahydroxy-7,8,9,10-tetrahydrobenzo[a]pyrene (Weston et al. 1993a, 1993b).

Becher and Bjorseth (1983, 1985) and Becher (1986) developed an HPLC method for biological monitoring of PAHs and PAH metabolites in the urine of humans following occupational exposure to PAHs. Using the HPLC/fluorescence detector technique, recoveries of the individual PAH compounds varied between 10 and 85% with the more volatile 3-ring PAHs having the lowest recoveries. A detection limit of less than 1 µg of PAHs per mmol of creatinine was obtained. HPLC equipped with a fluorescence detector has also been used to measure 1-pyrenol (1-hydroxypyrene, a pyrene metabolite) in urine of workers exposed to PAHs in coal tar pitch with a detection limit of

0.45 nmol/L (Tolos et al. 1990). Recovery and precision data were not reported. A strong correlation was observed between the concentrations of urinary 1-hydroxypyrene in workers and environmental PAHs, indicating that pyrene may be used as a biomarker of exposure for assessing worker exposure to coal tar pitch containing pyrene (Tolos et al. 1990). Since 1-Hydroxypyrene glucuronide is approximately 5 times more fluorescent than 1-hydroxypyrene, the former may be a more sensitive biomarker for PAH exposure (Strickland et al. 1994). A sensitive HPLC/synchronous fluorescence spectroscopic method is available for the determination of 1-hydroxypyrene glucuronide (Strickland et al. 1994). Hecht et al. (1979) employed an HPLC analytical technique for determining the concentrations of benzo[a]pyrene and its metabolites in the feces of humans and rats following consumption of charcoal-broiled beef. A detection limit of 0.05 μg of benzo[a]pyrene metabolites per gram of sample was noted with HPLC/UV detection.

There is considerable evidence that PAHs are enzymatically converted to highly reactive metabolites that bind covalently to macromolecules such as DNA, thereby causing mutagenesis and carcinogenesis in experimental animals. Thus, benzo[ajpyrene, a prototype of the carcinogenic PAHs and the most thoroughly studied PAH, is activated by microsomal enzymes to 7β, 8α-dihydroxy-(9α,10α)-epoxy-7,8,9,10-tetrahydrobenzo[a]pyrene (BPDE) and binds covalently to DNA, resulting in formation of BPDE-DNA adducts (Harris et al. 1985; Haugen et al. 1986; Uziel et al. 1987). Sensitive methods are available to detect PAH-DNA adducts in the blood and tissues of humans and animals. These include immunoassays, i.e., enzyme-linked immunosorbent assays (ELISA), radioimmunoassay (RIA), dissociation-enhanced lanthanide fluoroimmunoassay (DELFIA), and ultrasensitive enzyme radioimmunoassay (USERIA); ^{32}P- and ^{35}S-postlabelling with radioactivity counting; surface-enhanced Raman spectroscopy; and synchronous luminescence spectroscopy (SLS) (Gorelick and Wogan 1989; Gorelick and Reeder 1993; Harris et al. 1985; Haugen et al. 1986; Helmenstine et al. 1993; Herikstad et al. 1993; Lau and Baird 1991; Perera et al. 1988; Phillips et al. 1987; Schoket et al. 1993).

The ELISA technique is used for detection of antibodies in serum bound to BPDE-DNA adducts. The USERIA method involves measuring the immunological response of BPDE-DNA in the presence of rabbit anti-serum. Several researchers have employed the immunoassay techniques for detecting PAH-DNA adducts at 10^{-15} mol levels in the blood and tissues of humans occupationally exposed to

PAHs (Harris et al. 1985; Haugen et al. 1986; Newman et al. i988; Perera et al. 1988; Shamsuddin et al. 1985; Weston et al. 1988).

^{32}P-postlabelling is a highly sensitive and specific method for detecting PAH-DNA adducts in the blood and tissues of humans and animals (Gorelick and Wogan 1989; Phillips et al. 1988, 1987; Willems et al. 1991). Detection limits ranging from $0.3x10^{-15}$ mol of PAH adduct per µg of DNA (<1 adduct in 10^7 nucleotides) to $<10^{-18}$ mol of adduct per ug of DNA have been achieved (Phillips et al. 1988, 1987; Willems et al. 1991). Further advantages of the ^{32}P-postlabelling technique are that adducts do not need to be fully characterized in order to be detected, and that the method is particularly suited to occupational exposure to a complex mixture of PAHs. Coupling ^{32}P-postlabelling methodology with HPLC analysis has improved the resolution of the labeled nucleotides and can be used to identify and quantify specific PAH-DNA adducts such as fluoranthene-DNA adducts (Gorelick and Wogan 1989). A detection limit of 0.1 femtomole (fmol) of adduct (3 adducts per 10^8 nucleotides in 1 µg DNA) has been achieved. The advantage of this method is that it is not limited with respect to the amount of DNA that can be analyzed; therefore, sensitivity can be enhanced by analyzing larger quantities of DNA. Average recovery was 10-15% at 3 adducts per 10^6 nucleotides. Recovery was greater (30-40%) from DNA containing higher levels of adducts (Gorelick and Wogan 1989). The ^{32}P-postlabelling assay and a combination of thin-layer and reverse-phase HPLC was also used to separate DNA adducts of 6 nitrated PAHs (King et al. 1994). PAH-DNA adducts have also been detected and identified using [^{35}S]phosphorothioate postlabelling combined with HPLC analysis (Lau and Baird 1991). The sensitivity of this assay is 1 adduct per 10^8 nucleotides for a 60-µg DNA sample with an overall adduct recovery of 20%. An advantage of ^{35}S-postlabelling over ^{32}P-postlabelling is that ^{35}S has a longer half-life (87 days) than ^{32}P (14 days). This allows longer storage times between labeling and adduct analysis with minimal loss in sensitivity. ^{35}S also has a lower radioactive decay energy than ^{32}P, which reduces the risk of human radiation exposure and eliminates the need for the radioisotope-shielding equipment that is required for studies with high specific radioactivity. On the other hand, ^{35}S is also less sensitive than the ^{32}P-postlabelling analysis because of the lower specific activity of [^{35}S]adenosine triphosphatase (ATP) compared to [^{32}P]ATP and because of the requirement for more radioactivity per adduct for accurate HPLC analysis. However, if large samples of DNA are available, the sensitivity of ^{35}S-postlabelling/HPLC can be increased substantially (Lau and Baird 1991).

HPLC/UV detection and HPLC/fluorescence detection have been used for determining concentrations of PAH-DNA adduct and hydrolyzed PAH-DNA adducts in biological tissues and fluids (Alexandrov et al. 1990; Autrup and Seremet 1986; Jongeneelen et al. 1986; Rice et al. 1985b; Rogan et al. 1990; Salhab et al. 1987; Shugart 1986; Shugart et al. 1983; Weston and Bowman 1991; Weston et al. 1988). A detection limit of l0-l5 mol of tetrols per sample was achieved (Haugen et al. 1986; Shugart et al. 1983; Weyand and Bevan 1987a). HPLC with a fluorescence detector has been used to measure the stereospecific formation of benzo[a]pyrene tetrols from cytochrome P-450-dependent metabolism of (-)-7,8-dihydroxy-7,8-dihydrobenzo[a]pyrene to BPDE in human hair (Alexandrov et al. 1990). This assay is simple, requiring only three human hair follicles and a low (0.5-2 μmol) substrate concentration. The limit of detection is ≈0.3 fmol of tetrols (Alexandrov et al. 1990). This is a rapid and noninvasive method that could be used to determine an individual's capacity to activate carcinogens to DNA-binding intermediates (Alexandrov et al. 1990). HPLC with fluorescence detection has also been used to detect BPDE-DNA adducts in human lung tissues (Weston and Bowman 1991). A detection limit of 6 pg benzo[a]pyrene-tetrol/mL (1 adduct in 10^8 nucleotides) was achieved (Weston and Bowman 1991). Recoveries ranged from 26 to 66% for the procedure. HPLC/UV has been used to identify and quantify a benzo[a]pyrene-DNA adduct, specifically 7-(benzo[a]pyrene-6-yl)guanine (BP-N7Gua) in urine and feces in the femtomole range (Rogan et al. 1990). The structure of the adduct was established by fluorescence line narrowing spectrometry (FLNS). Recovery and precision data were not reported (Rogan et al. 1990).

Using benzo[a]pyrene as a model carcinogen, Vahakangas et al. (1985), Haugen et al. (1986), and Harris et al. (1985) have developed an synchronous luminescence spectroscopy (SLS) technique for detecting trace levels of PAH-DNA adducts in the blood of humans occupationally exposed to high levels of PAHs. Vahakangas et al. (1985) detected less than 1 benzo[a]pyrene moiety per 10^7 DNA molecules by SLS technique following *in vitro* acid hydrolysis of BPDE-DNA adduct. Fiber-optic antibody-based fluoroimmunosensor (FIS) has been used to measure DNA adducts of benzo[a]pyrene in biological samples such as human placenta (Tromberg et al. 1988; Vo-Dinh et al. 1991). The FIS is used to detect the highly fluorescent benzo[a]pyrene 7,8,9,10-tetrol (BPT) after release from the weakly fluorescent BPDE-DNA by mild hydrolysis. The FIS is highly specific because of the antigen-antibody reaction. This assay is highly sensitive, achieving a detection limit of 14×10^{-18} mol

of BPT (Vo-Dinh et al. 1991). FIS precision is adequate (6.2-15% RSD) (Tromberg et al. 1988). Recovery data were not reported.

6.2 ENVIRONMENTAL SAMPLES

One of the difficulties associated with determination of PAHs in environmental samples is the complexity of PAH mixture in these samples. Even after extensive and rigorous clean-up, the PAH fraction may contain hundreds of compounds. Analytical methods that offer combinations of good chromatographic resolving power and detector selectivity are usually required to quantify selected compounds in such mixtures. There is essentially a three-step procedure for the analysis and determination of PAHs in environmental samples: (1) extraction and isolation of PAHs from the sample matrix; (2) clean-up of the PAH mixtures from impurities and fractionation of PAH into subgroups; and (3) identification and quantitative determination of the individual components in each of these subgroups.

The collection of PAHs from air for quantification requires special considerations. Some of the PAHs, especially those with lower molecular weights, exist primarily in the vapor phase while PAHs with higher molecular weights exist primarily in the particulate phase (Santodonato et al. 1981). Therefore, a combination of a particulate filter (usually glass-fiber filter) and an adsorbent cartridge (usually XAD-2 or polyurethane foam) is used for the collection of PAHs (Andersson et al. 1983; Harvath 1983; Hawthorne et al. 1993). Therefore, collection methods that use either a filtration system or an adsorbent alone may be incapable of collecting both particulate and vapor phase PAHs. In addition, a few PAHs are known to be susceptible to oxidation by ozone and other oxidants present in the air during the collection process (Santodonato et al. 1981).

The commonly used methods for the extraction of PAHs from sample matrices are Soxhlet extraction, sonication, or partitioning with a suitable solvent or a solvent mixture. Dichloromethane, cyclohexane, benzene, and methanol have been widely used as solvents (see Table 6-2). Supercritical fluid extraction (SFE) of heterogeneous environmental samples with carbon dioxide in the presence of a modifier, such as 5-10%. methanol or dichloromethane is preferable to the conventional extraction method because SFE is much less time consuming and has comparable or better PAH extraction

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Air	Collection on XAD and glass-fiber filters with 2-D labeled PAH internal standards; extraction with toluene; fractionation and clean-up on activated silica and alumina	HRGC/MS	0.001–0.03 ng/m^3	No data	Hippelein et al. 1993
	Collection on glass-fiber filter; extraction with methylene chloride; clean-up on silica gel column; analysis at 254 nm	GC/DAD	0.2–4.8 ng/sample	75–100	Desilets et al. 1984
	Collection of on glass-fiber filter; extraction with benzene:MeOH (4:1); concentration; fractionation into acid/neutral/base fractions; clean-up neutral fraction by column chromatography; concentration	GC/FID; HPLC/fluor-escence detector	0.05 ng/m^3	No data	Matsumoto and Kashimoto 1985
	Collection on a glass-fiber filter; thermal desorbtion of filter onto GC column	GC/LIMF	1–15 µg/sample	No data	Galle and Grennfelt 1983
	Collection on a glass-fiber filter; extraction with 35% methylene chloride in cyclohexane	HPLC/fluorometric detector	<0.01 ng/sample	No data	Golden and Sawicki 1978
	Collection on filter; extraction with organic solvent	TLC; GC/MS	<1 pg/sample	No data	Majer et al. 1970

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Air (cont.)	Collection on fiber-glass filter; extraction with cyclohexane; concentration	GC/GPFD	$1x10^{-6}$ ppm	100.5	Mulik et al. 1975
	Collection on filter; extraction with toluene; acid/base fractionation; drying and concentration	HPLC; GC/MS	0.11 ppm	>85	Naikwadi et al. 1987
	Collection on glass-fiber filter; ultrasonic extraction with benzene; concentration; fractionation by HPLC	HRGC/FID	low ng/m^3	8–100	Tomkins et al. 1982
	Collection on filter; extraction with cyclohexane; clean-up on silica column	GC/MS	0.001–0.002 ppm	No data	Oehme 1983
	Collection on glass-fiber filter (particulates) and XAD-2 resin (vapor); extraction with benzene or methylene chloride	HPLC; GC/MS	0.001–0.1 ppm	No data	Harvath 1983
	Collection on glass-fiber filter; extraction with benzene; concentration	HPLC/fluor-escence detector	0.000025 ppm	92–100	Fox and Staley 1976
	Collection through filter onto XAD-2 resin; extract with benzene, cyclohexane or methylene chloride (NIOSH Methods 5506 and 5515)	HPLC; GC/FID	<1 ppm	No data	NIOSH 1984

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Air (cont.)	Collection on a glass-fiber filter; extraction with cyclohexane; clean-up by partitioning to DMSO and pentane	GC/MS	0.00001 ppm	No data	Karlesky et al. 1987
	Collection of air particulates with high-volume sampler; ultrasonic extraction with acetonitrile	HPLC/fluor-escence detector	10–50 pg	No data	Miguel and DeAndrade 1989
Sea water	Extraction with hexane or carbon tetrachloride; acid-base fractionation; and clean-up on silica and alumina column	GC/FID	0.024–0.045 µg/L	44–85	Desiderie et al. 1984
Water	Collection on a column containing XAD-4:XAD-8 (1:1) resin; elution with acetone followed by chloroform	HPLC/UV; GC/MS	0.01–3 µg/L	No data	Thruston 1978
	Extraction with cyclohexane	HPLC with time-resolved fluorescence detection	180×10^{-15} g/sample	89–100	Furuta and Otsuki 1983
	Filtration into flotation vessel; adjustment to pH 3; addition of Triton X-100; bubbling nitrogen through mixture; collection of foam, and extraction with methylene chloride; evaporation and dissolution of residue in methanol	HPLC/fluor-escence detector	low ng/L	86–107	Xu and Fang 1988

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Water (cont.)	Extraction at neutral pH with methylene chloride (EPA Methods 8100, 8250,and 8310)	HPLC/fluor-escence detector GC/FID GC/MS	0.64–0.013 µg/L 2.0–45.1 µg/L 1.9–7.8 µg/L	No data	EPA 1986
	Collection through sampling cartridges containing XAD-2 resin; elution with acetone:hexane (15:85)	GC/MS	0.00005 µg/L	57–100	Beniot et al. 1979
Municipal and industrial waste water	Extraction with methylene chloride; reconstitution in cyclohexane; clean-up on silica gel column (EPA Method 610)	HPLC/UV fluorescence detector	0.013–2.3 µg/L	78–116	EPA 1982
	Adjustment to pH >11.0; extraction with methylene chloride; drying with sodium sulfate; concentration (EPA Method 625)	GC/MS	1.6–7.8 µg/L	41–83	EPA 1982
Sediments	Extraction with methylene chloride; clean-up on alumina column	TLC; GC/MS	0.2–2.7 µg/g	86–89	John and Nickless 1977
	Freeze drying, sieving and homogenization; extraction with methylene chloride; clean-up on silica gel followed by sephadex column	HPLC/DAD/MS	pg range	No data	Quilliam and Sim 1988

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Sediments (cont.)	Extraction of dry sample with methylene chloride; injection into supercritical fluid extracting system	GC/MS	2.8–7.3 µg/g	91–97	Hawthorne and Miller 1987a, 1987b
	Extraction of dried sample with benzene; clean-up on silica gel and alumina column	GC/FID; GC/MS	0.014–0.093 µg/g	76–110	Szepesy et al. 1981
Sediments	Direct sampling of sediment in sample insert of SSJ/LIF	SSJ/LIF	1.8 ppm (B[a]P); 0.4 ppm (pyrene)	No data	Lai et al. 1990
	Extraction by sonication; clean-up on silica mini-columns	Spectrofluoro-metry	0.008–4.5 ng/mL	80–95	Saber et al. 1991
Waste water and sediments	Freeze drying; extraction with chloroform:MeOH (2:1); concentration of crude extract; clean-up by TLC followed by HPLC	GC/FID	0.12–0.46 µg/g	51–100	Readman et al. 1986
Water and sediments	Extraction in organic solvent	GC/FT-IR	0.01–0.06 µg/g	No data	Gurka et al. 1987
Soil	Extraction in organic solvent; concentration	GC/FT-IR	0.025–0.25 µg/sample	0.998–0.85 correlation coefficient	Gurka and Pyle 1988
	Ultrasonic extraction of sieved sample with acetonitrile; filtration through teflon filter	HPLC/SF	0.017 µg/g	No data	Tanaka and Saito 1988

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Sediments/ suspended matter (river), airborne particulate, dust and soil	Extraction of dried sample with methylene chloride; clean-up on activated copper column followed by sephadex	GC/FID; GC/MS	0.03–0.09 µg/g	99–113	Giger and Shaffner 1978
Diesel exhaust particulate and dust	Collection on fiber filter; extraction with hexane; concentration; partitioning with DMSO; concentration of organic extract	HPTLC; FSD	1–50 pg/sample	No data	Butler et al. 1984a
Cigarette smoke	Collection in trap of smoking machine; dissolution in benzene:MeOH:H_2O (2:1:2); clean-up on silicic acid and gel filtration column	GC/FID	No data	92–95	Severson et al. 1976
	Collection on filter pad; extraction with cyclohexane	HPLC/fluore-scence detector	3 pg/sample	89–108	Risner 1988
Cooking oil fume	Collection on glass-fiber filter; extraction with acetone; concentration, then dissolution in cyclohexane; clean-up by partitioning in DMF and reconstitution in cyclohexane	TLC/FSD	0.11–0.41 ng	96–99	Shuguang et al. 1994
Coal-fly ash	Drying at 150 °C, cooling in desiccator; ultrasonic extraction with methylene chloride; concentration	GC/MS	No data	No data	Low et al. 1986

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Highly refined coal- and petroleum-derived fuels	Dissolution in methylene chloride	HPLC/HPLC/fluorescence detector	3.5–46 µg/L	56–100	Tomkins and Griest 1987
	Collection in brown Winchester bag; addition of 20% aqueous MeOH with shaking; clean-up on Sep-Pak C_{18} cartridge column	HPLC/UV and fluorescence detector	0.1–7.1 µg/L	45–95	Symons and Crick 1983
	Dissolution in hexane; clean-up on silica and alumina gel column	TLC; SPF	µg/L range	No data	Monarca and Fagioli 1981
Highly refined coal- and petroleum-derived fuels (con.)	Dissolution in methylene chloride	HPLC/UV-VIS; GC/MS	2000 µg/L	No data	Tomkins et al. 1986
Solvent refined coal	Crushing into fine particles; dissolution in benzene; filtration	N-SSL R-SSL	$7x10^{-7}$ M $7x10^{-5}$ M	No data	Lin et al. 1991
Shale and fuel oil	Dissolution in cyclohexane; fractionation into acid and base/neutral fractions; clean-up base/neutral fraction on alumina followed by alumina-silica column	XEOL	10 ng/sample	No data	Woo et al. 1980
	Dilution in ethanol	RTP SLS	No data No data	±15 RSD ±4 RSD	Vo-Dinh et al. 1984
Sun tan oil	Extraction with hexane; clean-up on silica gel column	TLC; SPF	Low µg/L	79–93	Monarca et al. 1982

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
White petroleum products	Collection on silica gel column; elution with pentane:ether (1.5:1); concentration; clean-up on basic and acidic alumina column	FPS	µg/L range	No data	Popl et al. 1975
Sewage sludge	Homogenization; extraction with cyclohexane; centrifugation; separation and concentration of organic phase	2-Dimensional TLC/fluorescence detector	<1 µg/g	80–100	McIntyre et al. 1981
Smoked foods (e.g., fish and meat)	Saponification; extraction with cyclohexane; clean-up on Florisil column	HPLC/fluorescence detector GC/FID GC/MS	2–27 pg/sample 10 pg/sample 1,000 pg/kg	28–142	Lawrence and Weber 1984
	Soxhlet extraction of homogenized sample with acetone; saponification with ethanolic KOH; extraction with cyclohexane; drying and concentration; clean-up on alumina column; concentration, then dilution in methanol	HPLC/fluorescence detector	0.1–µg/kg	75–90	Moll et al. 1993
Charcoal-broiled beef	Extraction of ground sample with benzene:MeOH (4:1); evaporation to dryness; dissolution of residue in MeOH:H_2O (4:1); clean-up on silica gel column	HPLC/fluorescence detector	20–50 ng/g	No data	Hecht et al. 1979

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Seafoods	Saponification of homogenized sample with ethanolic KOH; extraction with 1,1,2-trichlorotrifluoroethane; concentration; clean-up by silica, alumina and C_{18} cartridge (modified FDA method)	GC-MS	1–5 µg/kg	73–144	Nyman et al. 1993
	Saponification of homogenized sample with ethanolic KOH; extraction with 1,1,2-trichlorotrifluoroethane; concentration; clean-up by silica alumina and gel permeation HPLC (NMFS method)	GC/MS	1–5 µg/kg	63–106	Nyman et al. 1993
Cooked beef	Saponification of ground sample with methanolic KOH; extraction with cyclohexane, DMF, and n-hexane; concentration	LT-MLS SLS HPLC/ fluorescence detector	0.9 ppb 0.2 ppb 1.0 ppb	75–85 (extraction efficiency)	Jones et al. 1988
Food (meat/fish, dried dairy products, cereals, leafy vegetables, and oils)	Digestion with alcoholic KOH; partitioning into cyclohexane or isooctane; removal of lipids by solvent partitioning with dimethylformamide or dimethylsulfoxide/water; clean-up on silica gel, Florisil, or Sephadex	HPLC/fluor-escence detector; GC-MS/SIM	2–90 ng/kg	20.6–92.5 (ocean perch); 34.2–62.7 (bran cereal); 98 (powdered milk)	Lawrence and Das 1986

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Cereal products	Saponification; extraction with cyclohexane; reextraction with 15% caffeine in formic acid; dilution in sodium chloride solution; reextraction with cyclohexane; clean-up on silica gel; concentration	GC/MS	20 pg/inj	40–100	Tuominen et al. 1988
Vegetable oil	Dilution with *n*-pentane	LC-GC/MS	1 pg/sample	No data	Vreuls et al. 1991
Fat products	Dissolution in light petroleum; extraction with caffeine in formic acid; dilution in sodium chloride solution; reextraction with light petroleum; clean-up on silica gel column	HPLC/fluor-escence detector	0.1–0.5 ppb	76–85	Van Heddeghem et al. 1980
Barley malt	Homogenization; ultrasonic extraction with cyclohexane; centrifugation; clean-up of supernatant on silica gel-alumina column	HPLC/UV and fluorescence detector	2.5–5 ng/g	78–97	Joe et al. 1982
Alcoholic beverage	Continuous extraction with cyclohexane for 20 hours	HPLC/UV; GC/FID	1 µg/L	60	Toussaint and Walker 1979
Tea	Saponification; extraction with hexane; addition of DMSO with shaking; clean-up on silica gel	TLC; FSD	2–12 ng/g	92–95	Poole et al. 1987

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Fish tissue	Homogenization with 1.15% KCl solution; isolation on extraction cartridges packed with a styrene-divinylbenzene copolymer resin; washing with water; extraction with acetone:MeOH (1:1); extraction with methylene chloride:2-propanol (75:25)	HPLC/fluorescence detector; GC/MS	50–1,100 ng/g	>90	Krahn and Malins 1982
	Homogenization with distilled water and KOH pellets; reflux, then extraction with methylene chloride; clean-up on basic alumina column	GC/MS	<0.2 ng/g	72	Vassilaros et al. 1982
	Homogenization in methylene chloride; centrifugation; clean-up on alumina column	HPLC/UV; GC/MS	No data	89–98	Krahn et al. 1988
B[a]P metabolite formulation	Dissolution in MeOH	HPLC/MS	low ng/sample	No data	Bieri and Greaves 1987
PAH formulation	Dissolution in methylene chloride	GC/MS with laser multiphoton ionization detection	200×10^{-15} g sample	No data	Rhodes et al. 1983
	Dissolution in acetonitrile	UV-RRS	<1 ppb	No data	Asher 1984
	Dissolution in ethanol	HPLC/fluorescence detector	500–16,000 ppb	No data	Su et al. 1982

TABLE 6-2. Analytical Methods for Determining Polycyclic Aromatic Hydrocarbons in Environmental Samples (continued)

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
PAH formulation (cont.)	Conversion to nitroaromatic compound (packing sample in glass tube between glass-wool plugs, passing reagent gas through tube for 3 to 5 seconds); analysis for nitroaromatic compound	TQMS	100–500 ppb	No data	Hunt et al. 1983

B[a]P = benzo[*a*]pyrene; DMF = dimethylformamide; DMSO = dimethyl sulfoxide; EPA = Environmental Protection Agency; EtOH = ethanol; FPS = fluorescence and phosphorescence spectrometry; FSD = fluorescence scanning densitometry; GC = gas chromatography; GC/FID = gas chromatography/flame ionization detector; GC/DAD = gas chromatography/diode array detector; GC/LIMF = gas chromatography/laser induced molecular fluorescence; GC/GPFD = gas chromatography/gas phase fluorescence detector; GC/MS = gas chromatography/mass spectrometry; GC/FT-IR = gas chromatography/fourier transform-infra-red spectrometry; HPLC = high performance liquid chromatography; HCl = hydrochloric acid; HPLC/HPLC = high performance liquid chromatography/high performance liquid chromatography; HPLC/UV = high performance liquid chromatography/ultraviolet; HPLC/DAD/MS = high performance liquid chromatography/diode array detector/mass spectrometry; HPLC/SF = high performance liquid chromatography/spectrofluoremetry; HPTLC = high performance thin-layer chromatography; HPTLC/UV = high performance thin-layer chromatography/ultraviolet; H_2O = water; H_2SO_4 = sulfuric acid; inj = injection; KOH = potassium hydroxide; LC = liquid chromatography; LT-MLS = low temperature-molecular luminescence spectrometry; LC-GC/MS = liquid chromatography-gas chromatography/mass spectrometry; M = molar; MeOH = methanol; ng = nanogram; NMFS = National Marine Fisheries Service; PAHs = polycyclic aromatic hydrocarbons; R/N-SSL = resonant/nonresonant-synchronous scan luminescence; RSD = relative standard deviation; RTP = room temperature phosphorescence; SF = spectrofluorometry; SLS = synchronous luminescence spectroscopy; SSJ/LIF = supersonic jet/laser induced fluorescence; SIM = selected ion monitoring; SJS/SFC = supersonic jet spectroscopy/supercritical fluid chromatography; SP = spectrophotometer; SPF = spectrophotofluorometer; TCTFE = 1,1,2-trichloro-1,2,2-trifluoroethane; TLC = thin-layer chromatography; TQMS = triple quadruple mass spectrometer; UV-RRS = ultraviolet-resonance raman spectrometer; UV-VIS = UV-visible detector; XEOL = x-ray excited optical luminescence

recovery than the conventional methods (Burford et al. 1993; Dankers et al. 1993; Hawthorne et al. 1993; Hill and Hill 1993).

Column chromatography on silica, alumina, Sephadex or Florisil has been used most often for the clean-up and fractionation of PAHs in the sample extract (Desiderie et al. 1984; Desilets et al. 1984; Oehme 1983; Quilliam and Sim 1988). HPLC can also be used for the clean-up and fractionation of PAHs in sample extract (Readman et al. 1986). A disposable Sep-Pak cartridge with an amino stationary phase was used for the clean-up of benzo[a]pyrene in cigarette smoke condensate (Dumont et al. 1993). Some soil and sediment samples containing high amounts of sulfur may require clean-up on an activated copper column (Giger and Schaffner 1978).

A variety of analytical methods has been used for determining trace concentrations of PAHs in environmental samples (Table 6-2). These include GC with various detectors, HPLC with various detectors, and TLC with fluorimetric detectors. Various detection devices used for GC quantification include FID, MS, Fourier transform infrared spectrometer (FT-IR), laser induced molecular fluorescence detector (LIMF), diode array detector (DAD), and gas phase fluorescence detector (GPFDA). GC/MS and HPLC with UV or spectrofluorimetric detectors are perhaps the most prevalent analytical methods for determining concentrations of PAHs in environmental samples.

Oehme (1983) and Low et al. (1986) employed capillary GC coupled with negative ion chemical ionization MS for detecting and differentiating isomeric PAHs (including PAHs on EPA's priority pollutant list). This procedure was successfully used to differentiate the isomers benzolj]fluoranthene and benzo[b]fluoranthene at low ppb levels in complex matrices, such as air particulate matter and coal fly ash. An alternative method for the elucidation of PAH isomers is GC coupled with a charge-exchange and chemical ionization MS (Simonsick and Hites 1985). Simonsick and Hites (1985) demonstrated that the structural isomers pyrene, fluoranthene, aceanthrylene and acephenanthrylene can be identified on the basis of their first ionization potential and $(M+l)^+/M^+$ mass ion ratio.

HPLC has been one of the most widely used analytical methods for determining PAHs in complex environmental samples. The development of a chemically nonpolar stationary phase for HPLC has

provided a unique selectivity for separation of PAH isomers that are often difficult to separate by GC columns. For example, chrysene, benz[a]anthracene, and triphenylene are baseline resolved with a C-18 reverse phase column packing. A detection limit of subpicogram to picogram levels of PAHs per sample has been achieved by HPLC with fluorescence detector (Fox and Staley 1976; Furuta and Otsuki 1983; Futoma et al. 1981; Golden and Sawicki 1978; Lawrence and Weber 1984; Marcomini et al. 1987; Miguel and De Andrade 1989; Nielsen 1979; Risner 1988; Ton&ins et al. 1982). HPLC equipped with a fluorescence detector has selectively measured 10 PAHs (phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, and indeno[l,2,3-c,d]pyrene) in ambient air (Miguel and De Andrade 1989). Detection limits for the 10 PAHs were in the range of 10-50 pg and RSD was <10%. Recovery data were not reported. PAH levels in the ng/L range have also been successfully determined in water using flotation enrichment and HPLC/fluorescence detection (Xu and Fang 1988). Good recoveries (86-107%) were achieved, and RSD was 2.7-13.6% RSD. A quenchofluorometric detection system provides an inexpensive method to achieve selective detection for the fluoranthenic PAHs as a group (Konash et al. 1981). UV detectors have been used to measure PAHs in fats and oil samples; however, these detectors lacked the sensitivity and specificity of the fluorescence detectors for determining PAHs at low levels (ppb and lower) (Van Heddeghem et al. 1980).

A number of less commonly used analytical techniques are available for determining PAHs. These include synchronous luminescence spectroscopy (SLS), resonant (R)/nonresonant (NR)-synchronous scan luminescence (SSL) spectrometry, room temperature phosphorescence (RTP), ultravioletresonance Raman spectroscopy (UV-RRS), x-ray excited optical luminescence spectroscopy (XEOL), laser-induced molecular fluorescence (LIMF), supersonic jet/laser induced fluorescence (SSJ/LlF), low-temperature fluorescence spectroscopy (LTFS), high-resolution low-temperature spectrofluorometry, low-temperature molecular luminescence spectrometry (LT-MLS), and supersonic jet spectroscopy/capillary supercritical fluid chromatography (SJS/SFC) (Asher 1984; Garrigues and Ewald 1987; Goates et al. 1989; Jones et al. 1988; Lai et al. 1990; Lamotte et al. 1985; Lin et al. 1991; Popl et al. 1975; Richardson and Ando 1977; Saber et al. 1991; Vo-Dinh et al. 1984; Vo-Dinh and Abbott 1984; Vo-Dinh 1981; Woo et al. 1980). More recent methods for the determination of PAHs in environmental samples include GC-MS with stable isotope dilution calibration (Bushby et al. 1993), capillary electrophoresis with UV-laser excited fluorescence detection (Nie et al. 1993), and

laser desorption laser photoionization time-of-flight mass spectrometry of direct determination of PAH in solid waste matrices (Dale et al. 1993).

Among the less commonly used spectroscopic methods, SLS and room temperature phosphorescence (RTP) are used for determining trace levels of PAHs in environmental media. Vo-Dinh (1981), Vo-Dinh and Abbott (1984), and Vo-Dinh et al. (1984) reported a cost-effective and relatively simple SLS and RTP technique for determining trace amounts of PAHs (less than $1x10^{-9}$ g per sample) in air particulate extracts collected at a wood-burning area. Improved selectivity is the main advantage of SLS and RTP over conventional luminescence or fluorescence spectroscopy. Additionally, R/N-SSL spectrometry has been applied to determine trace amounts of anthracene and its derivatives in solvent-refined coal (Lin et al. 1991). The sensitivity of N-SSL ($7x10^{-7}$ M) is about two orders of magnitude better than that of R-SSL spectrometry (7x10-5 M). The detection limit for N-SSL is several times better than that of conventional fluorescence spectrometry ($3x10^{-6}$ M). The better sensitivity comes from a higher efficiency in fluorescence collection (Lin et al. 1991). The combination of R- and N-SSL spectrometries provides a sensitive and selective analytical method because of the spectral simplicity of R-SSL and the high sensitivity of N-SSL spectrometry (Lin et al. 1991). This spectrometric method is also applicable to other PAHs in the environment, such as benzo[a]pyrene in airborne particulates.

Low temperature-molecular luminescence spectrometry (LT-MLS), SLS, and HPLC/fluorescence detection have been used to measure pyrene in broiled hamburger (Jones et al. 1988). A comparison of the three methods showed that sensitivity for all three methods was in the low-ppb range and that all methods were comparably reproducible (6-9% RSD). Adequate recovery (75-85%) was obtained from the extraction procedure for all three methods. While HPLC is the least expensive and easiest to operate, it has the longest analysis time (30 minutes), and it provides the least resolution of components. LT-MLS is the fastest technique (5 minutes), and it gives mores spectral information than the other two methods. SLS, with an analysis time of 15 minutes, offers no real advantages over LT-MLS other than cost of equipment.

Methods 8100, 8250, and 8310 are the test methods recommended by EPA (1986) for determining PAHs in a variety of matrices at solid waste sites. EPA Methods 610 and 625, recommended for

municipal and industrial waste water have been used to measure PAHs in groundwater contaminated by petroleum hydrocarbons at detection limits in the low-ppb range (Thomas and Delfino 1991). Recovery and precision data were not reported. NIOSH (1985) has recommended methods 5506 and 5515 as the analytical methods for determining PAHs in air samples at concentrations below ppm level.

6.3 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of PAHs is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of PAHs.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

6.3.1 Identification of Data Needs

Methods for Determining Biomarkers of Exposure and Effect. Adequate methods are available to separate and quantify PAHs in biological materials such as adipose tissue (Gay et al. 1980; Liao et al. 1988; Modica et al. 1982), lungs (Brandys et al. 1989; Mitchell 1979; Tomingas et al. 1976; Weston and Bowman 1991; Weyand and Bevan 1987a), liver (Amin et al. 1982; Obana et al. 1981; Rice et al. 1985b), skin (Phillips et al. 1987; Shugart et al. 1983), hair (Alexandrov et al. 1990), blood (Brandys et al. 1989; Harris et al. 1985; Haugen et al. 1986; Perera et al. 1988; Phillips et al. 1988; Shamsuddin et al. 1985; Shugart 1986), urine (Au&up and Seremet 1986; Becher and Bjorseth 1985; Rogan et al. 1990; Tolos et al. 1990; Uziel et al. 1987), and feces (Hecht et al. 1979; Rogan et

al. 1990). These methods include GC/FID, GCMS, HPLC, TLC, and spectrofluorometry (SF). The difficulties involved in recovering bound benzo[a]pyrene from feces hinder studies on absorption and bioavailability in humans after exposure to benzo[a]pyrene. Therefore, there is a need to develop a satisfactory analytical method for the determination of benzo[a]pyrene in feces. Immunoassays (i.e., ELISA and USERIA, ^{32}P-arid ^{35}S-postlabelling, SLS, and FIS) are methods currently being developed to detect the presence of carcinogenic PAH adducts bound covalently to macromolecules (e.g., DNA). The parent compound is generally measured in biological tissues, but both the parent compound and its metabolites can be measured in biological fluids, particularly urine. However, improved methods for identifying and characterizing conjugated PAH metabolites from various biological fluids would be useful. PAH-DNA adducts can be measured in blood, serum, and other tissues. These methods are accurate, precise, and sensitive enough to measure background levels in the population and levels at which biological effects occur. Additional quantitative information regarding the relationships between body and environmental levels of PAHs for both short- and long-term exposures might allow investigators to predict environmental exposure levels from measured body levels.

The urinary level of 1-Hydroxypyrene has the potential to be used as a biomarker for exposure to PAHs, and analytical methods for the detection of the hydroxy metabolite in urine of exposed and non-exposed control persons are available (Ariese et al. 1993a; Jongeneelen et al. 1988; Kanoh et al. 1993; Mercado Calderon 1993; Van Hummelen et al. 1993). The correlation coefficient between total PAHs in air of a coke production plant and hydroxypyrene in urine of workers was 0.77 ($p<0.0001$) (Mercado Calderon 1993). A study attempted to use benzo[a]pyrene metabolite 3-hydroxy-benzo[a]pyrene in urine as a biomarker for occupational exposure to PAH (Ariese et al. 1993a). Since the level of 3-hydroxybenzo[a]pyrene is about 3 orders of magnitude lower than 1-hydroxypyrene, a sensitive method was developed to estimate levels of 3-hydroxybenzo[a]pyrene in occupational groups (Ariese et al. 1993a). However, no significant correlation between the metabolite and levels of airborne benzo[a]pyrene was found.

The available biomarkers of effect for PAHs are not specific for effects induced by PAHs other than cancer or genotoxicity. PAHs form DNA adducts that can be measured in body tissues or blood following exposure to PAHs and mixtures that contain PAHs. The formation of benzo[a]pyrene-DNA adducts has been demonstrated, and this may serve as a biomarker of PAH-induced carcinogenicity.

HPLC and immunoassays, (i.e., ELISA and USERIA, ^{32}P-and ^{35}S-postlabelling, SLS, and FIS) are sensitive, selective, and reproducible methods being developed to detect the presence of carcinogenic PAH adducts bound covalently to macromolecules (e.g., DNA) (Gorelick and Wogan 1989; Haugen et al. 1986; Lau and Baird 1991; Phillips et al. 1988; Weston and Bowman 1991). Chromosomal aberration and sister chromatid exchange methods were used to show that several types of cultured human tissue cells demonstrated positive results for benzo[a]pyrene-induced genotoxicity (Abe et al. 1983a, 1983b; Huh et al. 1982; Lo Jacono et al. 1992; Van Hummelen et al. 1993; Weinstein et al. 1977; Wienke et al. 1990). However, statistically significant correlation between the cytogenetic markers and airborne occupational PAH levels was not found (Van Hummelen et al. 1993).

Methods for Determining Parent Compounds and Degradation Products in Environmental Media. Standardized methods are available that are reliable, reproducible, and sensitive enough to separate and quantify PAHs in air (Andersson et al. 1983; Fox and Staley 1976; Golden and Sawicki 1978; Harvath 1983; Karlesky et al. 1987; Majer et al. 1970; Miguel and De Andrade 1989; Naikwadi et al. 1987; NIOSH 1984; Oehme 1983; Tomkins et al. 1982; Matsumoto and Kashimoto 1985), water (Beniot et al. 1979; Desiderie et al. 1984; EPA 1986; Furuta and Otsuki 1983; Thomas and.Delfino 1991; Thruston 1978; Xu and Fang 1988), soil and sediment (Hawthorne and Miller 1987a, 1987b; John and Nickless 1977; Saber et al. 1991; Szepesy et al. 1981; Tanaka and Saito 1988), and other media, such as food (Hecht et al. 1979; Joe et al. 1984; Jones et al. 1988; Krahn and Malins 1982; Krahn et al. 1988; Lawrence and Das 1986; Lawrence and Weber 1984; Poole et al. 1987; Toussaint and Walker 1979; Tuominen et al. 1988; Van Heddeghem et al. 1980; Vassilaros et al. 1982; Vreuls et al. 1991), cigarette smoke (Risner 1988; Severson et al. 1976), coal tar (Alben 1980; Goates et al. 1989; Low et al. 1986), and fuels (Lin et al. 1991; Monarca and Fagioli 1981; Symons and Crick 1983.; Ton&ins and Griest 1987; Vo-Dinh et al. 1984; Woo et al. 1980). These methods include GC, HPLC, TLC, and others. Various detection devices used for GC quantification include FID, MS, FT-IR, LIMF, DAD, or GPFDA. GC/MS and HPLC are perhaps the most prevalent analytical methods for determining concentrations of PAHs in environmental samples. These methods are adequate to measure environmental levels that may be associated with adverse human effects. All of the available analytical methods for PAHs in soil and food items are sensitive down to levels of <1 ppb.

6.3.2 Ongoing Studies

The Environmental Health Laboratory Sciences Division of the National Center for Environmental Health and Injury Control, Centers for Disease Control and Prevention, is developing methods for the analysis of PAHs and other volatile organic compounds in blood. These methods use purge and trap methodology, high resolution gas chromatography, and magnetic sector mass spectrometry, which gives detection limits in the low parts per trillion (ppt) range.

7. REGULATIONS AND ADVISORIES

The international, national, and state regulations and guidelines regarding polycyclic aromatic hydrocarbons (PAHs) in air, water, and other media are summarized in Table 7-1.

An MRL of 0.6 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to acenaphthene, based on a minimal LOAEL of 175 mg/kg/day for liver weight in mice (EPA 1989c).

An MRL of 0.4 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to fluoranthene, based on a minimal LOAEL of 125 mg/kg/day for increased liver weight in mice (EPA 1988e).

An MRL of 0.4 mg/kg/day has been derived for intermediate-duration oral exposure (15-364 days) to fluorene, based on a minimal LOAEL of 125 mg/kg/day for relative liver weight in mice (EPA 1989e).

Reference doses have been developed by EPA for anthracene (0.3 mg/kg/day), acenaphthene (0.06 mg/kg/day), fluoranthene (0.04 mg/kg/day), fluorene (0.04 mg/kg/day), and pyrene (0.03 mg/kg/day). No reference concentrations exists for any of the PAHs.

PAHs are regulated under The Emergency Planning and Community Right-to-Know (EPCRA) standards of 40 CFR Subpart J. EPCRA requires owners and operators of certain facilities that manufacture, import, process, or otherwise use these chemicals to report annually their release of those chemicals to any environmental media.

OSHA regulates the benzene soluble fraction of coal tar pitch volatiles and mineral oil mist, which contain several of the PAH compounds. Employers of workers who are occupationally exposed must institute engineering controls and work practices to reduce and maintain employee exposure at or below permissible exposure limits (PEL). The employer must use engineering and work controls, if feasible, to reduce exposure to or below an 8-hour time-weighted average (TWA) of 0.2 mg/m^3 for coal tar pitch volatiles and 5 mg/m^3 for mineral oil mist.

7. REGULATIONS AND ADVISORIES

PAHs are regulated by the Clean Water Effluent Guidelines in Title 40, Sections 400-475, of the Code of Federal Regulations. For each point source category, PAHs may be regulated as a group of chemicals controlled as Total Toxic Organics, may have a specific regulatory limitation, or may have a zero discharge limitation. The point source categories for which the PAHs are controlled as a Total Toxic Organic include electroplating, and metal molding and casting. The point source categories for which the PAHs have specific regulatory limitations include organic chemicals, plastics, and synthetic fibers; cokemaking; and nonferrous metals manufacturing.

Under the Resource Conservation and Recovery Act (RCRA), several PAHs are listed as hazardous wastes when they are discarded commercial chemical products, off-specification species, container residues, and spill residues (40 CFR 261.33).

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons

Agency	Description	Information	Reference
INTERNATIONAL			
IARC	Carcinogenic classification[a]		IARC 1987; IARC 1984; IARC 1984; IARC 1983; IARC 1973
	(B[a]A; B[a]P)	Group 2A[b]	
	(B[b]F; B[j]F; B[k]F; I[123cd]P)	Group 2B[c]	
	(Anthracene; B[ghi]P; B[e]P; Chrysene; Fluoranthene; Fluorene; Phenanthrene; Pyrene)	Group 3[d]	
	(Mineral oil mists)	Group 1	
			IARC 1984
	Occupational exposure limits		
	Oil mists, mineral		
	Australia, Belgium, German Democratic Republic, Italy, Netherlands, Switzerland	5 mg/m^3 (TWA	
	Japan, Finland, Sweden	3 mg/m^3 (TWA)	
	Coal-tar pitch volatiles	0.2 mg/m^3 (TWA)	
	Australia, Belgium, Italy, Netherlands, Switzerland, Yugoslavia		
WHO	European standard for drinking water[e]	0.2 µg/L	WHO 1971
NATIONAL			
Regulations:			
a. Air:		0.2 mg/m^3	
OSHA	PEL, TWA		29 CFR 1910.1000
	Coal tar pitch volatiles-benzene soluble fraction[f]		29 CFR 1910.1002 OSHA 1993 ACGIH 1991
	Oil mist, mineral	5 mg/m^3	29 CFR 1910.1000
EPA	Hazarouds Air Pollutants: Proposed Regulations Governing Constructed, Reconstructed or Modified Major Sources	Yes	59 FR 15504 April 1, 1994 (40 CFR 63.44)
b. Non-specific media:			
EPA	Solid Waste		40 CFR Subchapter I
	Criteria for municipal solid waste landfills		40 CFR 258
	List of hazardous inorganic and organic constituents (all PAHs)	Yes	40 CFR App. II
	Identification and Listing of Hazardous Waste	Yes	40 CFR 261
	Off-specification and discarded materials, and residues (B[a]A, B[a]P, Chrysene, DB[a,h]A, DB[a,i]P, Fluoranthene, I[1,2,3-cd]P)		40 CFR 261.33

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Basis for listing hazardous waste (Acenaphthylene; B[a]A; B[a]P; B[b]F; B[k]F; Chrysene; DB[a,h]A; Fluoranthene; I[1,2,3-cd]P)	Yes		40 CFR 261, App. VII
	Hazardous constituents of waste (B[a]A; B[b]F; B[j]F; B[k]F; B[a]P; Chrysene; DB[a,e]P; DB[a,h]P; DB[a,i]P; Fluoranthene, I[1,2,3-cd]P)	Yes		40 CFR 261, App. VIII
	Waste excluded from nonspecific sources	Yes		40 CFR 261, App. IX
	Carbamate production identification and listing of hazardous waste: oral and inhalation toxicity information for waste constituents (Notice of proposed rulemaking)	Yes		59 FR 9808 March 1, 1994 (40 CFR 261.32) EPA 1994
	Standards for Owners, and Operators of Hazardous Waste Treatment, Storage & Disposal Facilities	Yes		40 CFR 264
	Groundwater monitoring list (all PAHs)			40 CFR 264, App. IX
	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities			40 CFR 266
	Limits for exclusion of waste-derived residues			40 CFR 266, App. VII
	(B[a]A)	$1x10^{-4}$ mg/kg		
	(DB[a,h]A)	$7x10^{-6}$ mg/kg		
	Land Disposal Restrictions			40 CFR 268
	Waste to be evaluated (B[a]A; B[a]P; Chrysene; DB[a,h]A; I[1,2,3-cd]P)	Yes		40 CFR 268.10
	List of wastes to be identified by May 8, 1990	Yes		40 CFR 268.12
	Land disposal treatment concentrations			40 CFR 268.43
	Waste No. F039	Wastewaters (mg/L)	Non-wastewaters (mg/kg)	
	Acenaphthalene	0.059	3.4	
	Acenaphthene/Anthracene/ Fluorene	0.059	4.0	
	B[a]A; Chrysene	0.059	8.2	
	B[b]F; B[k]F	0.055	3.4	
	B[g,h,i]P	0.055	1.5	
	B[a]P	0.061	8.2	
	DB[a,h]A	0.055	8.2	
	DB[a,e]P	0.061	NA	
	Fluoranthene	0.068	8.2	
	Phenanthrene	0.059	3.1	
	Pyrene	0.067	8.2	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Waste No. K035			
	Acenaphthrene; Anthracene, B[a]P; DB[a,h]A; Fluorene; I[1,2,3-cd]P	NA	3.4	
	B[a]A; Chrysene; Phenanthrene	0.059	3.4	
	Fluoranthene	0.068	3.4	
	Pyrene	0.067	8.2	
	Waste No. K048			
	B[a]P	0.047	12	
	Chrysene	0.043	15	
	Fluorene	0.011	14	
	Phenanthrene	0.033	42	
	Pyrene	0.047	36	
	Waste No. K087			
	Acenaphthalene; Chrysene; Fluoranthene; I[1,2,3-cd]P; Phenanthrene	0.028	3.4	
	Waste No. K049			
	Anthracene	0.039	28	
	B[a]P	0.047	12	
	Chrysene	0.043	15	
	Phenanthrene	0.033	42	
	Pyrene	0.047	3.6	
	Waste No. K051			
	Acenaphthene	0.05	NA	
	Anthracene	0.039	28	
	B[a]A	0.043	20	
	Phenanthrene	0.011	14	
	Pyrene	0.033	42	
	Waste No. U018, U050 (B[a]A; Chrysene)	0.059	8.2	
	U022 (B[a]P)	0.061	8.2	
	U063 (DB[a,h]A)	0.055	8.2	
	U120 (Fluoranthene)	0.068	8.2	
	U137 (I[1,2,3-cd]P)	0.0055	8.2	
	Requirements Authorization of State Hazardous Waste Programs			40 CFR 271

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
NATIONAL (cont.)	Regulations implementing the HSWA of 1984	Yes	40 CFR 271.1
	Proposed rule: Universal treatment standards for organics	Yes	58 FR 48092 Sept. 14, 1993
	Maximum grab sample (non-wastewaters)		(40 CFR 148, 260, 261, 268, 271)
	Acenaphthalene; acenaphthene; anthracene; B[a]A; B[a]P; chrysene; fluoranthene; fluorene; I[1,2,3-cd]P	3.4 mg/kg	
	B[b]F; B[k]F	6.8 mg/kg	
	B[g,h,i]P	1.8 mg/kg	
	DB[a,h]A; pyrene	8.2 mg/kg	
	Phenanthrene	5.6 mg/kg	
	Maximum grab sample (wastewaters)		
	Acenaphthalene; acenaphthene; anthracene; B[a]A; chrysene; fluorene; phenanthrene	0.059 mg/L	
	B[a]P; DB[a,e]P	0.061.mg/L	
	B[b]F; B[k]F	0.11 mg/L	
	B[g.h,i]P; I[1,2,3-cd]P	0.0055 mg/L	
	DB[a,h]A	0.055 mg/L	
	Fluoranthene	0.068 mg/L	
	Pyrene	0.067 mg/L	
	Proposed rule: BDAT standard		
	Maximum grab sample (non-wastewaters)		
	B[a]A; B[a]P; chrysene; I[1,2,3-cd]P	3.4 mg/kg	
	B[b]F; B[k]F	6.8 mg/kg	
	DB[a,h]A	8.2 mg/kg	
	Maximum grab samples (wastewaters)		
	B[a]A; chrysene	0.059 mg/L	
	B[a]P	0.061 mg/L	
	B[b]F; B[k]F	0.11 mg/L	
	I[1,2,3-cd]P	0.0055 mg/L	
	DB[a,h]A	0.055 mg/L	
	Superfund, Emergency Planning, and Community Right-To-Know Programs		40 CFR Subchapter J

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
NATIONAL (cont.)	Designation, Reportable Quantities and Notification		40 CFR 302
	Designation and Reportable Quantities of Hazardous Waste		40 CFR 302.4
	Acenaphthene; chrysene, fluoranthene, I[1,2,3-cd]P	100 pounds	
	Acenaphthylene; anthracene, B[k]F; B[g,h,i]P; fluorene; phenanthrene, pyrene	5,000 pounds	
	B[a]A	10 pounds	
	B[b]F; B[a]P; DB[a,h]A	1 pound	
	Emergency Planning and Notification		40 CFR 355
	List of extremely hazardous substances and threshold planning quanitties		40 CFR 355, App. A
	Pyrene	1,000/10,000 lbs.	
	Toxic Chemical Release Reporting: Community Right-to-Know		40 CFR 372
	Toxic chemical listing (anthracene)	Yes	40 CFR 272.65
	Proposed Rule: National oil and hazardous substance pollution contingency plan; QA/QC of chemical analysis of oil compositoin using GC/MS	Yes	58 FR 54702 October 22, 1993 40 CFR 300
	Proposed Rule: Addition of certain chemicals; toxic chemical release reporting; comunity right-to-know	Yes	59 FR 1788 January 12, 1994 40 CFR 372
	Toxic Substances Control Act		40 CFR Subchapter R
	Reporting and Recordkeeping Requirements		40 CFR 704
	Chemical substance matrix for CAIR reporting (Phenanthrene, pyrene)	Yes	40 CFR 704.225
	Health and Safety Data Reporting		40 CFR 716
	Listing of substances and mixtures (anthracene)	Yes	40 CFR 716.120
	Significant New Uses of Chemical Substances		40 CFR 721
	Fluorene substituted aromatic amines	Yes	40 CFR 721.3764
	Provisional Test Guidelines		40 CFR 795

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Protocol for determining anaerobic microbiological transformation rate data for chemicals in the subsurface environment	Yes		40 CFR 795.54
DOT	Hazardous materials transport	Yes		49 CFR 171 DOT 1991
c. Water				
EPA	Water Programs			40 CFR Subchapter D
	National Pollution Discharge Elimination System (NPDES)			40 CFR 122
	Testing requirements for NPDES permits			
	B[a]P; acenaphthene; aenaphthalene	Yes		40 CFR 122, App. D
	Guidelines Establishing Test Procedures for the Analysis of Pollutants			40 CFR 136
	Guidelines for testing pollutants under the CWA (all PAHs)			40 CFR 136.3
	Testing procedures for PAHs base/neutrals and acids, semivolatile organic compounds (all PAHs)	Yes		40 CFR 136, App. A Methods 610, 625, 1625 (Revision B)
	National Primary Drinking Water Regulations			40 CFR 141
	Effective dates (B[a]P)	Yes		40 CFR 141.6
	Sampling and Analytical Requirements for organic chemicals (B[a]P)	Yes		40 CFR 141.24
	Public notification under the SDWA (B[a]P)	0.002 ppm		40 CFR 141.32
	Special monitoring for organic and inorganic compounds (B[a]P)	Yes		40 CFR 141.40
	Maximum contaminant levels for organic contaminants (B[a]P)	0.0002 mg/L		40 CFR 141.61
	Final Rule: Water quality standards; numeric criteria for priority toxic pollutants; states' compliance	Yes		57 FR 60848 Dec. 22, 1992 (40 CFR 131)
	Human health (10^{-6} risk for carcinogens); for consumption of (µg/L):	Water and Organism	Organism Only	
	Anthracene	9,600	110,000	
	B[a]A; B[a]P; B[b]F; B[k]F; chrysene; DB[a,h]A; I[1,2,3-cd]P	0.0028	0.031	
	Fluoranthene	300	370	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Fluorene	1,300	14,000	
	Pyrene	960	11,000	
	Proposed Rule: National primary and secondary drinking water regulations; analytical methods for regulated drinking water contaminants (B[a]P)	Yes		58 FR 5622 Dec. 15, 1993 (40 CFR 141, 143)
	Effluent Guidelines and Standards			40 CFR Subchapter N
	General Provisions			40 CFR 401
	Toxic pollutants under Sec. 307(a) of the CWA (Acenaphthene, fluoranthene)	Yes		40 CFR 401.15
	General Pretreatment Regulations for Existing and New Sources of Pollution			40 CFR 403
	Pretreatment regulations for POTWs (acenaphthene, fluoranthene)	Yes		40 CFR 403, App. B
	Electroplating Point Source Category			40 CFR 413
	Definition of total toxic organic (TTO) (all PAHs, excluding acenaphthene)	Yes		40 CFR 413.02
	Organic Chemicals, Plastics, and Synthetic Fiber			40 CFR 414
	Toxic effluent standards for point sources that use end-of-pipe biological treatment	Daily maximum (µg/L)	Monthly Maximum (µg/L)	40 CFR 414.91 (58 FR 36872) July 9, 1993
	Acenaphthene; acenaphthylene; anthracene; B[a]A; B[k]F; Chrysene; fluorene; phenanthrene	59	22	
	Fluoranthene	68	25	
	B[a]P	61	23	
	Pyrene	67	25	
	Toxic pollutant standards for point sources that do not use end-of-pipe biological treatment			58 FR 36872 (40CFT 414.101
	Acenaphthene; acenaphthylene; anthracene; B[a]A; B[k]F; Chrysene; fluorene; phenanthrene	47	19	
	B[a]P; pyrene	48	20	
	Fluoranthene	54	22	
	Toxic pollutant standards for indirect discharge point sources			58 FR 36872 40 CFR 414.111
	Acenaphthene; anthracene; fluorene; phenanthrene	47	19	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Fluoranthene	54	22	
	Pyrene	48	20	
	Iron and Steel Manufacturing Point Source Category			40 CFR 420
	Definition (B[a]P)	Yes		40 CFR 420.02
	Effluent limitations attainable using BAT for cokemaking B[a]P--1 day maximum (kg/kkg of product)			40 CFR 420.13
	cokemaking--iron and steel	0.0000319		
	--iron and steel with physical chemical treatment	0.0000215		
	--merchant	0.0000355		
	--merchant with physical chemical treatment	0.0000250		
	New source performance standards (B[a]P)--1 day maximum (kg/kkg of product)	Yes		40 CFR 420.14
	cokemaking--iron and steel	0.0000319		
	--merchant	0.0000355		
	Nonferrous Metals Manufacturing Point Source Category			40 CFR 421
	Definition of B[a]P for primary aluminum smelting	Yes		40 CFR 421.21
	Effluent limitations attainable by application of BAT for primary aluminum smelting plants (mg/kg)	Max. 1-day limit	Max. monthly avg.	40 CFR 421.23
	Anode and cathode plastic plant wet air pollution control	0.005	0.002	
	Anode contact cooling and briquette quenching	0.007	0.003	
	Anode bake plant wet air pollution control (closed top)	0.146	0.067	
	Anode bake plant wet air pollution control (open top ring furnace with spray tower only	0.002	0.001	
	Anode bake plant wet air pollution control (open top ring furnace with wet ESP and spray tower)	0.025	0.011	
	Anode bake plant wet air pollution control (tunnel kiln)	0.038	0.018	
	Cathode reprocessing (with dry potline scrubbing and not commigled)	1.181	0.547	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Cathode reprocessing (with wet potline scrubbing)	0.000	na	
	Potline wet air pollution control (w/o cathode reprocessing)	0.028	0.013	
	Potline wet air pollution control (w/cathode reprocessing and not commingled)	0.028	0.013	
	Potline wet air pollution control (w/cathode reprocessing and commingled)	0.028	0.013	
	Pot room wet air pollution control	0.056	0.026	
	Potline SO_2 emissions wet air pollution control	0.045	0.021	
	Degreasing wet air pollution control	zero	zero	
	Pot repair and pot soaking	0.000	na	
	Direct chill casting contact cooling	zero	zero	
	Continuous rod casting contact cooling	zero	zero	
	Stationary casting or shot casting contact cooling	0.000	na	
	New Source Performance Standards for Primary Aluminum Smelting (B[a]P) (mg/kg)	Max. 1-day limit	Max. monthly avg.	40 CFR 421.24
	Anode and cathode paste plant wet air pollution control	0.000	na	
	Anode contact cooling and briquette quenching	0.007	0.003	
	Anode bake plant wet air pollution control	0.000	na	
	Cathode reprocessing (operating with dry potline scrubbing and commingled)	1.181	0.547	
	Potline wet air pollution control	0.000	na	
	Potroom wet air pollution control	0.000	na	
	Potline SO_2 emissions wet air pollution control	0.045	0.021	
	Degassing wet air pollution control	0.000	na	
	Pot repair and pot soaking	0.000	na	
	Direct chill casting contact cooling	zero	zero	
	Continuous rod casting contact cooling	zero	zero	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information		Reference
NATIONAL (cont.)	Stationary casting or shot casting contact cooling	0.000	na	
	Pretreatment standards for primary aluminum smelting sources (B[a]P) (mg/kg)	Max. 1-day limit	Max. monthly avg.	40 CFR 421.26
	Anode and cathode paste plant wet air pollution control	0.000	na	
	Anode contact cooling and briquette quenching	0.007	0.003	
	Anode bake plant wet air pollution control	0.000	na	
	Cathode reprocessing (operating with dry potline scrubbing and not commingled)	1.181	0.547	
	Cathode reprocessing (operating with dry potline scrubbing and commingled)	1.181	0.547	
	Potline wet air pollution control	0.000	na	
	Potroom wet air pollution control	0.000	na	
	Potline SO_2 emissions wet air pollution control	0.045	0.021	
	Degassing wet air pollution control	0.000	na	
	Pot repair and pot soaking	0.000	na	
	Direct chill casting contact cooling	zero	zero	
	Continuous rod casting contact cooling	zero	zero	
	Stationary casting or shot casting contact cooling	0.000	na	
	Steam Electric Power Generating Point Source Category			40 CFR 423
	Priority pollutants for steam power generators (all PAHs)	Yes		40 CFR 423, App. A
	Metal Finishing Point Source Category			40 CFR 433
	Definition of total toxic organics (TTO) for metal refinishing (all PAHs)	Yes		40 CFR 433.11
	Metal Molding and Casting Point Source Category			40 CFR 464
	Definition of TTO for aluminum casting (Acenphthene; anthracene; B[a]A; B[a]P; chrysene; fluorene; fluoranthene; phenanthrene; pyrene)	Yes		40 CFR 464.11

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
NATIONAL (cont.)	Definition of TTO for copper casting (Acenphthene; acenaphthylene; anthracene; B[a]A; B[b]F; chrysene; phenanthrene; pyrene)	Yes	40 CFR 464.21
	Definition of TTO for ferrous casting (Acenaphthene; chrysene; acenaphthylene; anthracene; fluoranthene; fluorene; phenanthrene; pyrene)	Yes	40 CFR 464.31
	Definition of TTO for zinc casting (Acenaphthene; fluoranthene)	Yes	40 CFR 464.41
	Aluminum Forming Point Source Category		40 CFR 467
	Definition of TTO for aluminum casting (Acenaphthene; acenaphtylene; anthracene; B[k]F; B[a]P; B[g,h,i]P; chrysene; DB{a,h]A; fluoranthene; fluorene, I[1,2,3-cd]P; phenanthrene; pyrene)	Yes	40 CFR 467.02
	Copper Forming Point Source Category		40 CFR 468
	Definition of TTO for copper forming (Anthracene; phenanthrene)	Yes	40 CFR 468.02
Guidelines:			
a. Air:			
ACGIH	TLV TWA; Confirmed human carcinogens		ACGIH 1991
	Coal tar pitch volatiles-benzene soluble fraction	0.2 mg/m^3	
	Phenanthrene: cyclohexane extractable fraction	1030 mg/m^3	
	Oil mist, mineral		
	TWA	5 mg/m^3	ACGIH 1991
	STEL	10 mg/m^3	
NIOSH	REL TWA		NIOSH 1992
	Coal tar pitch volatiles; B[a]P; cyclohexane extractable fraction	Ca[g]; 0.1 mg/m^3	
	Chrysene	Ca[g]; lowest feasible concentration	
	Oil mist, mineral		
	TWA	5 mg/m^3	
	STEL	10 mg/m^3	
b. Water:			
EPA OWRS	Ambient water quality criteria for protection of human health		IRIS 1994
	Ingestion of water and organisms[h]		
	PAHs	0.0028 µg/L	
	Fluoranthene	42 µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
NATIONAL (cont.)	Ingestion of organisms only PAHs Fluoranthene	0.031 µg/L 54 µg/L	
	Organoleptic effects (acenaphthene)	0.02 mg/L	
EPA OW	Drinking water standards and health advisories		EPA 1994
	Maximum contaminant level goal (B[a]P) for organic chemicals	0 mg/L	40 CFR 141.50
	Maximum contaminant level (B[a]A) (B[a]P, B[b]F, B[k]F, chrysene) (DB[ah]A) (I[123cd]P)	 0.0001 mg/L 0.0002 mg/L 0.0003 mg/L 0.0004 mg/L	
EPA	Clean Water Act: Toxic pollutants subject to the effluent standards of the Clean Water Act section 301(a)(l)		EPA 1981b (40 CFR 401.15) EPA 1991b (40 CFR 129)
	Polynuclear aromatic hydrocarbons (include: acenaphthene; benzanthracene; benzopyrenes; benzofluoranthene; chrysenes; dibenzoanthracenes; indenopyrenes; fluoranthenes)	Yes	
c. Non-specific media: EPA	Carcinogenic classification[i]		IRIS 1994
	(Fluoranthene, anthracene, acenaphthylene)	Group D	
	(B[a]A, I[123cd]P, DB[ah]A, chrysene, B[k]F, B[b]F, B[a]P)	Group B	
EPA	RfD (Oral)		IRIS 1994
	Anthracene	0.3 mg/kg/day (u.f. 3000)	
	Acenaphthene	0.06 mg/kg/day (u.f. 3000)	
	Fluoranthene	0.04 mg/kg/day (u.f. 3000)	
	Fluorene	0.04 mg/kg/day (u.f. 3000)	
	Pyrene	0.03 mg/kg/day (u.f. 3000)	
	Acenaphthylene; B[a]P; B[e]P; B[a]A; B[b]F; B[ghi]P; B[k]F; B[j]F; chrysene; DB[ah]A; I[123cd]P; BP; phenanthrene	No data	
OSHA	NRC recommendations concerning chemical hygiene in laboratories (B[a]P)	Yes	29 CFR 1910.1450, App. A

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE			
Regulations and Guidelines:			
a. Air			
	Average acceptable ambient air concentrations		NATICH 1992
Arizona			
(B[a]P; B[a]A; DB[ah]A)	1-hour average	0.79 $\mu g/m^3$	
	24-hour average	0.21 $\mu g/m^3$	
	Annual	0.00057 $\mu g/m^3$	
Connecticut			
(B[a]P;)	8-hour average	0.1000 $\mu g/m^3$	
(Coal tar pitch volatiles)	8-hour average	2.0000 $\mu g/m^3$	
(Fluorene)	8-hour average	50.000 $\mu g/m^3$	
(Naphthalene)	8-hour average	10000.0000 $\mu g/m^3$	
Florida- Ft Ldle			
Coal tar pitch volatiles	8-hour average	2.00×10^{-3} $\mu g/m$	
Florida-Pinella			
(B[a]P)	Annual	0.0003 $\mu g/m^3$	
(B[a]A)	8- and 24-hour average	0.00 $\mu g/m^3$	
	Annual	0.00110 $\mu g/m^3$	
(DB[ah]A)	Annual	7.10×10^{-5} $\mu g/m^3$	
Coal tar pitch volatiles	8-hour average	2.00 $\mu g/m^3$	
	24-hour average	0.48 $\mu g/m^3$	
Indiana			
(B[a]P)	8-hour average	0.100 $\mu g/m^3$	
	Annual	0.0006 $\mu g/m^3$	
Kansas			
(B[a]P)	Annual	3.03×10^{-4} $\mu g/m^3$	
(Coal tar pitch volatiles)	Annual	0.00161 $\mu g/m^3$	
Kansas-KC		3.03×10^{-4} $\mu g/m^3$	
(B[a]P)	Annual		
Louisiana			
(Fluoranthene)	Annual	0.0600 $\mu g/m^3$	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
Maryland (B[a]P; B[a]A; DB[ah]A; Fluorene; Fluoranthene; Acenaphthene; Acenaphthylene; Anthracene; B[b]F; B[k]F; B[ghi]P; Chrysene; I[123cd]P; Phenanthrene; Pyrene; B[e]P)		0.00 $\mu g/m^3$	
Maine (B[a]P)	Annual	5.70×10^{-4} $\mu g/m^3$	
Michigan (B[a]P)	Annual	3.00×10^{-4} $\mu g/m^3$	
Nevada (Coal tar pitch volatiles)	8-hour average	0.0050 mg/m^3	
New York (B[a]P)		0.00 $\mu g/m^3$	NATICH 1992
North Carolina (B[a]P)	Annual	3.30×10^{-5} mg/m^3	
(Coal tar pitch volatiles)	Annual	3.30×10^{-5} mg/m^3	
North Dakota (B[a]P; B[a]A; DB[ah]A; B[b]F; Chrysene; I[123cd]P)		0.00 $\mu g/m^3$	
Pennsylvania-Phila (B[a]P)	1-year average Annual	7.00×10^{-4} $\mu g/m^3$ 7.00×10^{-4} $\mu g/m^3$	
(Coal tar pitch volatiles)	1-year average	0.4800 $\mu g/m^3$	
Texas (B[a]P)	30-minute average Annual	0.03 $\mu g/m^3$ 0.003 $\mu g/m^3$	
(Chrysene)	30-minute average Annual	0.500 $\mu g/m^3$ 0.05 $\mu g/m^3$	
Virginia (B[a]P; chrysene)	24-hour average	0.00 $\mu g/m^3$	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
(Coal tar pitch volatiles)	24-hour average	2.0000 $\mu g/m^3$	
Vermont			
(B[a]P)	Annual	3.00×10^{-14} $\mu g/m^3$	
(Phenanthrene)	Annual	1.30 $\mu g/m^3$	
(Pyrene)	Annual	3.40 $\mu g/m^3$	
Washington-SWest (B[a]P)	Annual	6.00×10^{-4} $\mu g/m^3$	
Kentucky	Significant emission levels of toxic air pollutants		401 KAR 63:022 NREPC 1991
	B[a]P; B[b]F; B[a]A; DB[ah]A; I[123cd]P	5.100×10^{-7} pounds/hour	
	Chrysene; coal tar pitch volatiles	5.103×10^{-5} pounds/hour	
b. Water:			
	Water quality standards		NYSDEC 1994
New York Acenaphthene		20 $\mu g/L$	
	Drinking water quality standards		
Arizona (B[a]P)		0.003 $\mu g/L$	FSTRAC 1990
Kansas (B[a]P)		0.03 $\mu g/L$	
(All other PAHs)		0.029 $\mu g/L$	
Maine (PAHs)		25 $\mu g/L$	
Minnesota (PAHs)		0.028 $\mu g/L$	
New Hampshire (B[a]P)		0.003 $\mu g/L$	
New Mexico (B[a]P)		10 $\mu g/L$	
(All other PAHs)		30 $\mu g/L$	
New Jersey (All PAHs)		1 $\mu g/L$	NJDEP 1989

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
State (cont.)			
	ACENAPHTHYLENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	** (no value recorded)	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria	0.003 µg/L	
	Domestic Water Supply (DWS)	0.002 µg/L	
	Fish Consumption (FC)	0.12 µg/L	
	Full Body Contact (FBC)	NNS (no numerical standard)	
	Partial Body Contact (PBC)		
MO	Human Health Protection-Fish Consumption	0.03 µg/L	
	Drinking Water Supply (This concentration is allowed for each of a goup of PAHs)	0.003 µg/L	
	Groundwater	0.003 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	ACENAPHTHENE		
	Water Quality: Human Health		CELDS 1994
AL	Consumption of Water and Fish	20(0) µg/L	
	Fish Consumption Only	20(0) µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
AZ	Numeric Water Quality Criteria		
	Domestic Water Source (DWS)	420 µg/L	
	Fish Consumption (FC)	2600 µg/L	
	Full Body Contact (FBC)	8400 µg/L	
	Partial Body Contact (PBC)	8400 µg/L	
MO	Class II Human Health Protection-Fish Consumption	2700 µg/L	
	Class III Drinking Water Supply	20 µg/L	
WI	Threshold conc. for substances causing taste and odor in water (not toxic to humans)	20 µg/L	
OH	Water Supply Public Water Supply Outside mixing zone Human health 30 day-average	20 µg/L	
DC	Numerical Standards for Water Quality Criteria for Classes (Maximum)		
	Classes A, B, C	50.0 µg/L	
	Classes D, E	20.0 µg/L	
	Water Quality: Aquatic Life		CELDs 1994
AZ	Acute Criteria for Aquatic and Wildlife Uses		
	Cold Water Fishery (A&Wc)	850	
	Warm Water Fishery (A&Ws)	850	
	Effluent Dominated Water (A&Wedw)	850	
	Ephemeral (A&We)	NNS	
	Chronic Criteria for Aquatic and Wildlife Uses		
	Cold Water Fishery (A&Wc)	550 µg/L	
	Warm Water Fishery (A&Ws)	5,500 µg/L	
	Effluent Dominated Water (A&Wedw)	NNS	
	Ephemeral (A&We)		
CO	Aquatic life segments-organic compounds to the second power		
	Standard (acute)	1,700 µg/L	
	Standard (chronic)	520 µg/L	
HI	Numeric Standards for Toxic Pollutants		
	Applied to All Waters	570 µg/L	
	Freshwater (acute)	320 µg/L	
	Saltwater (acute)	NS (no standard developed)	
	Fish Consumption		
OH	Aquatic Life Habitat-Coldwater		
	Outside mixing zone (maximum)	67 µg/L	
	Outside mixing zone (30-day average)	67 µg/L	
	Inside mixing zone (maximum)	134 µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
	Aquatic Life Habitat-Limited Resource Warmwater Outside mixing zone (maximum) Inside mixing zone (maximum)	 67 µg/L 134 µg/L	
NY	Water Classes-A, A-S, AA, AA-S Standards µg/L Type-health (water source) Basis code-chem.correlation	 20 µg/L	
	Groundwater Monitoring		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Groundwater Quality Standards		CELDs 1994
MO	Class VII-Groundwater	20 µg/L	
	ANTHRACENE		
	Water Quality: Human Health		CELDs 1994
AZ	Numeric Water Quality Criteria Domestic Water Source (DWS) Fish Consumption (FC) Full Body Contact (FBC) Partial Body Contact (PBC)	 2100 µg/L 6300 µg/L 420000µg/L NNS	
MO	Human Health Protection-Fish Consumption Drinking Water Supply Groundwater	0.03 µg/L 0.003 µg/L 0.003 µg/L	
OH	Water Supply Public Water Supply		

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
	Outside mixing zone Human Health 30-day average	0.028 0.003 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CA		Yes	
IL		Yes	
KY		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater Outside mixing zone Human Health 30-day average	0.31 µg/L*	
	Aquatic Life Habitat-Limited Resource Warmwater Outside mixing zone Human Health 30-day average	0.31 µg/L*	
	*This value applies to the sum of PAHs		
	BENZ(a)ANTHRACENE		
	Hazardous Constituents		CELDs 1994
AL		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MA		Yes	
ME		Yes	
MD		Yes	
MN		Yes	
MT		Yes	
NH		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
NJ		Yes	
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	Water Quality: Human Health		CELDs 1994
AL	Human Health Criteria:		
	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
	-Classified as a carcinogen		
AZ	Numeric Water Quality Criteria:		
	Domestic Water Source (DWS)	0.03 µg/L	
	Fish Consumption (FC)	0.00008 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS	
	-known, probable, or possible human carcinogen		
MO	Human Health Protection-Fish		
	Consumption	0.03 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater	0.003 µg/L	
	Water Supply		
	Public Water Supply		
OH	Outside mixing zone		
	Human health		
	30-day average	0.028 µg/L	
WI	Human Cancer Criteria*		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	*Human cancer criteria for PAHs are applicable to any combination of 10 PAHs (specific)		

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
WI	Human Cancer Criteria*		
	Non-Public Water Supplies		
	Warmwater Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	*Human cancer criteria are applicable to any combination of 9 PAHs.		
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater		
	Outside mixing zone		
	Human Health		
	30-day average	0.31 µg/L*	
	Aquatic Life Habitat-Limited Resource Warmwater		
	Outside mixing zone		
	Human Health		
	30-day average	0.31 µg/L*	
	* This value applied to the sum of 13 PAHs		
	BENZO(b)FLUORANTHENE		
	Water Quality: Human Health		CELDs 1994
OH	Water Supply-Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L*	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 µg/L	
	Cold Water Communities	0.023 µg/L	
	Great Lakes	0.023 µg/L	
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.31 mg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
IL		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
LA		Yes	
KY		Yes	
MD		Yes	
MN		Yes	
MT		Yes	
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	BENZO(k)FLUORANTHENE		
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater Outside Mixing Zone Human Health 30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater Outside Mixing Zone Human Health 30-day average	0.31 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
IL		Yes	
MD		Yes	
MT		Yes	
NE		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WY		Yes	
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Source (DWS)	0.003 µg/L	
	Fish Consumption (FC)	0.00001 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS	
OH	Water Supply		
	Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
	BENZO(g,h,i)PERYLENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Source (DWS)	0.003 µg/L	
	Fish Consumption (FC)	0.0001 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS	
OH	Water Supply		
	Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.31 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	BENZO(a)PYRENE		
	Water Quality: Human Health Criteria		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only -Carcinogen	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Supply (DWS)	0.003 µg/L	
	Fish Consumption (FC)	0.002 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS	
MO	Human Health Protection-Fish Consumption	0.03 µg/L 0.003 µg/L	
	Drinking Water Supply*	0.003 µg/L	
	Groundwater*		
	*These conclusions are allowed for each of the PAHs		
NM	Groundwater Standards		
	Human Health Standards	0.0007 mg/L	
OH	Water Supply-Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L	
OK	Maximum Allowable Levels for Organic Chemicals	0.4 mg/L	
TN	National Primary Drinking Water		
	Standard Organic Chemicals	0.002 mg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Human Cancer Criteria		
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
	Special Monitoring, Reporting and Public Notification Requirements for Unregulated Organic and Inorganic Contaminants Nonregulated Organic Contaminants	Yes	
	Water Quality: Aquatic Life		CELDs 1994
NY	Water Classes-GA Standards (µg/L)-ND Type-H(WS) Basis code-F		
OH	Aquatic Life Habitat-Coldwater Outside Mixing Zone Human Health 30-day average	0.31 µg/L*	
	Aquatic Life Habitat-Limited Resource Warm Water Outside Mixing Zone Human Health 30-day average	0.31 µg/L*	
	*This value applies to the sum of 13 PAHs		
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MA		Yes	
ME		Yes	
MD		Yes	
MN		Yes	
MT		Yes	
NH		Yes	
NJ		Yes	
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Groundwater Quality Standards		CELDs 1994
NY	Groundwater Effluent Standard	Not detectable	
WI	Public Health Groundwater Quality Standards		
	Enforcement Standard	0.003 µg/L	
	Preventive Action	0.0003 µg/L	
	CHRYSENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Supply (DWS)	0.03 µg/L	
	Fish Consumption (FC)	0.0001 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
MO	Human Health Protection-Fish Consumption	0.03 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater	0.003 µg/L	
OH	Water Supply-Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Human Cancer Criteria		
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.31 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
WI		Yes	
WV		Yes	
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MA		Yes	
ME		Yes	
MD		Yes	
MN		Yes	
MT		Yes	
NH		Yes	
NJ		Yes	
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	DIBENZ(a,j)ACRIDINE		
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
IL		Yes	
LA		Yes	
KY		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
MD		Yes	
MN		Yes	
MT		Yes	
NE		Yes	
ND		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	DIBENZO(a,h)ANTHRACENE		
	Water Quality: Human Health		CELDs 1994
MO	Human Health Protection-Fish Consumption	0.03 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater	0.003 µg/L	
AL	Human Health Criteria		
	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Supply (DWS)	0.003 µg/L	
	Fish Consumption (FC)	0.00003 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS	
OH	Water Supply-Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Human Cancer Criteria		
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	Water Quality: Aquatic Life		©ELDs 1994

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
OH	Aquatic Life Habitat-Coldwater Outside Mixing Zone Human Health 30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater Outside Mixing Zone Human Health 30-day average	0.31 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
C0		Yes	
IL		Yes	
KY		Yes	
LA		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Hazardous Constituents		CELDs 1994
AL		Yes	
CA		Yes	
CO		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MA		Yes	
ME		Yes	
MD		Yes	
MT		Yes	
NH		Yes	
NJ		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	FLUORANTHENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Source (DWS)	280 µg/L	
	Fish Consumption (FC)	130 µg/L	
	Full Body Contact (FBC)	5600 µg/L	
	Partial Body Contact (PBC)	5600 µg/L	
IN	Continuous Criterion Concentration (4-Day) Average for Human Health		
	Outside of Mixing Zone	54 (T)*	
	Point of Water	42	
	*(T) - T is derived from threshold toxicity		
KY	Water Quality Criteria for Protection of Human Health from the Consumption of Fish Tissue Substances Not Linked to Cancer Organics	54 µg/L	
	Domestic Water Supply Source Criteria Substances Not Linked to Cancer Maximum Contaminant Level (organics)	0.042 mg/L	
MO	Drinking Water Supply	40 µg/L	
	Human Health Protection-Fish Consumption	54 µg/L	
	Groundwater	40 µg/L	
OH	Water Supply-Public Water Supply Outside Mixing Zone Human Health 30-day average	42 µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
WI	Human Threshold Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	28 µg/L	
	Cold Water Communities	9.1 µg/L	
	Great Lakes	9.3 µg/L	
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	32 µg/L	
	Cold Water Communities	9.5 µg/L	
	Warm Water and Limited Fish and Limited Aquatic	41,000 µg/L	
HI	(Water Quality Standards: Basic Water Quality Criteria for All Waters)		
	Numeric Standards for Toxic Pollutants Applicable to All Waters		
	Freshwater		
	Acute	1,300 µg/L	
	Chronic	NS	
	Saltwater		
	Acute	13 µg/L	
	Chronic	NS	
	Fish Consumption	18 µg/L	
	Water Quality: Aquatic Life		CELDs 1994
AZ	Acute Criteria for Aquatic and Wildlife Uses	2000 µg/L	
	A&Wc: Cold Water Fishery	2000 µg/L	
	A&Ws: Warm Water Fishery	2000 µg/L	
	A&Wedw: Effluent Dominated Water	NNS	
	A&We: Ephemeral		
	Chronic Criteria for Aquatic and Wildlife Uses	1600 µg/L	
	A&Wc: Cold Water Fishery	1600 µg/L	
	A&Ws: Warm Water Fishery	1600 µg/L	
	A&Wedw: Effluent Dominated Water	NNS	
	A&We: Ephemeral		
CO	Aquatic Life Segments (organic compounds to the second power)	3,980 µg/L	
	Standard (acute)		
FL	Maximum Concentration Levels for Mixing Zone Pollutants	540 µg/L	
OH	Aquatic Life Habitat-Coldwater		
	Outside mixing zone		
	Maximum	200 µg/L	
	30-day average	8.9 µg/L	
	Human Health		
	30-day average	54 µg/L	
	Inside Mixing Zone		
	Maximum	400 µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
	Outside Mixing Zone Maximum Human Health 30-day average	 200 µg/L 54 µg/L	
	Inside Mixing Zone Maximum	 400 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MA		Yes	
ME		Yes	
MD		Yes	
MN		Yes	
MT		Yes	
NH		Yes	
NJ		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	FLUORENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Source (DWS)	280 µg/L	
	Fish Consumption (FC)	580 µg/L	
	Full Body Contact (FBC)	5600 µg/L	
	Partial Body Contact (PBC)	5600 µg/L	
MO	Human Health Protection-Fish	0.03 µg/L	
	Consumption	0.003 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater		
OH	Water Supply		
	Public Water Supply		
	Outside mixing zone		
	Human Health 30-day average	0.028 µg/L	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater		
	Outside mixing zone		
	Human Health		
	30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater		
	Outside mixing zone		
	Human Health		
	30-day average	0.31 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	INDENO(1,2,3-CD)PYRENE		
	Water Quality: Human Health Criteria		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Supply (DWS)	0.003 µg/L	
	Fish Consumption (FC)	0.000003 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS µg/L	
MO	Human Health Protection-Fish Consumption	0.03 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater	0.003 µg/L	
OH	Water Supply-Public Water Supply		
	Outside Mixing Zone		
	Human Health		
	30-day average	0.028 µg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Human Cancer Criteria		
	Non-Public Water Supplies		
	Warm Water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	Water Quality: Aquatic Life		CELDs 1994

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
OH	Aquatic Life Habitat-Coldwater Outside mixing zone Human Health 30-day average	0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater Outside mixing zone Human Health 30-day average	0.31 µg/L*	
	Hazardous Constituents		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MA		Yes	
ME		Yes	
MD		Yes	
MN		Yes	
MT		Yes	
NH		Yes	
NJ		Yes	
NE		Yes	
ND		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
VA		Yes	
VT		Yes	
WI		Yes	
WV		Yes	
WY		Yes	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	PHENANTHRENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Supply (DWS)	0.003 µg/L	
	Fish Consumption (FC)	0.0005 µg/L	
	Full Body Contact (FBC)	0.12 µg/L	
	Partial Body Contact (PBC)	NNS	
MO	Human Health Protection-Fish Consumption	0.03 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater	0.003 µg/L	
WI	Human Cancer Criteria		
	Public Water Supplies		
	Warm Water Sport Fish Communities	0.023 mg/L	
	Cold Water Communities	0.023 mg/L	
	Great Lakes	0.023 mg/L	
	Non-Public Water Supplies		
	Warm water Sport Fish Communities	0.1 mg/L	
	Cold Water Communities	0.1 mg/L	
	Warm Water and Limited Fish and Limited Aquatic	6.1 mg/L	
	Water Quality: Aquatic Life		CELDs 1994s
AZ	Acute Criteria for Aquatic and Wildlife Uses	30 µg/L	
	A&Wc: Cold Water Fishery	30 µg/L	
	A&Ws: Warm Water Fishery	540 µg/L	
	A&Wedw: Effluent Dominated Water	NNS	
	A&We: Ephemeral		

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
	Chronic Criteria for Aquatic and Wildlife Uses	6.3 µg/L	
	A&Wc: Cold Water Fishery	6.3 µg/L	
	A&Ws: Warm Water Fishery	6.3 µg/L	
	A&Wedw: Effluent Dominated Water	NNS	
	A&We: Ephemeral		
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	
	PYRENE		
	Water Quality: Human Health		CELDs 1994
AL	Consumption of Water and Fish	**	
	Fish Consumption Only	**	
AZ	Numeric Water Quality Criteria		
	Domestic Water Source (DWS)	210 µg/L	
	Fish Consumption (FC)	1100 µg/L	
	Full Body Contact (FBC)	4200 µg/L	
	Partial Body Contact (PBC)	4200 µg/L	
MO	Human Health Protection-Fish Consumption	0.03 µg/L	
	Drinking Water Supply	0.003 µg/L	
	Groundwater	0.003 µg/L	
OH	Water Supply		
	Public Water Supply		
	Outside mixing zone		
	Human Health		
	30-day average	0.028 µg/L	

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

Agency	Description	Information	Reference
STATE (cont.)			
WI	Human Cancer Criteria Public Water Supplies Warm Water Sport Fish Communities Cold Water Communities Great Lakes	 0.023 mg/L 0.023 mg/L 0.023 mg/L	
	Human Cancer Criteria Non-Public Water Supplies Warm Water Sport Fish Communities Cold Water Communities Warm Water and Limited Fish and Limited Aquatic	 0.1 mg/L 0.1 mg/L 6.1 mg/L	
	Water Quality: Aquatic Life		CELDs 1994
OH	Aquatic Life Habitat-Coldwater Outside mixing zone Human Health 30-day average	 0.31 µg/L	
	Aquatic Life Habitat-Limited Resource Warmwater Outside mixing zone Human Health 30-day average	 0.31 µg/L	
	Groundwater Monitoring Parameters		CELDs 1994
AL		Yes	
CO		Yes	
CA		Yes	
IL		Yes	
LA		Yes	
KY		Yes	
MN		Yes	
NY		Yes	
OH		Yes	
SC		Yes	
TN		Yes	
VA		Yes	
WI		Yes	
WV		Yes	

[a]Degree of evidence in animals revised on the basis of data that appeared after the most recent monograph and/or on the basis of present criteria. Overall evaluation based on evidence of carcinogenicity in monograph 32, 1983.

[b]Group 2A = Probable human carcinogen

[c]Group 2B = Possible human carcinogen

TABLE 7-1. Regulations and Guidelines Applicable to Polycyclic Aromatic Hydrocarbons (continued)

[d]Group 3 = Not classifiable as to carcinogenicity

[e]The following PAHs were used as indicators in deriving this standard: B[a]P; B[b]F; B[a]F; B[k]F; fluoranthene; and I[123cd]P. Source: EPA 1986b.

[f]Includes anthracene, B[a]P, phenanthrene, acridine, chrysene, and pyrene

[g]Agent recommended by NIOSH to be treated as a potential occupational carcinogen.

[h]Because of their carcinogenic potential, the EPA-recommended concentration for PAHs in ambient water is zero. However, because attainment of this level may not be possible, the recommended criteria requires a E-G estimated incremental lifetime cancer risks.

[i]Group D = not classifiable as to human carcinogenicity, Group B2 = Probable Human Carcinogen

[j]When "all PAHs" are listed, it includes the following compounds, unless specified otherwise:
Anthracene, Acenaphthylene, Acenaphthene, B[a]A, B[a]P, B[b]F, B[h]F, B[g,h,i]P, Chrysene, DB[a,h]A, Fluoranthene, Flourene, I[1,2,3-cd]P, Phenanthrene, Pyrene

ACHIH = American Conference of Governmental Industrial Hygienists; B[a]A = Benzo[a]Anthracene; B[a]P = Benzo[a]Pyrene; B[b]F = Benzo[b]Fluoranthene; B[e]P = Benzo[e]Pyrene; B[ghi]P = Benzo(ghi)perylene; B[j]F = Benzo[j]Fluoranthene; B[k]F = Benzo[k]Fluoranthene; B[ghi]P = Benzo[ghi]perylene; BP = Benzopyrene; DB[a,h]A = Dibenz[a,h]Anthracene; DB[a,e]P = Dibenzo[a,e]pyrene; DB[a,i] = Dibenzo[a,i]pyrene; DOT = Department of Transportation; EPA = Environmental Protection Agency; IARC = International Agency for Research on Cancer; I[123cd]P = Indeno[1,2,3-c,d]Pyrene; ng = nanogram; NIOSH = Natinonal Institute for Occupational Safety and Health; OERR = Office of Emergency and Remedial Response; OSHA = Occupational Safety and Health Administration; OWRS = Office of Water Regulations and Standards; PAH = Polycyclic Aromatic Hydrocarbons; PEL = Permissible Exposure Limit; RCRA = Resource Conservation and Recovery Act; REL = Recommended Exposure Limit; RfD = Reference Dose; TLV = Threshold Limit Value; TWA = Time-Weighted Average; u.f. = Uncertainty Factor; WHO = World Health Organization

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9. GLOSSARY

Acute Exposure-Exposure to a chemical for a duration of 14 days or less, as specified in the Toxicological Profiles.

Adsorption Coefficient (K_{oc})-The ratio of the amount of a chemical adsorbed per unit weight of organic carbon in the soil or sediment to the concentration of the chemical in solution at equilibrium.

Adsorption Ratio (Kd)-The amount of a chemical adsorbed by a sediment or soil (i.e., the solid phase) divided by the amount of chemical in the solution phase, which is in equilibrium with the solid phase, at a fixed solid/solution ratio. It is generally expressed in micrograms of chemical sorbed per gram of soil or sediment.

Bioconcentration Factor (BCF)-The quotient of the concentration of a chemical in aquatic organisms at a specific time or during a discrete time period of exposure divided by the concentration in the surrounding water at the same time or during the same period.

Cancer Effect Level (CEL)-The lowest dose of chemical in a study, or group of studies, that produces significant increases in the incidence of cancer (or tumors) between the exposed population and its appropriate control.

Carcinogen-A chemical capable of inducing cancer.

Ceiling Value-A concentration of a substance that should not be exceeded, even instantaneously.

Chronic Exposure- Exposure to a chemical for 365 days or more, as specified in the Toxicological Profiles.

Developmental Toxicity- The occurrence of adverse effects on the developing organism that may result from exposure to a chemical prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism.

Embryotoxicity and Fetotoxicity- Any toxic effect on the conceptus as a result of prenatal exposure to a chemical; the distinguishing feature between the two terms is the stage of development during which the insult occurred. The terms, as used here, include malformations and variations, altered growth, and in utero death.

EPA Health Advisory-An estimate of acceptable drinking water levels for a chemical substance based on health effects information. A health advisory is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state, and local officials.

Immediately Dangerous to Life or Health (IDLH)-The maximum environmental concentration of a contaminant from which one could escape within 30 min without any escape-impairing symptoms or irreversible health effects.

Intermediate Exposure-Exposure to a chemical for a duration of 15-364 days, as specified in the Toxicological Profiles.

Immunologic Toxicity-The occurrence of adverse effects on the immune system that may result from exposure to environmental agents such as chemicals.

In vitro-Isolated from the living organism and artificially maintained, as in a test tube.

In vivo-Occurring within the living organism.

Lethal Concentration$_{(LO)}$ (LC_{LO})-The lowest concentration of a chemical in air which has been reported to have caused death in humans or animals.

Lethal Concentration$_{(50)}$ (LC_{50})-A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

Lethal Dose$_{(LO)}$ (LD_{LO})-The lowest dose of a chemical introduced by a route other than inhalation that is expected to have caused death in humans or animals.

Lethal Dose$_{(50)}$ (LD_{50})-The dose of a chemical which has been calculated to cause death in 50% of a defined experimental animal population.

Lethal Time$_{(50)}$ (LT_{50})-A calculated period of time within which a specific concentration of a chemical is expected to cause death in 50% of a defined experimental animal population.

Lowest-Observed-Adverse-Effect Level (LOAEL)-The lowest dose of chemical in a study, or group of studies, that produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

Malformations-Permanent structural changes that may adversely affect survival, development, or function.

Minimal Risk Level-An estimate of daily human exposure to a dose of a chemical that is likely to be without an appreciable risk of adverse noncancerous effects over a specified duration of exposure.

Mutagen-A substance that causes mutations. A mutation is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

Neurotoxicity-The occurrence of adverse effects on the nervous system following exposure to chemical.

No-Observed-Adverse-Effect Level (NOAEL)-The dose of chemical at which there were no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Octanol-Water Partition Coefficient (K_{ow})-The equilibrium ratio of the concentrations of a chemical in n-octanol and water, in dilute solution.

Permissible Exposure Limit (PEL)-An allowable exposure level in workplace air averaged over an 8-hour shift.

q_1*-The upper-bound estimate of the low-dose slope of the dose-response curve as determined by the multistage procedure. The q_1* can be used to calculate an estimate of carcinogenic potency, the incremental excess cancer risk per unit of exposure (usually μg/L for water, mg/kg/day for food, and $\mu g/m^3$ for air).

Reference Dose (RfD)-An estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure of the human population to a potential hazard that is likely to be without risk of deleterious effects during a lifetime. The RfD is operationally derived from the NOAEL (from animal and human studies) by a consistent application of uncertainty factors that reflect various types of data used to estimate RfDs and an additional modifying factor, which is based on a professional judgment of the entire database on the chemical. The RfDs are not applicable to nonthreshold effects such as cancer.

Reportable Quantity (RQ)-The quantity of a hazardous substance that is considered reportable under CERCLA. Reportable quantities are (1) 1 pound or greater or (2) for selected substances, an amount established by regulation either under CERCLA or under Sect. 311 of the Clean Water Act. Quantities are measured over a 24-hour period.

Reproductive Toxicity-The occurrence of adverse effects on the reproductive system that may result from exposure to a chemical. The toxicity may be directed to the reproductive organs and/or the related endocrine system. The manifestation of such toxicity may be noted as alterations in sexual behavior, fertility, pregnancy outcomes, or modifications in other functions that are dependent on the integrity of this system.

Short-Term Exposure Limit (STEL)-The maximum concentration to which workers can be exposed for up to 15 min continually. No more than four excursions are allowed per day, and there must be at least 60 min between exposure periods. The daily TLV-TWA may not be exceeded.

Target Organ Toxicity-This term covers a broad range of adverse effects on target organs or physiological systems (e.g., renal, cardiovascular) extending from those arising through a single limited exposure to those assumed over a lifetime of exposure to a chemical.

Teratogen-A chemical that causes structural defects that affect the development of an organism.

Threshold Limit Value (TLV)-A concentration of a substance to which most workers can be exposed without adverse effect. The TLV may be expressed as a TWA, as a STEL, or as a CL.

Time-Weighted Average (TWA)-An allowable exposure concentration averaged over a normal 8-hour workday or 40-hour workweek.

Toxic Dose (TD_{50})-A calculated dose of a chemical, introduced by a route other than inhalation, which is expected to cause a specific toxic effect in 50% of a defined experimental animal population.

Uncertainty Factor (UF)-A factor used in operationally deriving the RfD from experimental data. UFs are intended to account for (1) the variation in sensitivity among the members of the human population, (2) the uncertainty in extrapolating animal data to the case of human, (3) the uncertainty in extrapolating from data obtained in a study that is of less than lifetime exposure, and (4) the uncertainty in using LOAEL data rather than NOAEL data. Usually each of these factors is set equal to 10.

APPENDIX A

USER'S GUIDE

Chapter 1

Public Health Statement

This chapter of the profile is a health effects summary written in non-technical language. Its intended audience is the general public especially people living in the vicinity of a hazardous waste site or chemical release. If the Public Health Statement were removed from the rest of the document, it would still communicate to the lay public essential information about the chemical.

The major headings in the Public Health Statement are useful to find specific topics of concern. The topics are written in a question and answer format. The answer to each question includes a sentence that will direct the reader to chapters in the profile that will provide more information on the given topic.

Chapter 2

Tables and Figures for Levels of Significant Exposure (LSE)

Tables (2-l) 2-2, and 2-4) and figures (2-1, 2-2, and 2-3) are used to summarize health effects and illustrate graphically levels of exposure associated with those effects. These levels cover health effects observed at increasing dose concentrations and durations, differences in response by species, minimal risk levels (MRLs) to humans for noncancer end points, and EPA's estimated range associated with an upper-bound individual lifetime cancer risk of 1 in 10,000 to 1 in 10,000,000. Use the LSE tables and figures for a quick review of the health effects and to locate data for a specific exposure scenario. The LSE tables and figures should always be used in conjunction with the text. All entries in these tables and figures represent studies that provide reliable, quantitative estimates of No-Observed-Adverse-Effect Levels (NOAELs), Lowest-Observed-Adverse-Effect Levels (LOAELs), or Cancer Effect Levels (CELs).

The legends presented below demonstrate the application of these tables and figures. Representative examples of LSE Table 2-l and Figure 2-l are shown. The numbers in the left column of the legends correspond to the numbers in the example table and figure.

LEGEND

See LSE Table 2-1

(1) Route of Exposure One of the first considerations when reviewing the toxicity of a substance using these tables and figures should be the relevant and appropriate route of exposure. When sufficient data exists, three LSE tables and two LSE figures are presented in the document. The three LSE tables present data on the three principal routes of exposure, i.e., inhalation, oral, and dermal (LSE Table 2-1, 2-2, and 2-3, respectively). LSE figures are limited to the inhalation (LSE Figure 2-l) and oral (LSE Figure 2-2) routes. Not all substances will have data on each route of exposure and will not therefore have all five of the tables and figures.

(2) Exposure Period Three exposure periods - acute (less than 15 days), intermediate (15 to 364 days), and chronic (365 days or more) are presented within each relevant route of exposure. In this example, an inhalation study of intermediate exposure duration is reported. For quick reference to health effects occurring from a known length of exposure, locate the applicable exposure period within the LSE table and figure.

(3) Health Effect The major categories of health effects included in LSE tables and figures are death, systemic, immunological, neurological, developmental, reproductive, and cancer. NOAELs and LOAELs can be reported in the tables and figures for all effects but cancer. Systemic effects are further defined in the "System" column of the LSE table (see key number 18).

(4) Key to Figure Each key number in the LSE table links study information to one or more data points using the same key number in the corresponding LSE figure. In this example, the study represented by key number 18 has been used to derive a NOAEL and a Less Serious LOAEL (also see the 2 " 18r" data points in Figure 2-l).

(5) Species The test species, whether animal or human, are identified in this column. Section 2.4, "Relevance to Public Health," covers the relevance of animal data to human toxicity and Section 2.3, "Toxicokinetics," contains any available information on comparative toxicokinetics. Although NOAELs and LOAELs are species specific, the levels are extrapolated to equivalent human doses to derive an MRL.

(6) Exposure Frequency/Duration The duration of the study and the weekly and daily exposure regimen are provided in this column. This permits comparison of NOAELs and LOAELs from different studies. In this case (key number 18), rats were exposed to [chemical x] via inhalation for 6 hours per day, 5 days per week, for 3 weeks. For a more complete review of the dosing regimen refer to the appropriate sections of the text or the original reference paper, i.e., Nitschke et al. 1981.

(7) System This column further defines the systemic effects. These systems include: respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, renal, and dermal/ocular. "Other" refers to any systemic effect (e.g., a decrease in body weight) not covered in these systems. In the example of key number 18, 1 systemic effect (respiratory) was investigated.

(8) NOAEL A No-Observed-Adverse-Effect Level (NOAEL) is the highest exposure level at which no harmful effects were seen in the organ system studied. Key number 18 reports a NOAEL of 3 ppm for the respiratory system which was used to derive an intermediate exposure, inhalation MRL of 0.005 ppm (see footnote "b").

(9) LOAEL A Lowest-Observed-Adverse-Effect Level (LOAEL) is the lowest dose used in the study that caused a harmful health effect. LOAELs have been classified into "Less Serious" and "Serious" effects. These distinctions help readers identify the levels of exposure at which adverse health effects first appear and the gradation of effects with increasing dose. A brief description of the specific endpoint used to quantify the adverse effect accompanies the LOAEL. The respiratory effect reported in key number 18 (hyperplasia) is a less serious LOAEL of 10 ppm. MRLs are not derived from Serious LOAELs.

(10) Reference The complete reference citation is given in chapter 8 of the profile.

(11) CEL A Cancer Effect Level (CEL) is the lowest exposure level associated with the onset of carcinogenesis in experimental or epidemiologic studies. CELs are always considered serious effects. The LSE tables and figures do not contain NOAELs for cancer, but the text may report doses not causing measurable cancer increases.

(I 2) Footnotes Explanations of abbreviations or reference notes for data in the LSE tables are found in the footnotes. Footnote "b" indicates the NOAEL of 3 ppm in key number 18 was used to derive an MRL of 0.005 ppm.

LEGEND

See Figure 2-1

LSE figures graphical!y illustrate the data presented in the corresponding LSE tables. Figures help the reader quickly compare health effects according to exposure concentrations for particular exposure periods.

(13) Exposure Period The same exposure periods appear as in the LSE table. In this example, health effects observed within the intermediate and chronic exposure periods are illustrated.

(14) Health Effect These are the categories of health effects for which reliable quantitative data exists. The same health effects appear in the LSE table.

(15) Levels of Exposure Exposure concentrations or doses for each health effect in the LSE tables are graphically displayed in the LSE figures. Exposure concentration or dose is measured on the log scale "y" axis. Inhalation exposure is reported in mg/m3 or ppm and oral exposure is reported in mg/kg/day.

(16) NOAEL In this example, 18r NOAEL is the critical endpoint for which an intermediate inhalation exposure MRL is based. As you can see from the LSE figure key, the open-circle symbol indicates to a NOAEL for the test species-rat. The key number 18 corresponds to the entry in the LSE table. The dashed descending arrow indicates the extrapolation from the exposure level of 3 ppm (see entry 18 in the Table) to the MRL of 0.005 ppm (see footnote "b" in the LSE table).

(17) CEL Key number 38r is 1 of 3 studies for which Cancer Effect Levels were derived. The diamond symbol refers to a Cancer Effect Level for the test species-mouse. The number 38 corresponds to the' entry in the LSE table.

(18) Estimated Upper-Bound Human Cancer Risk Levels This is the range associated with the upper-bound for lifetime cancer risk of 1 in 10,000 to 1 in 10,000,000. These risk levels are derived from the EPA's Human Health Assessment Group's upper-bound estimates of the slope of the cancer dose response curve at low dose levels (q_1*).

(19) Key to LSE Figure The Key explains the abbreviations and symbols used in the figure.

SAMPLE

1 → **TABLE 2-1. Levels of Significant Exposure to [Chemical x] – Inhalation**

Key to figure[a]	Species	Exposure frequency/ duration	System	NOAEL (ppm)	LOAEL (effect) Less serious (ppm)	LOAEL (effect) Serious (ppm)	Reference
2 → INTERMEDIATE EXPOSURE							
	5	6	7	8	9		10
3 → Systemic	↓	↓	↓	↓	↓		↓
4 → 18	Rat	13 wk 5d/wk 6hr/d	Resp	3[b]	10 (hyperplasia)		Nitschke et al. 1981
CHRONIC EXPOSURE							
					11		
					↓		
Cancer							
38	Rat	18 mo 5d/wk 7hr/d			20	(CEL, multiple organs)	Wong et al. 1982
39	Rat	89–104 wk 5d/wk 6hr/d			10	(CEL, lung tumors, nasal tumors)	NTP 1982
40	Mouse	79–103 wk 5d/wk 6hr/d			10	(CEL, lung tumors, hemangiosarcomas)	NTP 1982

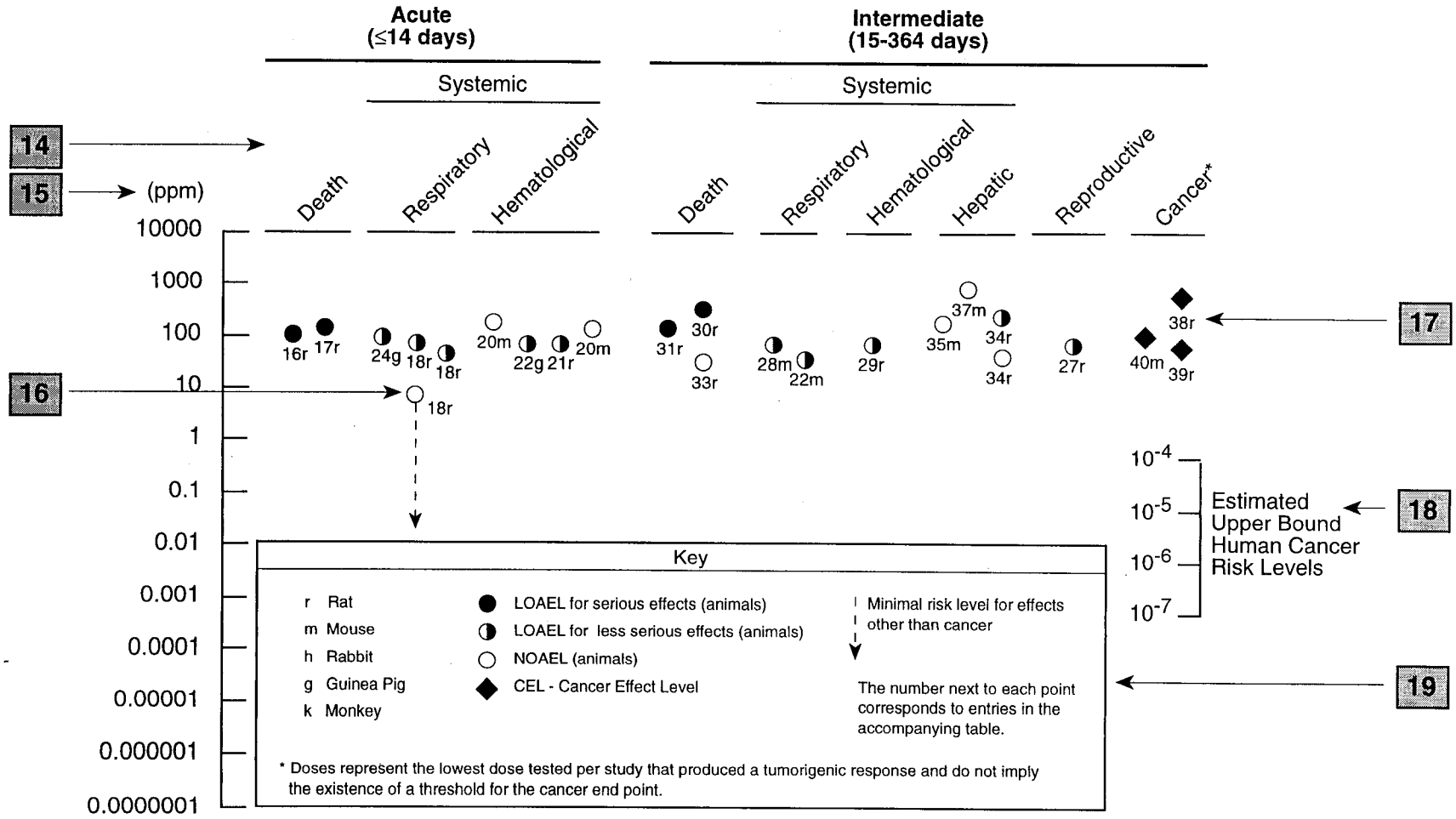
[a] The number corresponds to entries in Figure 2-1.

12 → [b] Used to derive an intermediate inhalation Minimal Risk Level (MRL) of 5 x 10^{-3} ppm; dose adjusted for intermittent exposure and divided by an uncertainty factor of 100 (10 for extrapolation from animal to humans, 10 for human variability).

CEL = cancer effect level; d = days(s); hr = hour(s); LOAEL = lowest-observed-adverse-effect level; mo = month(s); NOAEL = no-observed-adverse-effect level; Resp = respiratory; wk = week(s)

SAMPLE

13 → **Figure 2-1. Levels of Significant Exposure to [Chemical X] – Inhalation**



APPENDIX A

Chapter 2 (Section 2.4)

Relevance to Public Health

The Relevance to Public Health section provides a health effects summary based on evaluations of existing toxicologic, epidemiologic, and toxicokinetic information. This summary is designed to present interpretive, weight-of-evidence discussions for human health endpoints by addressing the following questions.

1. What effects are known to occur in humans?
2. What effects observed in animals are likely to be of concern to humans?
3. What exposure conditions are likely to be of concern to humans, especially around hazardous waste sites?

The section covers endpoints in the same order they appear within the Discussion of Health Effects by Route of Exposure section, by route (inhalation, oral, dermal) and within route by effect. Human data are presented first, then animal data. Both are organized by duration (acute, intermediate, chronic). In vitro data and data from parenteral routes (intramuscular, intravenous, subcutaneous, etc.) are also considered in this section. If data are located in the scientific literature, a table of genotoxicity information is included.

The carcinogenic potential of the profiled substance is qualitatively evaluated, when appropriate, using existing toxicokinetic, genotoxic, and carcinogenic data. ATSDR does not currently assess cancer potency or perform cancer risk assessments. Minimal risk levels (MRLs) for noncancer endpoints (if derived) and the endpoints from which they were derived are indicated and discussed.

Limitations to existing scientific literature that prevent a satisfactory evaluation of the relevance to public health are identified in the Data Needs section.

Interpretation of Minimal Risk Levels

Where sufficient toxicologic information is available, we have derived minimal risk levels (MRLs) for inhalation and oral routes of entry at each duration of exposure (acute, intermediate, and chronic). These MRLs are not meant to support regulatory action; but to acquaint health professionals with exposure levels at which adverse health effects are not expected to occur in humans. They should help physicians and public health officials determine the safety of a community living near a chemical emission, given the concentration of a contaminant in air or the estimated daily dose in water. MRLs are based largely on toxicological studies in animals and on reports of human occupational exposure.

MRL users should be familiar with the toxicologic information on which the number is based. Chapter 2.4, “Relevance to Public Health,” contains basic information known about the substance. Other sections such as 2.7, “Interactions with Other Chemicals”, and 2.8, “Populations that are Unusually Susceptible” provide important supplemental information.

To derive an MRL, ATSDR generally selects the most sensitive endpoint which, in its best judgement, represents the most sensitive human health effect for a given exposure route and duration. ATSDR cannot make this judgement or derive an MRL unless information (quantitative or qualitative) is available for all potential systemic, neurological, and developmental effects. If this information and reliable quantitative data on the chosen endpoint are available, ATSDR derives an MRL using the most sensitive species (when information from multiple species is available) with the highest NOAEL that does not exceed any adverse effect levels. When a NOAEL is not available, a lowest-observed-adverse-effect level (LOAEL) can be used to derive an MRL, and an uncertainty factor (UF) of 10 must be employed. Additional uncertainty factors of 10 must be used both for human variability to protect sensitive subpopulations (people who are most susceptible to the health effects caused by the substance) and for interspecies variability (extrapolation from animals to humans). In deriving an MRL, these individual uncertainty factors are multiplied together. The product is then divided into the inhalation concentration or oral dosage selected from the study. Uncertainty factors used in developing a substance-specific MRL are provided in the footnotes of the LSE Tables.

APPENDIX B

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACGIH	American Conference of Governmental Industrial Hygienists
ADME	Absorption, Distribution, Metabolism, and Excretion
atm	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
BCF	bioconcentration factor
BSC	Board of Scientific Counselors
C	Centigrade
CDC	Centers for Disease Control
CEL	Cancer Effect Level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	centimeter
CNS	central nervous system
d	day
dL	deciliter
DHEW	Department of Health, Education, and Welfare
DHHS	Department of Health and Human Services
DOL	Department of Labor
ECG	electrocardiogram
EEG	electroencephalogram
EPA	Environmental Protection Agency
EKG	see ECG
F	Fahrenheit
F_1	first filial generation
FAO	Food and Agricultural Organization of the United Nations
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
fpm	feet per minute
ft	foot
FR	Federal Register
g	gram
GC	gas chromatography
gen	generation
HPLC	high-performance liquid chromatography
hr	hour
IDLH	Immediately Dangerous to Life and Health
IARC	International Agency for Research on Cancer
ILO	International Labor Organization
in	inch
Kd	adsorption ratio
kg	kilogram
kkg	metric ton
K_{oc}	organic carbon partition coefficient

K_{ow}	octanol-water partition coefficient
L	liter
LC	liquid chromatography
LC_{Lo}	lethal concentration, low
LC_{50}	lethal concentration, 50% kill
LD_{Lo}	lethal dose, low
LD_{50}	lethal dose, 50% kill
LOAEL	lowest-observed-adverse-effect level
LSE	Levels of Significant Exposure
m	meter
mg	milligram
min	minute
mL	milliliter
mm	millimeter
mm Hg	millimeters of mercury
mmol	millimole
mo	month
mppcf	millions of particles per cubic foot
MRL	Minimal Risk Level
MS	mass spectrometry
NIEHS	National Institute of Environmental Health Sciences
NIOSH	National Institute for Occupational Safety and Health
NIOSHTIC	NIOSH's Computerized Information Retrieval System
ng	nanogram
nm	nanometer
NHANES	National Health and Nutrition Examination Survey
nmol	nanomole
NOAEL	no-observed-adverse-effect level
NOES	National Occupational Exposure Survey
NOHS	National Occupational Hazard Survey
NPL	National Priorities List
NRC	National Research Council
NTIS	National Technical Information Service
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
pg	picogram
pmol	picomole
PHS	Public Health Service
PMR	proportionate mortality ratio
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
REL	recommended exposure limit
RfD	Reference Dose
RTECS	Registry of Toxic Effects of Chemical Substances
sec	second
SCE	sister chromatid exchange
SIC	Standard Industrial Classification

SMR	standard mortality ratio
STEL	short term exposure limit
STORET	STORAGE and RETRIEVAL
TLV	threshold limit value
TSCA	Toxic Substances Control Act
TRI	Toxics Release Inventory
TWA	time-weighted average
U.S.	United States
UF	uncertainty factor
yr	year
WHO	World Health Organization
wk	week
>	greater than
≥	greater than or equal to
=	equal to
<	less than
≤	less than or equal to
%	percent
α	alpha
β	beta
δ	delta
γ	gamma
μm	micron
μg	microgram
μM	micromolar

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ATSDR Agency for Toxic Substances and Disease Registry

Environmental Health and Medicine Education

Lead Toxicity

What Are Routes of Exposure to Lead?

Learning Objectives

Upon completion of this section, you will be able to

- Identify the most common routes of exposure to lead in the United States today.

Introduction

Today almost everyone is exposed to environmental lead. Exposure to lead and lead chemicals can occur through inhalation, ingestion, dermal absorption, absorption from retained or embedded leaded foreign body, and trans-placental (endogenous) routes.

- Most human exposure to lead occurs through ingestion or inhalation.
- In the United States, the public is not as likely to encounter lead that readily enters the human body through the skin (dermal exposure), especially now that leaded gasoline is banned for on-road vehicles.
- Retained shrapnel, bullets or other embedded leaded foreign bodies can be a source of ongoing lead exposure.
- Inhalation may be the major contributor for workers in lead-related occupations and “do-it-yourself” home renovators and persons with hobbies (stained glass making/soldering, etc.).

Lead exposure is a global issue. Lead mining and lead smelting are common in many countries, where children and adults can receive substantial lead exposure from often unregulated sources at high levels that are uncommon today in the United States [Kaul et al. 1999; Litvak et al. 1999; Wasserman et al. 1997; López-Carrillo et al. 1996; Rothenberg et al. 1994]. Most countries have discontinued or are in the process of phasing out the use of leaded gasoline for all uses [UNEP 2011].

Ingestion

Lead exposure in the general population (including children) occurs primarily through ingestion, making it the route that most commonly leads to elevated BLLs. This includes swallowing a foreign body containing lead (i.e., jewelry, etc.).

From 20% to 70% of ingested lead is absorbed into the body, (with children generally absorbing a higher percentage than adults) [ATSDR 2010] (see the *“What are Possible Health Effects from Lead Exposure?”* section).

- Lead paint is the major source of higher lead level exposures in children in the United States [ATSDR 2010, AAP 1993]. As higher lead content paint
  - Deteriorates,
  - Peels,
  - Chips,
  - Is removed (e.g., during renovation),
  - Or crumbles due to friction (e.g., in windowsills, steps, and doors), house dust and surrounding soil may become contaminated. Lead then enters the body through normal hand-to-mouth activity [Sayre et al. 1974, as cited in AAP 1993].

- Ingestion of contaminated
  - Food,
  - Water, or
  - Alcohol may be significant for some populations. In addition, ingesting certain traditional, folk or home remedy medicines may expose people to lead or lead compounds (see the *"Where is Lead Found?"* section).
- When fine particulate lead is inhaled, it can be absorbed directly through the lungs or could also be carried by the mucociliary tree to the throat where it can be swallowed and absorbed via the GI system.

Inhalation

Inhalation is the second major pathway of exposure for the general population in the United States. The amount absorbed from the respiratory system depends on particle size, respiratory volume, amount of deposition, and the mucociliary clearance of the inhaled lead.

- Almost all inhaled lead is absorbed into the body (with children generally absorbing a higher percentage than adults, as they have a higher respiratory frequency) [ATSDR 2010] (see the *"What are Possible Health Effects from Lead Exposure?"* section).
- Since leaded gasoline additives were phased out beginning in the 1970s and control measures were implemented in industries to reduce air emissions, inhalation from these sources is no longer the major exposure pathway to lead for the general population in the United States.
- Leaded gasoline is still used in only a handful of countries, but the resulting emissions pose a major public health threat.
- Inhalation may be the primary route of exposure for some workers in industries that involve lead.
- Inhalation may be the primary route of exposure for adults involved in home renovation activities, and hobbies like lead glass making, stained glass making/soldering.
- Lead is a component of tobacco and tobacco smoke, and smokers have higher blood lead levels (BLLs) than do nonsmokers [Mannino et al. 2005; Mannino et al. 2003].
- Second hand smoke may contribute to increased BLLs in U.S. children. Lead dust concentrations, usually ingested during hand to mouth activity, do not appear to mediate this association, suggesting inhalation of second hand smoke is a major pathway of exposure [Apostolou et al. 2012].
- Eliminating second hand smoke exposure may reduce lead exposure in children [Apostolou et al. 2012].

Dermal

Dermal exposure plays a role for exposure to organic lead among workers, but is not considered a significant pathway for the general population.

- Organic lead may be absorbed directly through the skin.
- Organic lead (tetraethyl lead) is more likely to be absorbed through the skin than inorganic lead.
- Dermal exposure is most likely among people who work with lead or materials that contain lead.

Endogenous Exposure

Endogenous exposure to lead may contribute significantly to an individual's current BLL. Numerous reports document lead poisoning resulting from retained bullet or shrapnel fragments; thus, a history of military or other penetrating trauma may be important [Kathuria 2014]. If in a pregnant woman, this poses a particular risk to the developing fetus (See the *"What are Possible Health Effects from Lead Exposure?"* section). Trans-placental exposure to the unborn child can happen if the mother is exposed to lead.

- Once absorbed into the body, lead may be stored for long periods in mineralizing tissue (*e.g.,* teeth and bones).

- The stored lead may be released again into the bloodstream, especially in times of calcium stress (*e.g.,* pregnancy, lactation, osteoporosis) or calcium deficiency.

Key Points

- Ingestion is the most common route of exposure to lead for children, and the route that most commonly leads to elevated BLLs.
- Inhalation can be a significant exposure pathway, particularly for workers in lead industries, “do-it yourself” home renovators, persons with hobbies (stained glass making/soldering), smokers and children exposed to second hand smoke.
- Embedded or retained leaded foreign bodies can be a source of ongoing lead exposure.
- Trans-placental exposure to the unborn child can happen if the mother is exposed to lead.

The request is blocked.

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Last Reviewed: May 24, 2023

Phase II Assessment
Fox River, Wisconsin

For

US Army Corps of Engineers
Detroit District
Under DACW35-98-D0007

Prepared by:

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April 2001

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TABLE OF CONTENTS

1.0 Introduction **1**

2.0 Project Description **2**

2.1 De Pere 2
2.1.1 Little Kaukauna *3*
2.1.2 Kaukauna *3*
2.1.3 Little Chute *5*
2.1.4 Appleton *5*
2.1.5 Menasha *7*

3.0 Field Sampling Activities **7**

3.1 Location of sample sites 8
3.2 Soil Sampling Procedures 8
3.3 Soil Characteristics 9
3.4 Groundwater Sampling Procedures 9
3.5 Groundwater Characteristics 10

4.0 Chemical Analysis Results **11**

4.1 Analytical Data Quality Assurance 13
4.2 Soil Analytical Results 13
4.2.1 De Pere Soil Results *13*
4.2.2 Little Kaukauna Soil Results *13*
4.2.3 Kaukauna Soil Results *14*
4.2.4 Little Chute Soil Results *14*
4.2.5 Appleton Soil Results *14*
4.2.6 Menasha Soil Results *15*
4.3 Groundwater Analytical Results 16
4.3.1 De Pere Groundwater Results *16*
4.3.2 Little Kaukauna Groundwater Results *16*
4.3.3 Kaukauna Groundwater Results *16*
4.3.4 Little Chute Groundwater Results *16*
4.3.5 Appleton Groundwater Results *16*
4.3.6 Menasha Groundwater Results *16*
4.3.7 QA/QC Samples *17*

5.0 Discussion **17**

5.1 Arsenic in Soil 17
5.2 DRO Contamination in Appleton 17
5.3 Dredged Material Disposal Sites 17
5.4 Suitability to Transfer 18

6.0 Conclusions and Recommendations **18**

LIST OF FIGURES

Figure 1. Sampling Site Location Map 1
Figure 2. De Pere Sampling Locations 2
Figure 3. Little Kaukauna Sampling Locations 3
Figure 4. Kaukauna Sampling Locations 4
Figure 5. Little Chute Sampling Locations 5
Figure 6. Appleton Sampling Locations 6
Figure 7. Menasha Sampling Locations 7

LIST OF TABLES

Table 1. Summary of Sample Locations, Matrices and Analytical Parameters 1
Table 2. Summary of Soil VOC Results, De Pere and Appleton 4
Table 3. Summary of Soil Metals Results, Little Kaukauna 5
Table 4. Summary of Soil PCB Results, Little Kaukauna 6
Table 5. Summary of Soil Metals Results, Kaukauna 7
Table 6. Summary of Soil Metals Results Continued, Kaukauna 8
Table 7. Summary of Soil PCB Results, Kaukauna 9
Table 8. Summary of Soil Metals Results, Little Chute 10
Table 9. Summary of Soil PCB Results, Little Chute 11
Table 10. Summary of Soil DRO-GRO Results, Appleton and Little Chute 12
Table 11. Summary of Soil Metals Results, Appleton 13
Table 12. Summary of Soil PCB Results, Appleton 14
Table 13. Summary of Soils Metals Results, Menasha 15
Table 14. Summary of Soil PCB Results, Menasha 16
Table 15. Summary of Groundwater VOC Results 17
Table 16. Summary of Groundwater TPH Results 18

1.0 Introduction

The United States Army Corps of Engineers, Detroit District (USACE) currently holds and manages eleven properties associated with navigation and appurtenant structures along the Fox River of Northern Wisconsin. The Fox River flows southward, from Green Bay, Lake Michigan into Lake Winnebago, a distance of approximately 50 miles (Figure 1).

USACE intends to transfer possession of these eleven properties associated with locks and dams and their support structures to the State of Wisconsin. Prior to transfer, an environmental clearance is required to support a Finding of Suitability to Transfer (FOST). The State of Wisconsin intends to continue to operate or to return to operation, the locks and dams located on these properties. The Fox River Phase II Assessment is intended to support this real property transfer. Altech Environmental Services (Altech) of Southfield, Michigan was contracted by USACE to conduct the Phase II assessment.

A Phase I Assessment was conducted for each Fox River parcel declared excess and scheduled to be transferred as the first major step in the environmental clearance process. It identified various potential sources of contamination that may have impacted the subject properties from past use by the Corps or the preceding parcel specific landowners. Several adjacent properties were found to have documented chemical contamination and were determined in the Phase I Assessment to be potential sources for on-site contamination. In addition to these issues, several drinking water wells located at former Lockmaster's residences on some of the properties were recommended for closure.

USACE personnel evaluated the results of the Phase I Assessment and developed the scope of work (SOW) for the Fox River Phase II Assessment. The SOW specifically identified potential impacts at six of the eleven properties being evaluated for transfer. These six properties are identified from north to south as:

1) De Pere
2) Little Kaukauna
3) Kaukauna
4) Little Chute
5) Appleton
6) Menasha

Six Lockmaster's residences that had drinking water wells to be abandoned were identified in the original SOW. Subsequent modifications to the SOW reduced this number to four wells at the following locations:

1) Kaukauna
2) Little Kaukauna
3) Cedars
4) Rapid Croche

New information about the locations, depths and construction of the wells discovered while in the field led to the decision to delay the well closures in order to allow time to adequately address these newly encountered issues related to the well closures.

The SOW included a Sampling and Analysis Plan (SAP) which was modified and applied to the identified properties and specific potential impacts as described below in Section 2 - Project Description.

2.0 Project Description

Two types of sampling and analyses were specified in the modified SAP. The first type of sampling and analyses were intended to provide quantitative chemical data for materials that exist on the subject parcels from past use by the Corps or its predecessors, particularly dredged material disposal sites. The second type was designed to investigate the presence of chemical contamination at the property line caused by others occupying properties adjacent to the subject properties or nearby up gradient sites where others have documented the presence of chemical contamination. In total the SAP specified the collection and chemical laboratory analyses of 35 soil and 36 groundwater samples from the locations outlined below. However, field conditions led to modifications to the SAP. The soils above bedrock were generally comprised of low permeability red clayey tills which prevented many of the monitoring wells specified in the SAP from generating water. Consequently, soil samples were substituted to chemically characterize conditions at most of these locations. A summary of the modifications below is followed by a fully detailed account of planned versus actual sampling and analysis. In summary the modifications were:

1) The deletion of two soil samples that were determined to be off USACE property.
2) The deletion of three groundwater samples that were determined to be unlikely to produce groundwater and had a minimum of soil over bedrock.
3) Collection of soil samples from locations designated for groundwater sampling when groundwater was absent. This procedure was initiated after the first day of sampling and so 5 dry wells from the first day of sampling do not have surrogate soil samples.
4) Changes in analytical parameters for a given sampling location. These changes are described below for the affected sampling locations.

These field modifications of the SAP resulted in a final total of 53 soil samples and 10 groundwater samples. The details of sample locations, matrices and analytical parameters for samples are described below for each of the six target properties and are summarized in Table 1.

2.1 De Pere

Property line sampling adjacent to the Osen Milling Company. Temporary wells were installed for collection of groundwater samples at two locations. The samples were collected for laboratory analysis for volatile organic compounds (VOCs) in accordance with USEPA SW846 Method 8260B to determine if there are VOCs migrating to the site from the adjacent

property. Only one sample was collected, as one of the wells did not produce groundwater. These samples are identified as:

DPa-1-01
DPa-2-01 – Not collected

AST fill line sampling and historical industrial activity. Three soil samples were obtained at three boring locations. Two of the samples were be collected along the length of the fill line and a third sample in the area of historical industrial activity for laboratory analysis of VOCs. These samples are identified as:

DPb-1-01
DPb-2-01
DPb-3-01

Sample locations for De Pere are identified on Figure 2.

2.1.1 Little Kaukauna

Sampling from dredged material disposal site. Three soil samples were obtained at three boring locations. The soil samples were collected for laboratory analysis of Poly-chlorinated biphenyls (PCBs) and metals. These samples are identified as:

LKa-1-01
LKa-2-01
LKa-3-01

Sampling property adjacent to Industrial activities. Temporary wells were installed for collection of groundwater samples at three locations. The samples were to be collected for laboratory analysis of VOCs. Only one sample was collected, as two of the wells did not produce groundwater. These samples are identified as:

LKc-1-01– Not collected
LKc-2-01– Not collected
LKc-3-01

Sample locations for Little Kaukauna are identified on Figure 3.

2.1.2 Kaukauna

Sampling from dredged material disposal site. Three soil samples were obtained at three boring locations. The soil samples were collected for laboratory analysis of metals and PCBs. These samples are identified as:

Ka-1-01
Ka-2-01
Ka-3-01

Sampling property adjacent to Industrial activities. Temporary wells were installed for collection of groundwater samples at three locations. The samples were collected for laboratory analysis of VOCs. One of the wells did not produce groundwater so only two samples were collected at these locations. These samples are identified as:

Kc-1-01
Kc-2-01
Kc-3-01 – Not collected

Sampling property adjacent to Industrial activities. Three soil samples were obtained at three boring locations. None of these wells produced groundwater so three soil samples were collected at these locations. The samples were collected for metals analysis. These samples are identified as:

Kc-4-01 - Matrix changed to soil.
Kc-5-01 - Matrix changed to soil.
Kc-6-01 - Matrix changed to soil.

Sampling property filling. Three soil samples were obtained at three boring locations. The soil samples were collected for laboratory analysis of metals and PCBs to determine the type of fill used at the property site. These samples are identified as:

Kd-1-01
Kd-2-01
Kd-3-01

Property line sampling adjacent to Thilmany Paper Company. Temporary wells were installed for collection of groundwater samples at eight locations. The groundwater samples were to be collected for laboratory analysis of VOCs and metals to determine if there are potential chemicals migrating on to the site from the adjacent property. None of these wells produced groundwater so eight soil samples were collected for laboratory analysis of metals at these locations. These samples are identified as:

Ke-1-01- Matrix changed to soil.
Ke-2-01- Matrix changed to soil.
Ke-3-01- Matrix changed to soil.
Ke-4-01- Matrix changed to soil.
Ke-5-01- Matrix changed to soil.
Ke-6-01- Matrix changed to soil.
Ke-7-01- Matrix changed to soil.
Ke-8-01- Matrix changed to soil.

2.1.3 Little Chute

Sampling from dredged material disposal site. Three soil samples were obtained at three boring locations. The soil samples were collected for laboratory analysis of metals and PCBs. The samples are identified as:

LCa-1-01
LCa-2-01
LCa-3-01

Property line sampling adjacent to 200 Sanitorium Road. Temporary wells were installed for collection of groundwater samples at two locations. The samples were collected for laboratory analysis of total petroleum hydrocarbons. The samples are identified as:

LCb-1-01
LCb-2-01

Sampling from exposed channel. Four soil samples were obtained at four boring locations. The soil samples were collected for laboratory analysis of metals and PCBs. The samples are identified as:

LCd-1-01
LCd-2-01
LCd-3-01
LCd-4-01

Sampling property adjacent to Industrial activities. Temporary wells were installed for collection of groundwater samples at four locations. The samples were to be collected for laboratory analysis of VOCs. Field observation of the sites indicated that three locations would not produce groundwater and had minimal soil cover so these sampling locations were deleted. The fourth well produced only 1/3 the required volume of water for VOC analysis and so an additional soil sample was collected and designated for diesel range organics – gas range organics (DRO-GRO) analysis in case of failure of the VOC analysis due to the limited sample volume. The samples are identified as:

LCe-1-01 – Soil DRO-GRO analysis added.
LCe-2-01 – Deleted.
LCe-3-01 – Deleted.
LCe-4-01 – Deleted.

2.1.4 Appleton

Sampling from dredged material disposal site. Five soil samples were obtained from five boring locations. The samples were collected for laboratory analysis of metals and PCBs. The samples are identified as:

APa-1-01

APa-2-01
APa-3-01
APa-4-01
APa-5-01

Property sampling adjacent to U.S. Government Office - Edison Light Company. Three soil samples were obtained from the three boring locations and temporary wells installed for collection of groundwater samples from the same three locations. The samples were collected for laboratory analysis of VOCs. The samples are identified as:

APc1-1-01
APc1-2-01
APc1-3-01

Property sampling adjacent to U.S. Government Property - North of canal between Lock 2 & 3. Temporary wells were installed for collection of groundwater samples at three locations. The samples were to be collected for laboratory analysis of VOCs and metals. None of these wells produced groundwater so three soil samples were collected for laboratory analysis of metals at these locations. The samples are identified as:

APc2-1-01_– Matrix changed to soil.
APc2-2-01_– Matrix changed to soil.
APc2-3-01_– Matrix changed to soil.

Property sampling adjacent to U.S. Government Property - Immediately south of Lock 3. Temporary wells were installed for collection of groundwater samples at three locations. The samples were to be collected for laboratory analysis of VOCs. None of these wells produced groundwater so three soil samples were collected for laboratory analysis. There were visual and olfactory indications of possible fuel contamination in the soil samples as they were collected and so the analytical parameter was changed from VOCs to DRO-GRO for these locations. The samples are identified as:

APc3-1-01– Matrix changed to soil.
APc3-2-01– Matrix changed to soil.
APc3-3-01– Matrix changed to soil.

Property sampling adjacent to U.S. Government Property - Immediately south of Lock 4. Temporary wells were installed for collection of groundwater samples at two locations. The samples were to be collected for laboratory analysis of total petroleum hydrocarbons (TPH). None of these wells produced groundwater so three soil samples were collected for laboratory analysis. The analytical parameter was also changed from TPH to DRO-GRO for these locations. The samples are identified as:

APc4-1-01– Matrix changed to soil.
APc4-2-01– Matrix changed to soil.

Property sampling adjacent to U.S. Government Property - Parcel west of dam. Three soil samples were obtained from the three boring locations. The soil samples were collected for laboratory analysis of VOCs and PCBs. The samples are identified as:

APc5-1-01
APc5-2-01
APc5-3-01

Property sampling adjacent to Consolidated Paper. Two soil samples were to be obtained from two boring locations. The soil samples were to be collected for laboratory analysis of petroleum products or solvents to determine if there are VOCs migrating on to the site from the adjacent property. It was determined in the field that these samples were located off of USACE property and so these locations were deleted. These samples are identified as:

APe-1-01 – Deleted.
APe-2-01 – Deleted.

2.1.5 Menasha

Sampling from dredged material disposal site. Three soil samples were obtained from three boring locations. The soil samples were collected for laboratory analysis of metals and PCBs. The samples are identified as:

M-1-01
M-2-01
M-3-01

3.0 Field Sampling Activities

Field sampling was accomplished between the dates of February 5th through February 15th, 2001 and was conducted in accord with established procedures for the collection of environmental samples for laboratory analyses by the specified analytical procedures. Clean tools, decontaminated using de-ionized water and comprised of stainless steel or other appropriate materials were used. Samples were collected and labeled as specified in the USACE SAP, described in Section 2 – Project Description and summarized in Table 1. Field preservatives were used and sample containers packed as appropriate to maintain the integrity of the samples from the point of collection to delivery at the specified laboratory. Samples were packed with ice and maintained at 4°C during shipping. Photographs of sampling activity and equipment are presented in Appendix A.

Access to many of the sampling locations was extremely difficult due to slopes, islands, snow, ice and trees. Fox River office USACE personnel gained permission to access private property and provided staff and equipment to remove snow and ice where necessary. Trees and brush were cleared by Altech to provide access to sampling sites on brushed over berms

and islands. Sites, which were inaccessible by large or small machine, were accessed on foot and the samples collected with hand-driven tooling.

Installation of boreholes and temporary monitoring wells was accomplished using Geoprobe sampling techniques. Altech employed two subcontractors to conduct Geoprobing operations for this project. Altech Services LLC of Southfield, MI operated a Geoprobe Model 6600 mounted on a Ford F350 panel truck. The Model 6600 was used to collect soil borings and install temporary wells in areas with relatively clear access. Environmental Drilling Services of De Pere, Wisconsin operated a Geoprobe Model 5400 mounted on a Ford F150 4X4 pick up truck and equipment used to hand drive and retrieve the geoprobe tooling for acquisition of samples in areas of difficult access. Hand sampling was accomplished with a pneumatic or electric jackhammer for driving sampling tubes into the ground and a car jack for extracting the tubes and the contained soil samples.

3.1 Location of sample sites

Location of sampling points was accomplished using sample location maps provided with the USACE SOW. Actual sample points were chosen in the field and marked on February 5th, 2001 with the assistance of Fox River office USACE personnel. Representatives of the area public and private utility companies as well as representatives of some of the industries located adjacent to the USACE properties were also consulted to assure field sample locations did not intersect with any underground utilities, tanks or pipelines.

Coordinates of sample sites were determined using a Sokkia differential GPS unit. The locations and coordinates of survey markers on the locks and dams were acquired with the assistance of the Fox River and Kewaunee office USACE staff with the intention of verifying the accuracy of the GPS unit. Snow cover, however prevented these markers from being located. Sample location marker flags were left in place after sampling activities were completed in order for coordinates to be acquired consecutively on a single day, February 15th, 2001. Sample locations are plotted on the maps depicted in figures 2 through 7 based on these coordinates.

3.2 Soil Sampling Procedures

Soil borings were advanced to a depth of ten feet below surface or until refusal. A geologist described and characterized the soil encountered in each boring. The boring records are presented in Appendix B. All holes left by soil borings and well installation were filled with remaining soil cuttings and bentonite chips.

Soil samples were collected using the Geoprobe sampling system, which is comprised of a steel sampling tube with a clean acetate inner liner. The sampling tube is forced into the ground by a combination of pushing and hammer action generated by the Geoprobe. After driving to the appropriate depth, the sampling tube is pulled from the ground and the acetate liner, which is now filled with soil, is removed. The liner is sliced open to expose the soil for description and sampling by a geologist. A new acetate liner is installed for each interval of soil collected.

Soil samples collected for all analytical parameters with the exception of VOCs are composite samples. Composite samples were produced by mixing discrete samples taken at one foot intervals along the soil boring with clean stainless steel spoons in a clean stainless steel bowl. The composite sample was then transferred to the appropriate container with a stainless steel spoon.

Soil samples for VOCs were discrete samples preserved in the field with methanol. A sample container of known weight was placed on a balance and small amounts of soil were collected from one-foot intervals along the soil boring and transferred to the sample container using the modified plastic syringe supplied by the laboratory for this purpose. 10 grams of soil was collected and preserved with ten milliliters of methanol. The laboratory supplied a pre-measured amount of methanol in a plastic ampoule.

3.3 Soil Characteristics

The soil at all six of the subject properties generally consisted of reddish brown moderately hard and moderately plastic silty clay (glacial till) with minor percentages of sand and gravel. At some locations there was an increase in gravel and sand components, typically in the upper two to three feet, which were then underlain by the typical reddish brown silty clay. Occasionally, areas of fill material were encountered. This fill material was comprised of dark brown to black, sandy clay, wood fragments, gravel and concrete fragments intermixed with portions of native clay soil.

The vast majority of borings were terminated at the top of bedrock. Bedrock was typically encountered between nine and ten feet below surface but was encountered at depths as low as three to five feet.

3.4 Groundwater Sampling Procedures

Groundwater was anticipated to occur at depths between 5 and 7 feet below surface. The SAP called for groundwater samples to be collected with a Geoprobe Screenpoint sampling device. The Screenpoint sampler consists of an inner stainless steel well screen enclosed in a steel Geoprobe tube with an expendable pointed tip. This combination tube is driven to the required depth and the outer casing pulled back to expose the screen at the appropriate depth. Sampling equipment is inserted through the geoprobe tooling into the stainless screen for well development and groundwater sampling.

Due to the soil conditions and extremely slow recharge rates, this method was inefficient, so ¾ inch inside diameter PVC temporary wells with a five foot screen and five foot riser were installed instead. This allowed the Geoprobe to continue soil sampling and well installation while the wells were charging. Wells were installed to a depth of ten feet or at the top of bedrock where refusal occurred. Each well was left for a minimum of 30 minutes before being classified as dry and the well removed. Most wells were left to charge for a period of

several hours. The field records of well installation and water level measurements are presented in Appendix B. Boring logs.

Well development and sampling for all parameters except VOCs was conducted where sufficient water was present using a peristaltic pump and clean tubing. Development and sampling for VOCs was conducted with a clean stainless steel bailer in order to limit aspiration of the groundwater samples.

Well development was accomplished only where sufficient water and recharge existed. Wells in this area were extremely slow to charge. The well development procedure was conducted as follows:

1) Measurements of pH, conductivity and temperature were conducted as water was being produced by the well. The well was considered developed when three consecutive readings of the above parameters within ten percent were achieved.
2) If this could not be attained after a reasonable effort then the well was considered developed after the purging of three well volumes of water.
3) If there was insufficient water and recharge for the purging of three well volumes then the well was considered developed when the water ran clear.
4) In instances with very little water in the well (6 inches or less) and very slow recharge rates, as is common in these soils, well development was not possible and samples were collected directly from the standing water in the well.

Following the USACE directive of February 7, 2001 soil samples were collected during each temporary well installation for use in the event that the well was dry. Five dry wells encountered on February 6, 2001 prior to this directive do not have surrogate soil samples.

3.5 Groundwater Characteristics

In general groundwater was extremely slow to charge. Groundwater was present in sufficient quantity to sample only nine wells of a planned 35. Many wells were completely dry up to 24 hours after installation. Well sampling and development data is presented in Appendix B.

It was evidence of the impermeability of the clay soils that wells installed in such close proximity to the Fox River would not produce water. As might be expected those wells which produced the highest quantity of water were those which were in the lowest lying areas and closest to the Fox River. It would be expected that this groundwater would contain a significant proportion of Fox River water.

Groundwater temperature ranged 34.2 ° to 41.8 °F with pH ranging from 7.4 to 7.7. The conductivity meter malfunctioned on the last day of groundwater sampling due to extremely cold temperatures causing ice formation on the probe. Readings were consistent but inaccurate relative to the standard solution. Readings from groundwater sampling earlier in the week prior to February 15th produced readings between 1120 and 1260 and these are considered accurate as the probe was properly reading the standard solution. Beyond the 15th

of February reading are erroneously low and were only used qualitatively for well development purposes.

Two wells contained enough water for sampling with the peristaltic pump: These wells were:

LCb-1-01
LCb-2-01

These two wells were to be sampled for TPH. There was insufficient water and recharge in these wells to develop them and to collect the large sample volume required for TPH analysis.

Well LCb-1-01 was pumped until dry to test the recharge rate.
Well LCb-2-01 as it contained more water than LCb-1-01 LCb-2-01 was pumped until the water ran clear before sampling was conducted.

There were only three wells for which sufficient water and recharge existed for well development according to procedure. These wells were APc1-1-01, APc1-2-01 and APc1-3-01 located at the former USACE office location.

These wells were considered developed when three consecutive readings of pH, temperature and conductivity were achieved. The development and sampling of these wells was conducted with a stainless steel bailer since they were to be sampled for VOC analysis.

4.0 Chemical Analysis Results

Samples were collected according to the SAP and sent for analysis to DLZ Laboratories Inc., Michigan (DLZ). DLZ subcontracted analyses to two USACE approved laboratories. Samples for TPH, Total Solids, DRO-GRO and selected Metals analysis were sent to DLZ Laboratories of Columbus, Ohio and samples for VOCs, PCBs and selected Metals analysis were sent to Trimatrix Laboratories of Grand Rapids, Michigan (Trimatrix). Analyses were performed in accordance with USACE/ACE 81-1 procedures, Standard Methods for the Examination of Water and Wastewater, USEPA/600/R-94/024, ASTM D421/422 and USEPA SW846 Methods as specified in the SAP and in accordance with USACE contract No. DACW35-98-D-007.

Analytical Results are presented in tables 2-14 and the laboratory QA/QC reports including case narratives are presented in Appendix C.

Soil analytical data are presented and compared where applicable to published State of Wisconsin Soil Cleanup Standards (SCS), Wisconsin Administrative Code, Chapter NR720 and/or to the USEPAs Generic Soil Screening Levels (SSL).

Comparisons of the soil analytical data to SCSs are interpreted in light of the following considerations:

1) Subsection 2 (d) of NR720.07 states that in cases where the cleanup standard is below the limit of detection that the soil cleanup standard shall not be considered to have been exceeded where the contaminant was below detection provided that appropriate analytical methods have been used.

2) Subsection 5 (b) of NR720.09 states that where the background value for a contaminant in soil is greater than the Residual contaminant level published in Table 2 of NR720.09 then the background value may be used as the cleanup criteria provided that it is determined in an appropriate manner.

3) The cleanup criteria published in Table 2 of NR720.09 are based on the protection of human health from the ingestion of soil or inhalation of particulate matter.

4) USEPA SSLs are designed for the evaluation of sites on the National Priorities List (NPL) with anticipated residential land use scenarios. Further, SSLs are not national cleanup standards. Where concentrations do no exceed SSLs at an NPL site no further action is warranted under CERCLA (except where states have more stringent SSL) and that where concentrations equal or exceed the SSLs at an NPL site, further study or investigation, but not necessarily cleanup, is warranted.

5) There are no published SCS or SSL values for copper, iron or manganese, which are generally of low toxicity and naturally occurring in most soils. For comparative purposes copper and manganese values were compared to USEPA values for trace element contents of natural soils (TEC), published in SW-874. Iron is a ubiquitous naturally occurring compound of low toxicity and generally of high natural background in soils. In addition, the red clays typical of the Fox River valley would be particularly expected to contain a significant background iron concentration.

6) There are a few VOC compounds in the analyte list, which do not have published SCS or SSL values. No other screening levels were applied since none of these compounds were detected in any samples.

Groundwater analytical data is compared to published State of Wisconsin Groundwater Quality Standards (GQS), Wisconsin Administrative Code, Chapter NR140 where applicable.

Comparisons of the groundwater analytical data to GQSs are interpreted in light of the following considerations:

1) Subsection 3 (a) of NR140 indicates that if the Preventive Action Limit (PAL) or Enforcement Standard (EFS) is less than or equal to the limit of quantitation and a substance is not detected then the regulatory agency may not consider the PAL or ES to be attained or exceeded.

2) There are a few VOC compounds in the analyte list, which do not have published SCS or SSL values. No other screening levels were applied since none of these compounds were detected in any samples.

The SAP for this Phase II assessment was designed for screening purposes only and not for the accomplishment of a remedial action. The extremely conservative cleanup criteria described above are applied for evaluating the presence or absence of contamination for the purposes of recommending areas for further study where necessary. Additionally, the planned immediate future use is also considered. The continued or restored operation of the lock and dam facilities found on the properties of concern would not present a significant risk of ingestion of soil or inhalation of particulate matter at the rates used to calculate the values published in Table 2 of NR720.

4.1 Analytical Data Quality Assurance

All analytical data has been certified by the DLZ and Trimatrix QA/QC managers to meet the data quality requirements of the USACE contract and the specified methods. Laboratory QA/QC certifications and reports are presented in Appendix C.

DLZ reported no QA/QC concerns with any analytical results and although Trimatrix reported a few anomalies, the compounds in question were not detected or were naturally occurring substances detected at levels well below applicable screening levels.

Although the SAP did not require field duplicates, trip or equipment blanks, one equipment blank and one methanol trip blank were collected and analyzed in conjunction with the VOC analyses.

4.2 Soil Analytical Results

4.2.1 De Pere Soil Results

Three soil samples were collected for VOC analysis from the De Pere site. Results of the VOC analyses are presented in Table 2.

None of the VOC analytes were detected in these samples.

4.2.2 Little Kaukauna Soil Results

Three soil samples were collected from Little Kaukauna for analysis of metals and PCBs. These results are presented in Table 3 for metals and Table 4 for PCBs.

Of the metals included for analysis, all levels of metals were generally low or not detected. Except for arsenic, no other metals were detected above SCS, SSL.

Arsenic concentrations at Little Kaukauna varied between 2.3 and 2.6 mg/Kg exceeding the SCS level of 1.6 but not the SSL value of 29 mg/Kg. The average value of arsenic detected from these samples was 2.27 mg/Kg, and the 95% upper confidence value for the mean was calculated to be 2.62 mg/Kg.

No PCB compounds were detected in these samples.

4.2.3 Kaukauna Soil Results

Seventeen soil samples were collected from Little Kaukauna for analysis of metals and PCBs. These results are presented in Tables 5 and 6 for metals and Table 7 for PCBs.

Of the metals included for analysis, all levels of metals were generally low or not detected. Other than arsenic, no other metals were detected above SCS or SSL values.

Arsenic concentrations at Kaukauna varied between 2.6 and 7.9 mg/Kg exceeding the SCS level of 1.6 mg/Kg but not the SSL value of 29 mg/Kg. The average value of arsenic detected from these samples was 3.99 mg/Kg, and the 95% upper confidence value for the mean was calculated to be 4.88 mg/Kg.

No PCB compounds were detected in these samples.

4.2.4 Little Chute Soil Results

Seven soil samples were collected from Little Chute for analysis of metals and PCBs. These results are presented in Table 8 for metals and Table 9 for PCBs. One soil sample was collected for analysis of DRO-GRO. These results are presented in Table 10.

Of the metals included for analysis, all levels of metals were generally low or not detected. Other than arsenic, no other metals were detected above SCS or SSL values.

Arsenic concentrations at Little Chute varied between 0.4 and 3.9 mg/Kg exceeding the SCS level of 1.6 mg/Kg but not the SSL value of 29 mg/Kg. The average value of arsenic detected from these samples was 2.3 mg/Kg, and the 95% upper confidence value for the mean was calculated to be 3.25 mg/Kg.

No PCB compounds were detected in these samples.

No DRO or GRO were detected in this sample.

4.2.5 Appleton Soil Results

Eight soil samples were collected from Appleton for analysis of metals and PCBs (APa-1-01 through APa-5-01 and APc2-1-10 through APc2-3-01). These results are presented in Table 11 for metals and Table 12 for PCBs. Five samples were collected for analysis of DRO-GRO (APc3-1-01 through APc3-3-01 and APc4-1-01 and APc4-2-01). These results are presented in Table 10. Six soil samples were collected for analysis of VOCs (APc5-1-01

through APc5-3-01 and APc1-1-01 through APc1-3-01). These results are presented in Table 2. Sample locations are illustrated on Figure 6.

Of the metals included for analysis, all levels of metals were generally low or not detected. Other than arsenic, no other metals were detected above SCS or SSL values.

Arsenic concentrations at Appleton varied between 2.6 and 4.1 mg/Kg exceeding the SCS level of 1.6 mg/Kg but not the SSL value of 29 mg/Kg. The average value of arsenic detected from these samples was 3.63 mg/Kg, and the 95% upper confidence value for the mean was calculated to be 4.51 mg/Kg.

No PCB compounds were detected in these samples.

DRO was detected in all five samples, varying in concentration from 12 to 570 mg/Kg, which indicates the soils at this property have been impacted by petroleum.
Of the five samples, two at 570 mg/Kg and 240 mg/Kg exceed the SSC value (APc3-1-01 and APc3-2-01).

No GROs were detected in these samples.

No VOCs were detected in five of the six samples from Appleton. The compounds benzene, ethylbenzene and toluene were detected in one of the six samples. None of the detected analytes exceeded the SSL values.

The average value of DRO detected from these samples was 174 mg/Kg, and the 95% upper confidence value for the mean was calculated to be 473.39 mg/Kg. While these values exceed the SSC, the data is not sufficient to adequately determine if the DRO in soil poses a significant risk to human health or the environment. DRO analysis groups numerous compounds that have varying levels of toxicity. The detection of VOCs; benzene, ethylbenzene and toluene indicate site soils have likely been impacted by petroleum, but the values are very low. Semi-Volatile Organic Compounds (SVOCs) are components of petroleum fuels that are more persistent in the environment, and it is likely that the DRO concentrations reflect the presence of SVOCs.

4.2.6 Menasha Soil Results

Three soil samples were collected from Menasha for analysis of metals and PCBs. These results are presented in Table 13 for metals and Table 14 for PCBs.

Of the metals included for analysis, all levels of metals were generally low or not detected. Other than arsenic, no other metals were detected above SCS or SSL values.

Arsenic concentrations at Menasha varied between 2.5 and 5.0 mg/Kg exceeding the SCS level of 1.6 but not the SSL value of 29 mg/Kg. The average value of arsenic detected from these samples was 3.87 mg/Kg, and the 95% upper confidence value for the mean was calculated to be 7.01 mg/Kg.

No PCB compounds were detected in these samples.

4.3 Groundwater Analytical Results

4.3.1 De Pere Groundwater Results

One groundwater sample was collected from De Pere for analysis of VOCs. These results are presented in Table 15.

Only one VOC, toluene was detected in this sample at a concentration of 2.2 µg/L. This value does not exceed the PAL or EFS for toluene.

4.3.2 Little Kaukauna Groundwater Results

One groundwater sample was collected from Little Kaukauna for analysis of VOCs. These results are presented in Table 15. None of the VOC analytes were detected in this sample.

4.3.3 Kaukauna Groundwater Results

Two groundwater sample was collected from Kaukauna for analysis of VOCs. These results are presented in Table 15.

Two VOCs, ethylbenzene at concentrations of 5.4 µg/L and 1.4 lµg/L and toluene at concentrations of 5.9 µg/L and 27 µg/L were detected in this sample. These values do not exceed the PAL or EFS for toluene or ethylbenzene.

4.3.4 Little Chute Groundwater Results

One groundwater sample was collected from Little Chute for analysis of VOCs. These results are presented in Table 15. Two samples were collected for TPH analysis. These results are presented in Table 16.

Only one VOC, toluene, was detected in this sample at a concentration of 1.3 µg/L. This value does not approach or exceed the PAL or EFS for toluene.

TPHs were not detected in either sample.

4.3.5 Appleton Groundwater Results

Three groundwater samples were collected from Appleton for analysis of VOCs. These results are presented in Table 15.

No VOCs were detected in these samples.

4.3.6 Menasha Groundwater Results

No groundwater samples were collected at Menasha.

4.3.7 QA/QC Samples

One equipment blank and one methanol blank were submitted for VOC analysis. No VOCs were detected in these samples.

5.0 Discussion

Groundwater and soil samples from six properties associated with USACE lock and dam structures were collected and analyzed for the presence of potential contaminants. The sampling and analysis were accomplished according to a Sampling and Analysis Plan provided by USACE. The purpose of the study was to screen soil and groundwater in the specified area in order to eliminate or confirm the need for further study at each of these properties before they are transferred to the State of Wisconsin. Comparison with conservative screening criteria indicates that there are only two issues, arsenic in soil, and confirmed DRO contamination in Appleton, which need to be evaluated further. These two issues and the dredged material disposal sites are discussed separately below.

5.1 Arsenic in Soil

Arsenic values range between 0.4 and 7.9 mg/Kg and in almost every case exceed the Wisconsin industrial residual contaminant level of 1.6 mg/Kg. These values however, do not exceed the USEPA SSL level for protection of groundwater of 29 mg/Kg (20 DAF). As it seems remote that ingestion or inhalation of soils will take place based on the current and presently planned future use of these properties it is suggested that the USEPA SSL groundwater is a sufficiently conservative and appropriate value to evaluate these analytical results. In addition, USEPA published values for the "Trace Chemical Element Content of Natural Soils" (SW-874) indicates that the common range of concentrations of arsenic in soil is from 1 to 50 mg/Kg, with an average value of 5 mg/Kg. The arsenic values encountered in these soils fit this range and suggest that these values are a result of naturally occurring background values. In some cases the State of Wisconsin may require sampling and analysis to establish local background values.

5.2 DRO Contamination in Appleton

The site of this diesel contamination in soil is a parking surface, which is located near the site of a former toy factory (see locations APc3-1-01 through APc3-3-01 on Figure 6 and data in table 10). The data indicate diesel contamination above SCSs, which increases in concentration toward the eastern end of the parking lot. Current information is insufficient to properly describe the nature, source and extent of the contamination. It is recommended that a remedial investigation, including further sampling and analysis be conducted in order to delineate the contamination and develop a corrective action plan.

5.3 Dredged Material Disposal Sites

Sampling from dredged material disposal sites was conducted at the Little Kaukauna, Kaukauna, Little Chute, Appleton and Menasha sites. The specific sites are identified in section 2 and illustrated in Figures 3 through 7. Soil borings were advanced to a depth of ten

feet or refusal and composite samples collected from the entire length of the core. In each case the samples of dredged material were analyzed for metals and PCBs. There were no PCBs detected in any sample and metals were either below levels of concern or were not detected. The investigation of dredged material placement sites indicates that these sites are not areas of concern.

5.4 Suitability to Transfer

While the sampling and analysis results indicate that there is some evidence of potential contamination of site soils by petroleum at the Appleton property, there appear to be no major contamination issues at any of the six properties investigated. Specifically, there is no indication of wide spread disposal or release of hazardous and toxic substances on any of the six subject properties. The range and distribution of arsenic concentrations found strongly suggest that arsenic is naturally occurring at the levels found at all six properties.

The results of the Phase II sampling and analyses strongly support a FOST for all of the properties except the Appleton property. While it appears highly unlikely that the DRO found at the Appleton property poses a substantial risk to either human health or the environment for the intended future land use, it does indicate that potentially hazardous and toxic substances have been released to the environment at or up gradient of the property.

6.0 Conclusions and Recommendations

- There is confirmed diesel contamination in the area of the former toy factory in Appleton, Wisconsin. A remedial investigation is recommended in order to develop a corrective action plan. In particular, SVOC analyses would facilitate delineation of specific compounds in the diesel range and direct comparison or evaluation of risks to human health or the environment based on the toxicity of the actual compounds identified.

- A FOST is strongly supported by the findings of the Phase II assessment for all properties with the exception of the area of diesel contamination located in Appleton, Wisconsin.

TABLES

LIST OF TABLES

Table 1. Summary of Sample Locations, Matrics and Analytical Parameters 1
Table 2. Summary of Soil VOC Results, De Pere and Appleton 4
Table 3. Summary of Soil Metals Results, Little Kaukauna..... 5
Table 4. Summary of Soil PCB Results, Little Kaukauna..... 6
Table 5. Summary of Soil Metals Results, Kaukauna 7
Table 6. Summary of Soil Metals Results Continued, Kaukauna..... 8
Table 7. Summary of Soil PCB Results, Kaukauna..... 9
Table 8. Summary of Soil Metals Results, Little Chute 10
Table 9. Summary of Soil PCB Results, Little Chute..... 11
Table 10. Summary of Soil DRO-GRO Results, Appleton and Little Chute 12
Table 11. Summary of Soil Metals Results, Appleton..... 13
Table 12. Summary of Soil PCB Results, Appleton..... 14
Table 13. Summary of Soils Metals Results, Menasha 15
Table 14. Summary of Soil PCB Results, Menasha 16
Table 15. Summary of Groundwater VOC Results 17
Table 16. Summary of Groundwater TPH Results 18

Table 1.
Summary of Sample Locations, Matrices and Analytical Parameters

Sample Description			Matrix		Parameters					
Property Location	Subsite	Sample No.	Soil	Water	VOCs - Soil	VOCs - Water	MI Metals - Soil	PCBs - Soil	DRO-GRO - Soil	TPH - Water
1 - De Pere	a	DPa-1-01		1		1				
		DPa-2-01		DRY		NO SAMPLE				
	b	DPb-1-01	1		1					
		DPb-2-01	1		1					
		DPb-2-01	1		1					
Totals			**3**	**1**	**3**	**1**	**0**	**0**	**0**	**0**
2 -Little Kaukauna	a	LKa-1-01	1				1	1		
		LKa-2-01	1				1	1		
		LKa-3-01	1				1	1		
	c	LKc-1-01		DRY		NO SAMPLE				
		LKc-2-01		DRY		NO SAMPLE				
		LKc-3-01		1		NO SAMPLE				
Totals			**3**	**1**	**0**	**0**	**3**	**3**	**0**	**0**
3 - Kaukauna	a	Ka-1-01	1				1	1		
		Ka-2-01	1				1	1		
		Ka-3-01	1				1	1		
	c1	Kc-1-01		1		1				
		Kc-2-01		1		1				
		Kc-3-01		DRY		NO SAMPLE				
	c2	Kc-4-01	/				/			
		Kc-5-01	/				/			
		Kc-6-01	/				/			
	d	Kd-1-01*	1				1	1		
		Kd-2-01*	1				1	1		
		Kd-3-01*	1				1	1		

Table 1.
Summary of Sample Locations, Matrices and Analytical Parameters

3 - Kaukauna	e	Ke-1-01	/				/			
Continued		Ke-2-01	/				/			
		Ke-3-01	/				/			
		Ke-4-01	/				/			
		Ke-5-01	/				/			
		Ke-6-01	/				/			
		Ke-7-01	/				/			
		Ke-8-01	/				/			
Totals			**17**	**2**	**0**	**2**	**17**	**6**	**0**	**0**
4 - Little Chute	a	LCa-1-01	1				1	1		
		LCa-2-01	1				1	1		
		LCa-3-01	1				1	1		
	c	LCc-1-01		1						1
		LCc-2-01		1						1
	d	LCd-1-01	1				1	1		
		LCd-2-01	1				1	1		
		LCd-3-01	1				1	1		
		LCd-4-01	1				1	1		
	e	LCe-1-01	1	1		1			1	
		LCe-2-01		DELETED		DELETED				
		LCe-3-01		DELETED		DELETED				
		LCe-4-01		DELETED		DELETED				
Totals			**8**	**3**	**0**	**1**	**7**	**7**	**1**	**2**
5 - Appleton	a	APa-1-01	1				1	1		
		APa-2-01	1				1	1		
		APa-3-01	1				1	1		

Table 1.
Summary of Sample Locations, Matrices and Analytical Parameters

5 - Appleton		APa-4-01	1				1	1		
Contined		APa-5-01	1				1	1		
	c1	APc1-1-01	1	1	1	1				
		APc1-2-01	1	1	1	1				
		APc1-3-01	1	1	1	1				
	c2	APc2-1-01	/				/			
		APc2-2-01	/				/			
		APc2-3-01	/				/			
	c3	APc3-1-01	/						/	
		APc3-2-01	/						/	
		APc3-3-01	/						/	
	c4	APc4-1-01	/						/	
		APc4-2-01	/						/	
	c5	APc5-1-01	1		1			1		
		APc5-2-01	1		1			1		
		APc5-2-01	1		1			1		
	e	APe-1-01	DELETED		DELETED					
		APe-2-01	DELETED		DELETED					
Totals			**19**	**3**	**6**	**3**	**8**	**8**	**5**	**0**
6 - Menasha	a	M-1-01	1				1	1		
		M-2-01	1				1	1		
		M-3-01	1				1	1		
Totals			**3**	**0**	**0**	**0**	**3**	**3**	**0**	**0**
Accumulated Totals			**53**	**10**	**9**	**7**	**38**	**27**	**6**	**2**

Table 2.
Summary of Soil VOC Results
De Pere and Appleton, Fox River, Wisconsin

		Sample Number									Screening Level
Cas No.	Volatile Organic Compound (µg/Kg)	DPb-1-01	DPb-2-01	DPb-3-01	APc5-1-01	APc5-3-01	APc5-2-01	APc1-1-01	APc1-2-01	APc1-3-01	SSL (20 DAF)
107-02-8	**Acrolein**	<58	<69	<63	<69	<82	<60	<79	<75	<82	NR
107-13-1	**Acrylonitrile**	<58	<69	<63	<69	<82	<60	<79	<75	<82	NR
71-43-2	**Benzene**	<58	<69	<63	180	<82	<60	<79	<75	<82	300
75-25-2	**Bromoform**	<58	<69	<63	<69	<82	<60	<79	<75	<82	800
75-27-4	**Dichlorobromomethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	400
74-83-9	**Bromomethane**	<290	<340	<310	<340	<82	<60	<79	<75	<82	200
56-23-5	**Carbon tetrachloride**	<58	<69	<63	<69	<82	<60	<79	<75	<82	70
108-90-7	**Chlorobenzene**	<58	<69	<63	<69	<82	<60	<79	<75	<82	1,000
75-00-3	**Chloroethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	NR
NR	**2-Chloroethyl Vinyl Ether**	<580	<690	<630	<690	<820	<600	<790	<750	<820	NR
67-66-3	**Chloroform**	<58	<69	<63	<69	<82	<60	<79	<75	<82	600
74-87-3	**Chloromethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	NR
124-48-1	**Chlorodibromomethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	400
75-34-3	**1,1-Dichloroethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	23,000
107-06-2	**1,2-Dichloroethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	20
75-35-4	**1,1-Dichloroethylene**	<58	<69	<63	<69	<82	<60	<79	<75	<82	60
78-87-5	**1,2-Dichloropropane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	30
NR	**cis-1,3-Dichloropropene**	<58	<69	<63	<69	<82	<60	<79	<75	<82	4
NR	**trans-1,3-Dichloropropene**	<58	<69	<63	<69	<82	<60	<79	<75	<82	4
100-41-4	**Ethylbenzene**	<58	<69	<63	280	<82	<60	<79	<75	<82	13,000
75-09-2	**Methylene Chloride**	<58	<69	<130	<69	<82	<60	<79	<75	<82	20
79-34-5	**1,1,2,2-Tetrachloroethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	6
127-18-4	**Tetrachloroethene**	<58	<69	<63	<69	<82	<60	<79	<75	<82	60
108-88-3	**Toluene**	<58	<69	<63	1,000	<82	<60	<79	<75	<82	12,000
NR	**1,2-Dichloroethylene (total)**	<58	<69	<63	<69	<82	<60	<79	<75	<82	400
71-55-6	**1,1,1-Trichloroethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	2,000
79-00-5	**1,1,2-Trichloroethane**	<58	<69	<63	<69	<82	<60	<79	<75	<82	20
79-01-6	**Trichloroethene**	<58	<69	<63	<69	<82	<60	<79	<75	<82	60
75-01-4	**Vinyl Chloride**	<58	<69	<63	<69	<82	<60	<79	<75	<82	10

Results are reported as dry weight values.
Analytical results above the laboratory reporting limits are highlighted.
< = Compound not detected above the laboratory reporting limit.
Concentration listed is the laboratory reporting limit.

SSL = USEPA Soil Screening Level for Groundwater Protection.
DAF = is the Dilution Attenuation Factor.

Table 3.
Summary of Soil Metals Results
Little Kaukauna, Fox River, Wisconsin

	Sample Number			Screening Level			
Metals (mg/Kg)	LKa-1-01	LKa-2-01	LKa-3-01	SCS (Industrial)	SSL (20 DAF)	TEC (range)	TEC (avg)
Total Solids, %	84	76	84				
Total Arsenic	2.3	1.9	2.6	1.6	29	1-50	5
Total Barium	70	66	63	NP	1,600		
Total Cadmium	0.17	0.16	0.21	8	8		
Total Chromium	21	17	16	NP	38		
Total Copper	20	14	16	NP	NP	2-50	30
Total Iron	36,600	18,500	17,600	NP	NP		
Total Lead	7.6	5.4	5.6	500	NP		
Total Manganese	488	440	508	NP	NP	600-6,000	5,000
Total Mercury	<0.10	<0.10	<0.10	NP	2		
Total Nickel	21	16	17	NP	130		
Total Selenium	0.70	0.70	0.83	NP	5		
Total Silver	<0.50	<0.50	<0.50	NP	34		
Total Zinc	38	37	33	NP	12,000		

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.

SCS = Wisconsin Industrial Soil Cleanup Standard.
SSL - USEPA Soil Screening Level
TEC = USEPA Trace elemet content of natural soil
DAF = Dilution and Attenuation Factor
NP = Not published

Table 4.
Summary of Soil PCB Results
Little Kaukauna, Fox River, Wisconsin

	Sample Number			Screening Level
PCBs	LKa-1-01	LKa-2-01	LKa-3-01	SSL
PCB-1016, µg/Kg	<100	<100	<100	1000
PCB-1221, µg/Kg	<100	<100	<100	1000
PCB-1232, µg/Kg	<100	<100	<100	1000
PCB-1242, µg/Kg	<100	<100	<100	1000
PCB-1248, µg/Kg	<100	<100	<100	1000
PCB-1254, µg/Kg	<100	<100	<100	1000
PCB-1260, µg/Kg	<100	<100	<100	1000

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
SSL - USEPA Soil Screening Level

Table 5.
Summary of Soil Metals Results
Kaukauna, Fox River, Wisconsin

	Sample Number									Screening Level			
Metal (mg/Kg)	Ka-1-01	Ka-2-01	Ka-3-01	Kc-4-01	Kc-5-01	Kc-6-01	Kd-1-01	Kd-2-01	Kd-3-01	SCS (Industrial)	SSL (20 DAF)	TEC (range)	TEC (avg)
Total Solids, %	83	75	83	80	78	79	84	89	91				
Total Arsenic	3.5	3.3	3.4	3.8	2.3	4.4	3.6	4.7	7.9	1.6	29	1-50	5
Total Barium	96	73	76	72	89	71	40	40	70	NP	1,600		
Total Cadmium	0.29	0.44	0.29	0.20	0.18	0.27	0.42	0.46	1.5	8	8		
Total Chromium	28	22	26	23	26	19	17	14	13	NP	38		
Total Copper	26	26	25	20	31	24	19	33	96	NP	NP	2-50	30
Total Iron	24,500	18,400	22,900	17,000	17,000	12,000	13,800	16,900	29,800	NP	NP		
Total Lead	17	51	10	21	6.8	42	39	62	291	500	NP		
Total Manganese	584	539	508	380	210	230	421	394	446	NP	NP	600-6,000	5,000
Total Mercury	<0.10	0.21	<0.10	<0.10	<0.10	0.19	0.23	<0.10	1.5	NP	2		
Total Nickel	25	15	25	21	23	12	14	15	18	NP	130		
Total Selenium	0.63	0.68	0.99	0.68	0.47	0.76	0.81	1.1	1.1	NP	5		
Total Silver	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NP	34		
Total Zinc	57	81	46	109	84	80	80	72	153	NP	12,000		

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit; concenration listed is the laboratory reporting limit.

SCS = Wisconsin Industrial Soil Cleanup Standard.
SSL - USEPA Soil Screening Level
TEC = USEPA Trace elemet content of natural soil
DAF = Dilution and Attenuation Factor
NP = Not published

Table 6.
Summary of Soil Metals Results
Kaukauna, Fox River, Wisconsin

	Sample Number									Screening Level		
Metal (mg/Kg)	Ke-1-01	Ke-2-01	Ke-3-01	Ke-4-01	Ke-5-01	Ke-6-01	Ke-7-01	Ke-8-01	Kd-3-01	SSL (20 DAF)	TEC (range)	TEC (avg)
Total Solids, %	78	81	79	75	73	78	80	82	91			
Total Arsenic	2.6	2.7	2.9	3.4	2.8	2.6	2.9	7.1	7.9	29	1-50	5
Total Barium	73	38	72	60	84	110	79	160	70	1,600		
Total Cadmium	0.16	0.085	0.088	0.30	0.12	0.14	0.20	0.11	1.5	8		
Total Chromium	22	14	24	19	23	26	23	24	13	38		
Total Copper	24	15	19	16	26	30	23	22	96	NP	2-50	30
Total Iron	18000	13000	19000	14000	20000	21000	18000	26000	29,800	NP		
Total Lead	14	6.4	10	23	7.9	8.2	8.6	5.7	291	NP		
Total Manganese	340	310	320	250	300	400	460	1100	446	NP	600-6,000	5,000
Total Mercury	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	0.20	<0.10	1.5	2		
Total Nickel	19	13	20	2.2	22	25	21	22	18	130		
Total Selenium	0.50	0.55	0.56	0.99	0.66	0.53	0.62	1.1	1.1	5		
Total Silver	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	34		
Total Zinc	55	43	44	86	53	77	49	46	153	12,000		

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit; concenration listed is the laboratory reporting limit.

SCS = Wisconsin Industrial Soil Cleanup Standard.
SSL - USEPA Soil Screening Level
TEC = USEPA Trace elemet content of natural soil
DAF = Dilution and Attenuation Factor
NP = Not published

Table 7.
Summary of Soil PCB Results
Kaukauna, Fox River, Wisconsin

	Sample Number			Screening Level
PCBs	Ka-1-01	Ka-2-01	Ka-3-01	SSL
PCB-1016, µg/Kg	<100	<100	<100	1000
PCB-1221, µg/Kg	<100	<100	<100	1000
PCB-1232, µg/Kg	<100	<100	<100	1000
PCB-1242, µg/Kg	<100	<100	<100	1000
PCB-1248, µg/Kg	<100	<100	<100	1000
PCB-1254, µg/Kg	<100	<100	<100	1000
PCB-1260, µg/Kg	<100	<100	<100	1000

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
SSL - USEPA Soil Screening Level

Table 8.
Summary of Soil Metals Results
Little Chute, Fox River, Wisconsin

	Sample Number							Screening Level		
Metal (mg/Kg)	LCa-1-01	LCa-2-01	LCa-3-01	LCd-1-01	LCd-2-01	LCd-3-01	LCd-4-01	SSL (20 DAF)	TEC (range)	TEC (avg)
Total Solids, %	84	79	76	76	83	79	68			
Total Arsenic	2.3	3.9	2.7	2.4	2.1	2.3	0.40	29	1-50	5
Total Barium	73	51	97	110	75	77	86	1,600		
Total Cadmium	0.078	0.12	0.10	0.12	0.069	0.085	0.10	8		
Total Chromium	19	14	23	26	21	22	20	38		
Total Copper	21	19	28	33	26	25	26	NP	2-50	30
Total Iron	15000	12000	19000	20000	16000	17000	16000	NP		
Total Lead	5.0	12	5.2	5.4	4.2	5.0	5.3	NP		
Total Manganese	360	340	380	410	300	400	280	NP	600-6,000	5,000
Total Mercury	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	2		
Total Nickel	19	12	24	28	23	24	21	130		
Total Selenium	0.54	0.63	0.47	0.50	0.51	0.58	<0.20	5		
Total Silver	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	34		
Total Zinc	30	47	42	58	31	42	9.1	12,000		

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit; concenration listed is the laboratory reporting limit.

SCS = Wisconsin Industrial Soil Cleanup Standard.
SSL - USEPA Soil Screening Level
TEC = USEPA Trace elemet content of natural soil
DAF = Dilution and Attenuation Factor
NP = Not published

Table 9.
Summary of Soil PCB Results
Little Chute, Fox River, Wisconsin

	Sample Number		Screening Level
PCBs	LCd-3-01	LCd-4-01	SSL
PCB-1016, µg/Kg	<100	<100	1000
PCB-1221, µg/Kg	<100	<100	1000
PCB-1232, µg/Kg	<100	<100	1000
PCB-1242, µg/Kg	<100	<100	1000
PCB-1248, µg/Kg	<100	<100	1000
PCB-1254, µg/Kg	<100	<100	1000
PCB-1260, µg/Kg	<100	<100	1000

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
SSL - USEPA Soil Screening Level

Table 10.
Summary of Soil DRO-GRO Results
Appleton and Little Chute, Fox RIver, Wisconsin

	Sample Numbers						Screening Levels	
DRO-GRO (mg/Kg)	APc3-1-01	APc3-2-01	APc3-3-01	APc4-1-01	APc4-2-01	Lce-1-01	SCS (non-industrial)	SCS (industrial)
Total Solids, %	78	82	85	81	80	74		
Diesel Range Organics	570	240	33	12	17	<10	100	250
Gasoline Range Organics	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	100	250

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.

SCS = Wisconsin Industrial Soil Cleanup Standard.

Table 11.
Summary of Soil Metal Results
Appleton, Fox River, Wisconsin

	Sample Number								Screening Level			
Metal (mg/Kg)	APa-1-01	APa-2-01	APa-3-01	APa-4-01	APa-5-01	APc2-1-01	APc2-2-01	APc2-3-01	SCS (Industrial)	SSL (20 DAF)	TEC (range)	TEC (avg)
Total Solids, %	78	81	85	89	86	79	78	75				
Total Arsenic	2.6	3.2	2.6	5.9	3.4	3.9	3.3	4.1	1.6	29	1-50	5
Total Barium	57	51	35	95	24	30	70	67	NP	1,600		
Total Cadmium	0.10	0.18	0.23	0.075	0.29	0.16	0.11	0.13	8	8		
Total Chromium	16	16	12	7.0	18	6.8	21	16	NP	38		
Total Copper	18	16	33	13	23	14	20	21	NP	NP	2-50	30
Total Iron	14,000	12,000	8,300	7,300	7,000	7,400	18,000	13,000	NP	NP		
Total Lead	9.6	12	58	16	64	28	6.3	23	500	NP		
Total Manganese	320	330	201	250	260	230	280	230	NP	NP	600-6,000	5,000
Total Mercury	<0.10	<0.10	0.23	<0.10	0.33	0.12	<0.10	0.11	NP	2		
Total Nickel	15	13	8.3	1.4	6.9	5.4	18	15	NP	130		
Total Selenium	0.59	0.40	0.45	1.5	0.59	0.72	0.56	0.70	NP	5		
Total Silver	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NP	34		
Total Zinc	55	41	56	51	107	49	62	62	NP	12,000		

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
DAF = Dilution and Attenuation Factor

SSL - USEPA Soil Screening Level
SCS = Wisconsin Industrial Soil Cleanup Standard.
TEC = USEPA Trace elemet content of natural soil
NP = Not published

Table 12.
Summary of Soil PCB Results
Appleton, Fox River, Wisconsin

	Sample Number		Screening Level
PCBs	APa-4-01	Apa-5-01	SSL
PCB-1016, µg/Kg	<100	<100	1000
PCB-1221, µg/Kg	<100	<100	1000
PCB-1232, µg/Kg	<100	<100	1000
PCB-1242, µg/Kg	<100	<100	1000
PCB-1248, µg/Kg	<100	<100	1000
PCB-1254, µg/Kg	<100	<100	1000
PCB-1260, µg/Kg	<100	<100	1000

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
SSL - USEPA Soil Screening Level

Table 13.
Summary of Soil Results
Menasha, Fox River, Wisconsin

	Sample Number			Screening Level		
Metal (mg/Kg)	M-1-01	M-2-01	M-3-01	SSL (20 DAF)	TEC (range)	TEC (avg)
Total Solids, %	73	78	83			
Total Arsenic	4.1	5.0	2.5	29	1-50	5
Total Barium	33	7.6	49	1,600		
Total Cadmium	0.11	<0.07	0.14	8		
Total Chromiu	9.8	3.0	17	38		
Total Copper	14	4.6	18	NP	2-50	30
Total Iron	8800	5000	13000	NP		
Total Lead	24	16	19	NP		
Total Manganes	240	220	290	NP	600-6,000	5,000
Total Mercury	<0.10	<0.10	<0.10	2		
Total Nickel	2.1	2.8	14	130		
Total Selenium	0.62	0.69	0.60	5		
Total Silver	<0.50	<0.50	<0.50	34		
Total Zinc	45	82	48	12,000		

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit; concenration listed is the laboratory reporting limit.

SCS = Wisconsin Industrial Soil Cleanup Standard.
SSL - USEPA Soil Screening Level
TEC = USEPA Trace elemet content of natural soil
DAF = Dilution and Attenuation Factor
NP = Not published

Table 14.
Summary of Soil PCB Results
Menasha, Fox River, Wisconsin

	Sample Number		Screening Level	
PCBs	M-1-01	M-2-01	M-3-01	SSL
PCB-1016, µg/Kg	<100	<100	<100	1000
PCB-1221, µg/Kg	<100	<100	<100	1000
PCB-1232, µg/Kg	<100	<100	<100	1000
PCB-1242, µg/Kg	<100	<100	<100	1000
PCB-1248, µg/Kg	<100	<100	<100	1000
PCB-1254, µg/Kg	<100	<100	<100	1000
PCB-1260, µg/Kg	<100	<100	<100	1000

Results reported as dry weight values for the above samples.
Analytical results exceeding criteria are highlighted.
< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
SSL - USEPA Soil Screening Level

Table 15.
Summary of Groundwater VOC Results
De Pere, Little Kauakuna, Kaukauna, Little Chute and Appleton, Wisconsin

		Sample Number										Screening Levels	
Cas No.	Volatile Oraganic Compounds (ug/L)	DPa-1-01	LKc-3-01	Kc-1-01	Kc-2-02	LCe-1-01	APc-1-1-01	APc-1-2-01	APc-1-3-01	EQUIP BL	METHANOL BLK	EFS	PAL
107-02-8	**Acrolein**	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	NP	NP
107-13-1	**Acrylonitrile**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NP	NP
71-43-2	**Benzene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	0.5
75-25-2	**Bromoform**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.4	0.44
75-27-4	**Dichlorobromomethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.6	0.06
74-83-9	**Bromomethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10	1
56-23-5	**Carbon tetrachloride**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	0.5
108-90-7	**Chlorobenzene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	100	20
75-00-3	**Chloroethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	400	80
110-75-8	**2-Chloroethyl Vinyl Ether**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	NP	NP
67-66-3	**Chloroform**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6	0.6
74-87-3	**Chloromethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3	0.3
124-48-1	**Chlorodibromomethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	60	6
75-34-3	**1,1-Dichloroethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	850	85
107-06-2	**1,2-Dichloroethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	0.5
75-35-4	**1,1-Dichloroethylene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7	0.7
78-87-5	**1,2-Dichloropropane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	0.5
NP	**cis-1,3-Dichloropropene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.2	0.02
NP	**trans-1,3-Dichloropropene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.2	0.02
100-41-4	**Ethylbenzene**	<1.0	<1.0	1.5	5.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	700	140
75-09-2	**Methylene Chloride**	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5	0.5
79-34-5	**1,1,2,2-Tetrachloroethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.2	0.02
127-18-4	**Tetrachloroethene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	70	7
108-88-3	**Toluene**	2.2	<1.0	5.9	27	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	1,000	200
NP	**1,2-Dichloroethylene (total)**	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	70	7
71-55-6	**1,1,1-Trichloroethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	200	40
79-00-5	**1,1,2-Trichloroethane**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	0.5
79-01-6	**Trichloroethene**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	0.5
75-01-4	**Vinyl Chloride**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.2	0.02

Results are reported as dry weight values.
Analytical results above the laboratory reporting limits are highlighted.
< = Compound not detected above the laboratory reporting limit; concentration listed is the laboratory reporting limit.

EFS = Wisconsin Groundwater Quality Enforcement Standard.
PAL = Wisconsin Groundwater Quality Preventive Action Limit.

Table 16.
Summary of Groundwater Total Petroleum Hydrocarbon Results
Little Chute, Fox River, Wisconsin

	Sample Number		Screening Levels	
	LCc-1-01	LCc-2-01	EFS	PAL
Total Petroleum Hydrocarbons, mg/L	<1.0	<1.0	NP	NP

< = Compound not detected above the laboratory reporting limit;
concenration listed is the laboratory reporting limit.
EFS = Wisconsin Groundwater Quality Enforcement Standard.
PAL = Wisconsin Groundwater Quality Preventive Action Limit.

FIGURES

LIST OF FIGURES

Figure 1. Sampling Site Location Map 1
Figure 2. De Pere Sampling Locations 2
Figure 3. Little Kaukauna Sampling Locations 3
Figure 4. Kaukauna Sampling Locations 4
Figure 5. Little Chute Sampling Locations 5
Figure 6. Appleton Sampling Locations 6
Figure 7. Menasha Sampling Locations 7

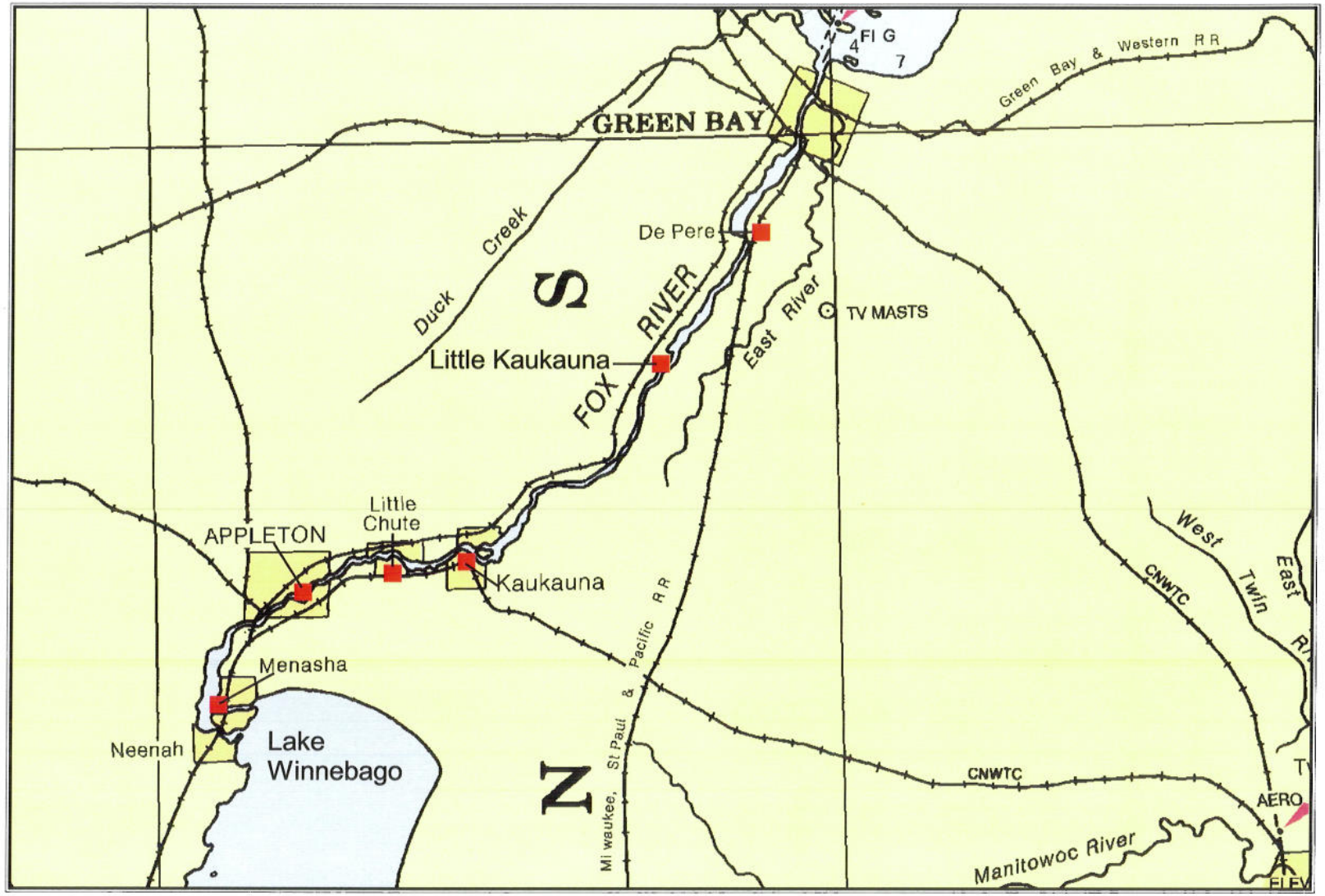

Figure 1.
Sampling Site Locations,
Fox River, Wisconsin

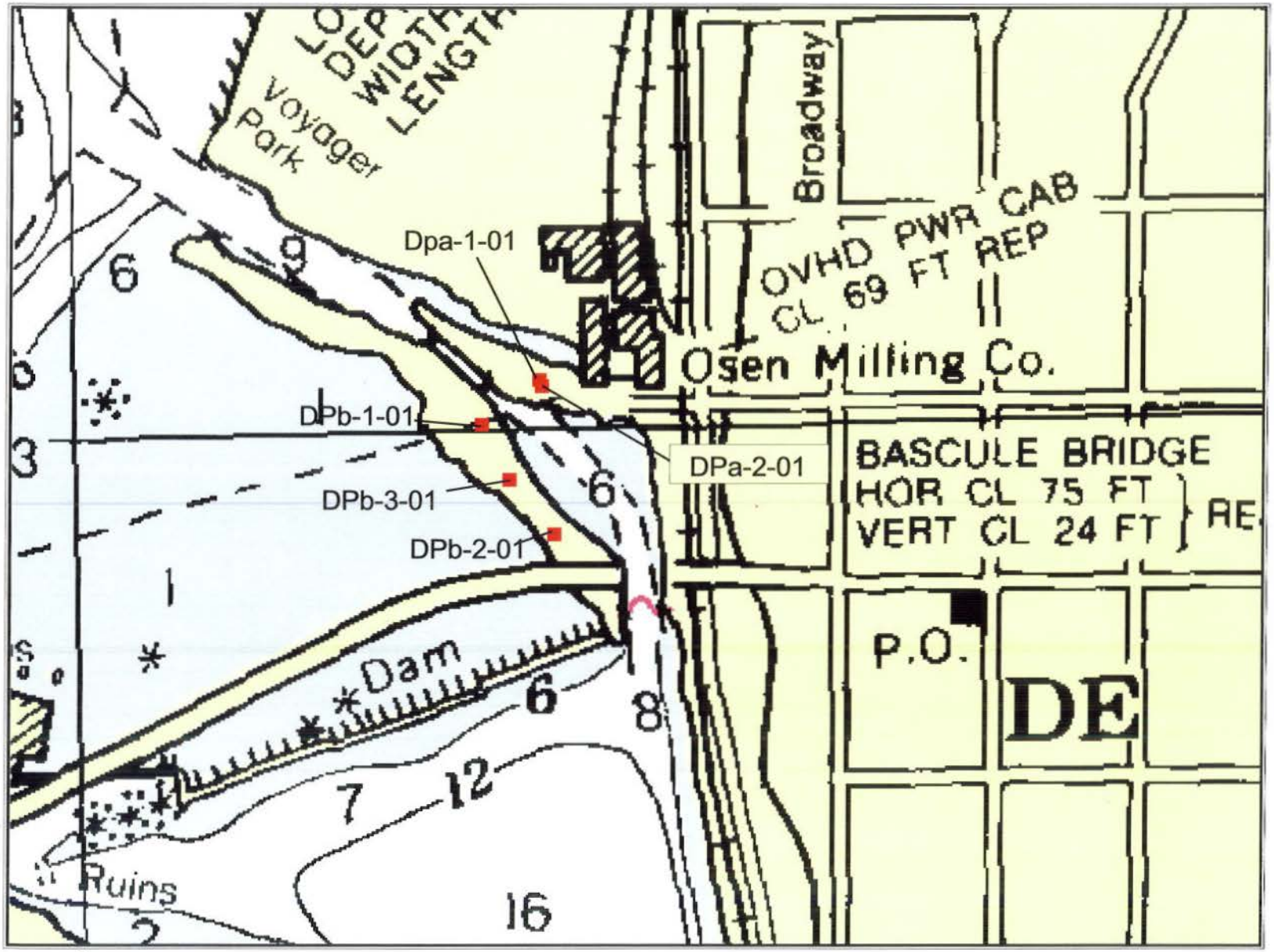

Figure 2.
De Pere Sampling Locations
Fox River, Wisconsin

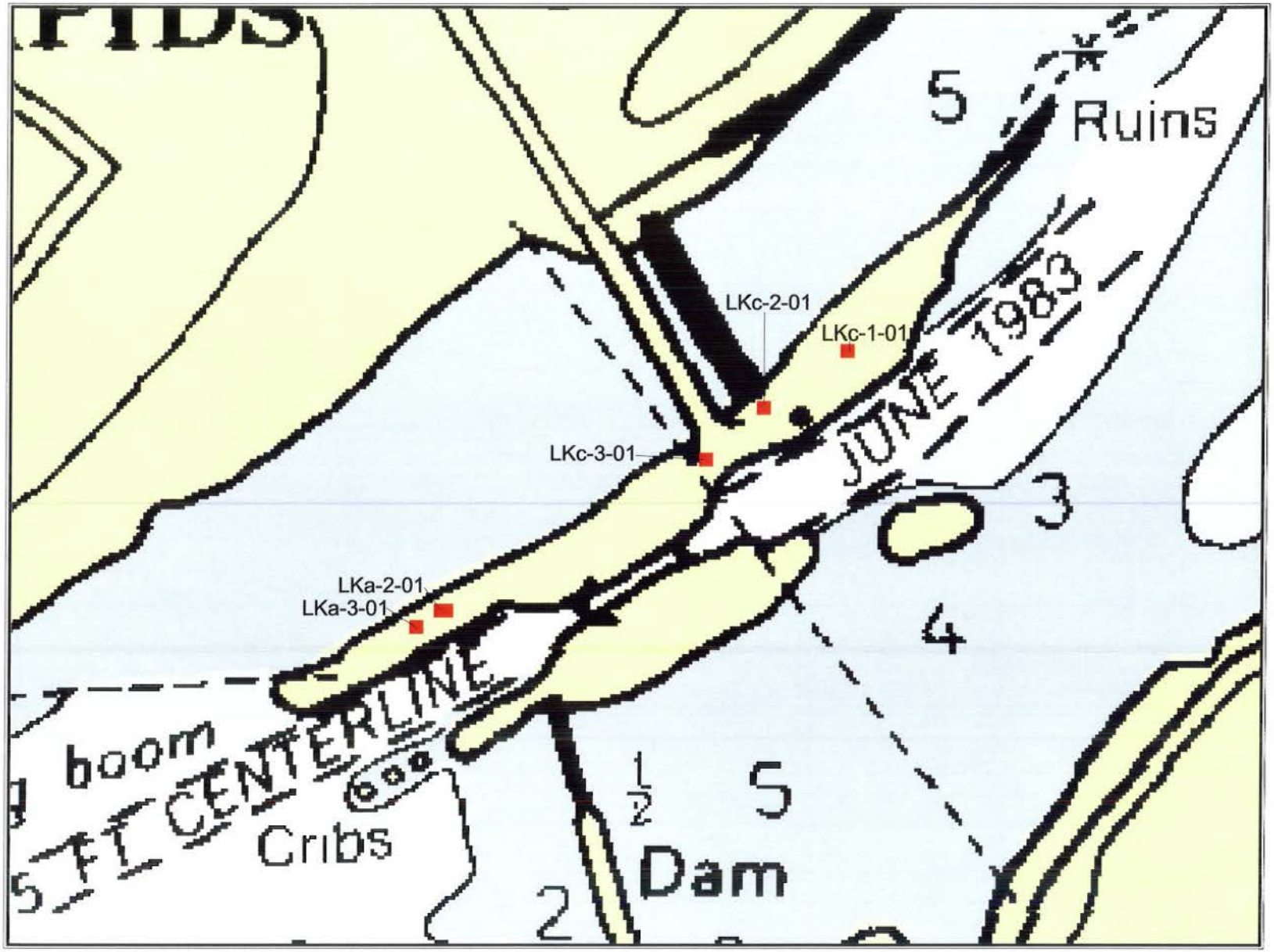

Figure 3.
Little Kaukauna Sampling Locations
Fox River, Wisconsin

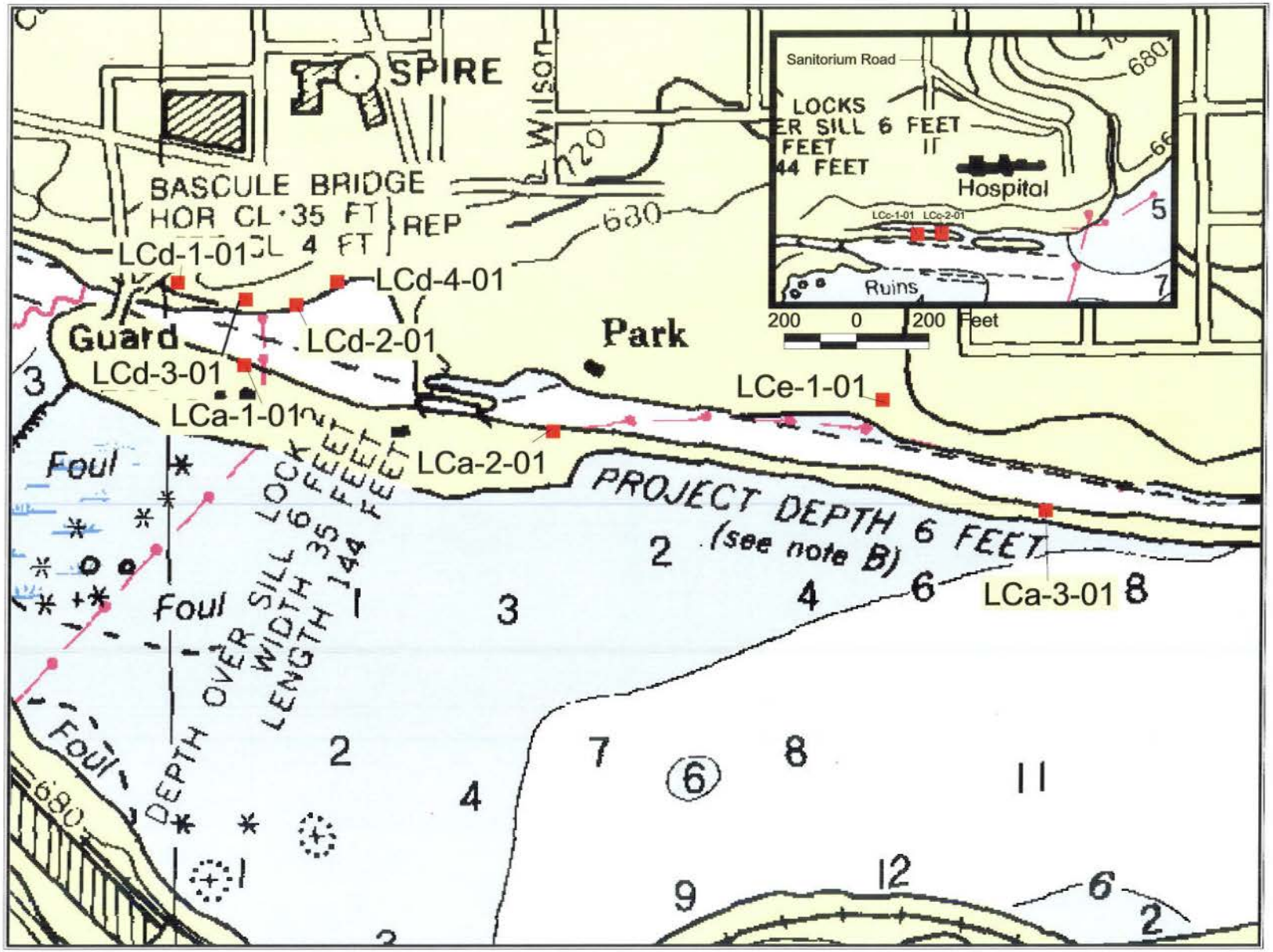

Figure 4.
Little Chute Sampling Locations
Fox River, Wisconsin

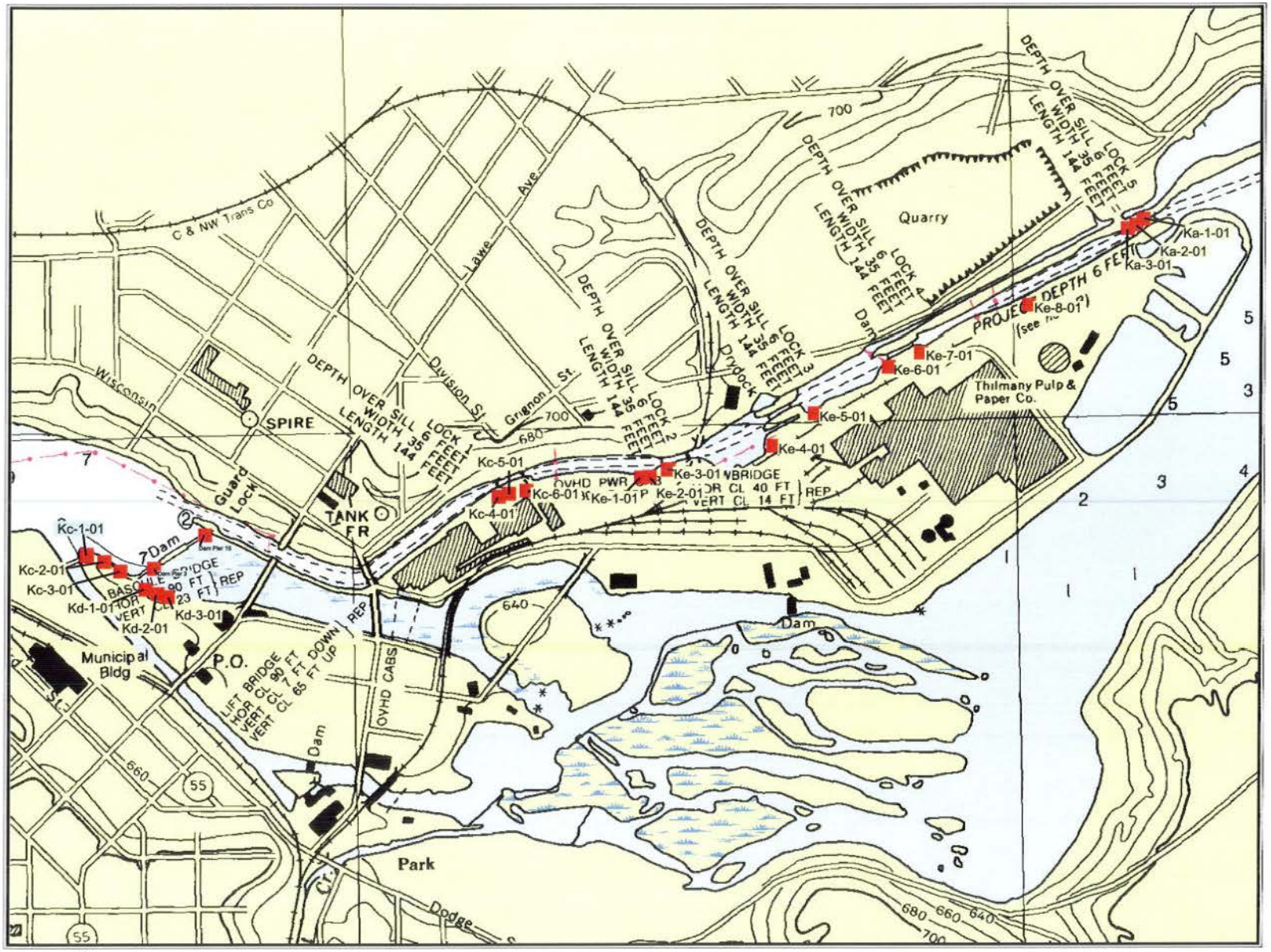

Figure 5.
Kaukauna Sampling Locations
Fox River, Wisconsin

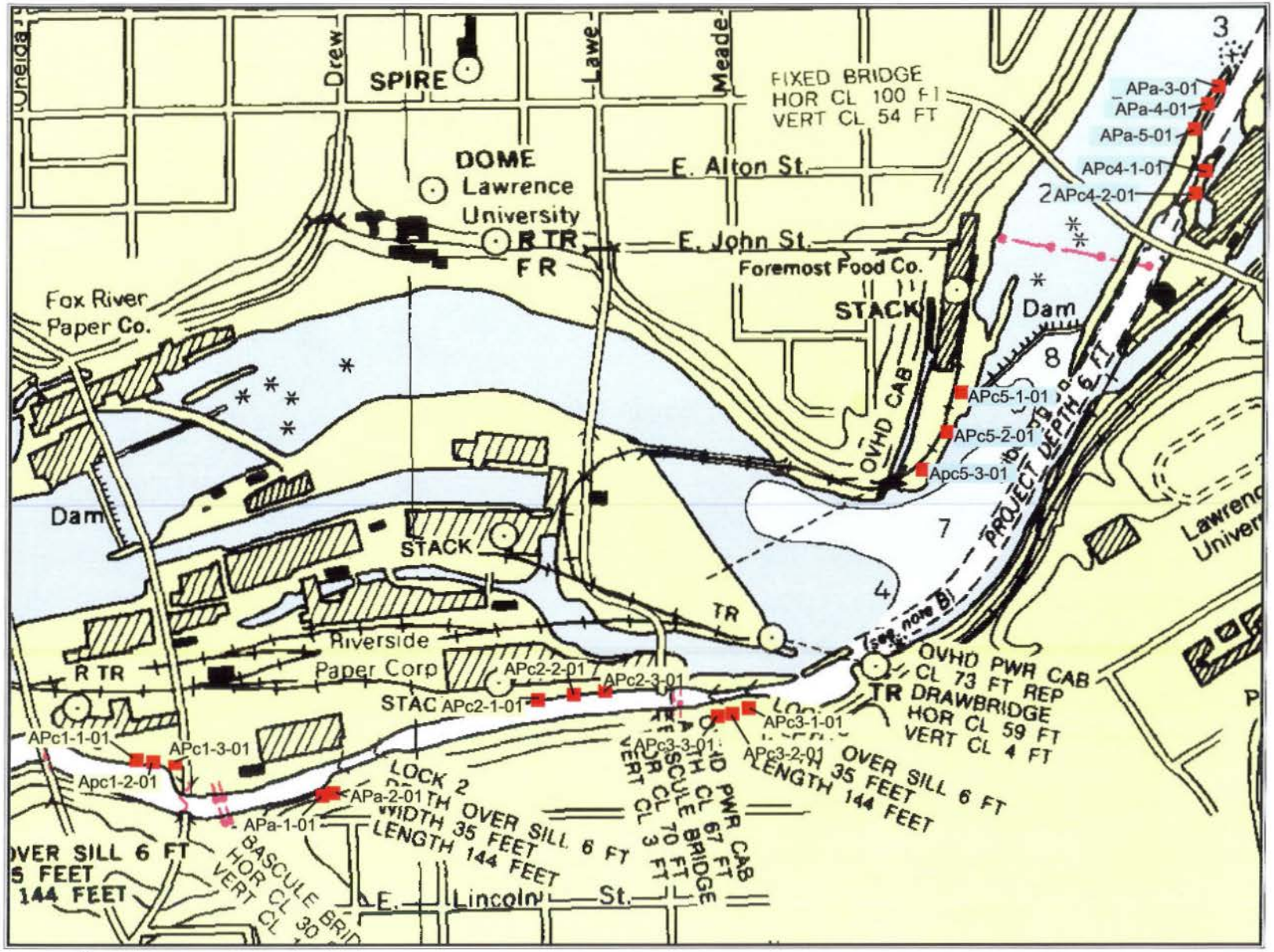

Figure 6.
Appleton Sampling Locations
Fox River, Wisconsin

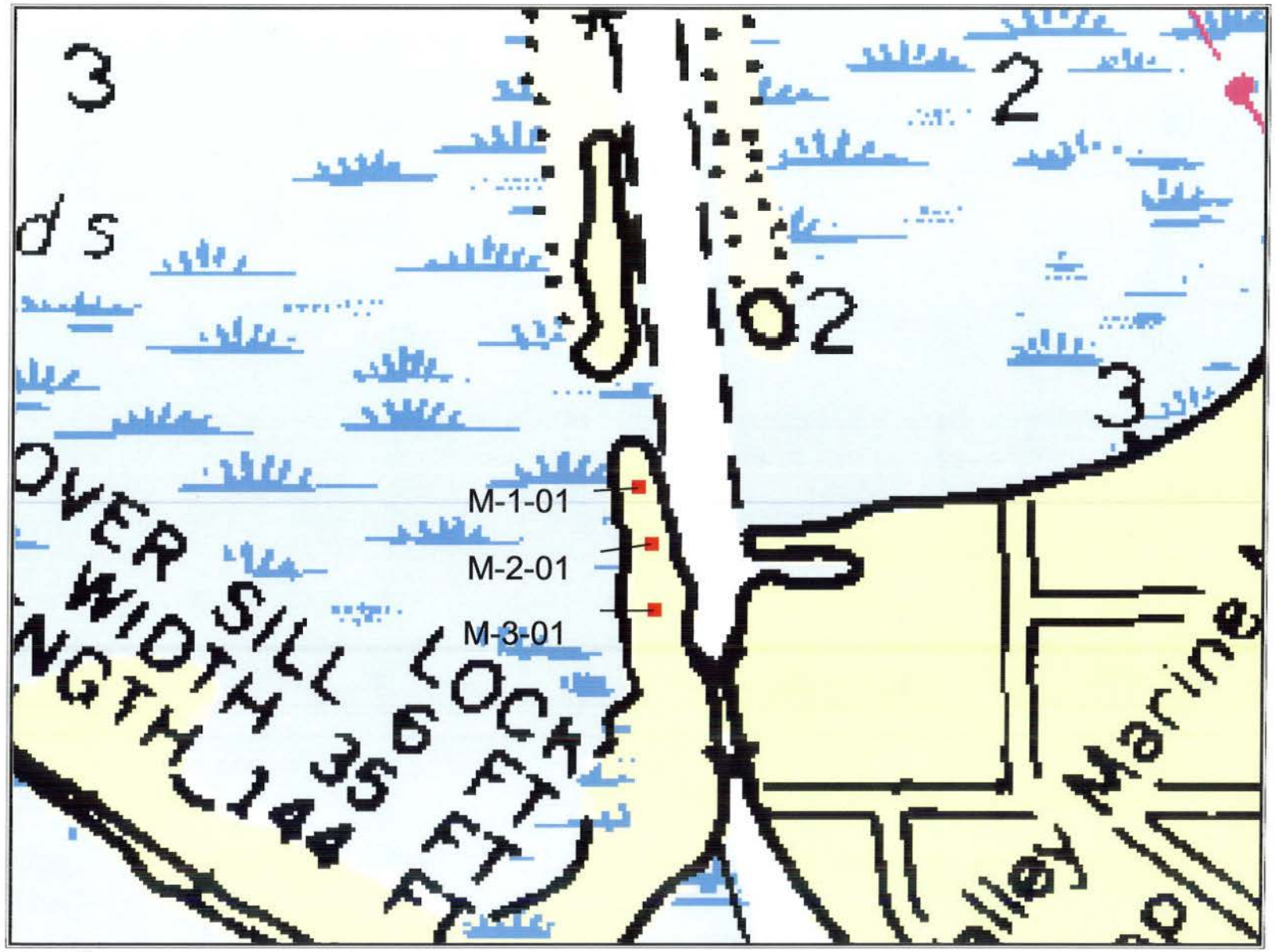

Figure 7.
Menasha Sampling Locations
Fox River, Wisconsin

APPENDIX A - PHOTOGRAPHS

Field Photographs, Phase II Assessment, Fox River, Wisconsin.



Photo #1. Little Chute. Altech Services 6600 Geoprobe.



Photo #2. Kaukauna. Environmental Drilling Services (EDS) 5400 Geoprobe.



Photo #3. Menasha. Geoprobe sampling tubes being emplaced with a pneumatic jackhammer.



Photo #4. Menasha. Pulling sampling tubes from the ground by hand.

Field Photographs, Phase II Assessment, Fox River, Wisconsin.



Photo #5. Appleton. Altech Services setting temporary wells behind Riverside Paper Company.



Photo #6. Kaukauna. Preparing and calibrating groundwater field meters.



Photo #7. Little Chute. Field sampling station.



Photo #8. Little Chute. Water level indicator and peristatic pump being used for groundwater sample collection.

Field Photographs, Phase II Assessment, Fox River, Wisconsin.



Photo #9. Menasha. The lock structure and navigational channel.



Photo #10. Menasha. Hand driving Geoprobe tooling with the electric jackhammer.



Photo #11. Menasha. Soil sample collection.



Photo #12. Menasha. Collection and compositing of soil sample.

GRO ANALYSIS SUMMARY SECTION B

Sample Holding Times

All samples from this set were analyzed within hold time criteria specified in SW846 for 8015 analysis.

System Monitoring Compound Recovery

All system monitoring compounds met established laboratory generated as well as SW846 recommended control limit criteria for Volatile analysis.

Matrix Spike/Matrix Spike Duplicate Recovery

All Matrix Spike, Matrix Spike Duplicate and RPD recovery results met established laboratory generated as well as SW846 recommended control limit criteria for the GRO scan.

Method Blank Summary

No selected volatile compounds were detected at or above the Contract Required Detection Limit (CRDL) in the Method Blanks corresponding to this sample set.

Initial Calibration

A minimum (5) point calibration was performed for each volatile surrogate and the targeted volatile compound mix. Each targeted analyte met SW846 Method 8015 RSD criteria.

Continuing Calibration

The Continuing Calibration Standards analyzed with this sample set all met laboratory generated and SW846 Method 8015 continuing calibration criteria.

Reportable Detection Limit

The Reportable Detection Limit for the selected volatile components met the Contract Required Detection Limits (CRDLs).

DRO ANALYSIS SUMMARY SECTION B

Sample Holding Times

All samples from this set were analyzed within hold time criteria specified in SW846 for 8015 analysis.

System Monitoring Compound Recovery

All system monitoring compounds met established laboratory generated as well as SW846 recommended control limit criteria for DRO analysis.

Matrix Spike/Matrix Spike Duplicate Recovery

All Matrix Spike, Matrix Spike Duplicate and RPD recovery results met established laboratory generated as well as SW846 recommended control limit criteria for the DRO scan.

Method Blank Summary

No selected volatile compounds were detected at or above the Contract Required Detection Limit (CRDL) in the Method Blanks corresponding to this sample set.

Initial Calibration

A minimum (5) point calibration was performed for each semi-volatile surrogate and the targeted DRO compound mix. Each targeted analyte met SW846 Method 8015 RSD criteria.

Continuing Calibration

The Continuing Calibration Standards analyzed with this sample set all met laboratory generated and SW846 Method 8015 continuing calibration criteria.

Reportable Detection Limit

The Reportable Detection Limit for the selected DRO components met the Contract Required Detection Limits (CRDLs).

METALS SUMMARY SECTION C

Selected analysis for Metals was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.

The metals analysis performed by DLZ Laboratories, Inc. QC summaries have all applicable QC limits specified on the forms. The SW846 QC criteria were met for this sample set.

INORGANICS SUMMARY SECTION D

The various inorganic parameters are submitted as a composite QA summary with all applicable QC limits specified on the forms. All SW846 and laboratory QC criteria were met for this sample set.

TRIMATRIX LABORATORY QA CONCERNS

Selected analysis for Metals was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.

There were some problems encountered with Se analysis in that the duplicate injection/aspiration precision was greater than 20% RSD for the following samples: APa-3-01, Kc-5-01, LCd-2-01, M-2-01, and M-1-01. This is traceable to ICP-MS matrix interference of the space charge especially evident with soil digests and regulatory insistence for very low reporting limits for Se. Therefore the results for Se for these samples must be considered as estimated.

The Method Blank for Zinc had a positive value above the project reporting limit. The corresponding sample results for LCd-4-01 is less than five times the result obtained for the Method Blank. Therefore the result for LCd-4-01 must be considered as estimated.

Matrix QC results for total iron are unavailable for sample LKa-1-01 due to high analyte concentration resulting in dilution of the sample to yield a determination of concentration.

Analysis for PPO Volatiles was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.

The matrix spike duplicate (MSD) RPD for this sample fell outside the laboratory established control limits for this method and matrix. The corresponding sample result for APc-1-1-01 must be considered estimated for 1,1-Dichloroethene.

Reporting detection limits were raised for Bromoethane due to contamination of the analytical system caused by trap degradation. The following samples are affected: LKC-3-01, KC-1-01, KC-2-02, DPa-1-01, and the Methanol Blank.

Positive results must be considered estimated and quantitation limits considered approximate for Acrolein and Acrylonitrile. The sample was not preserved at a pH of 4-5 at the time of collection, as specified in SW-846 revision 2, September 1994, Chapter 2, Table 2-33. The following samples are affected: LKC-3-01, KC-1-01, KC-2-02, and DPa-1-01.

Analysis for PCBs was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.
No problems associated with the PCB analysis were reported by Trimatrix Laboratory for these project samples.

The data presented as part of this report meets the minimum quality standards in the referenced analytical methods. Any exceptions have been noted. DLZ Laboratories, Inc and its officers and employees, assume no responsibility and make no warranty, express or implied, for uses or interpretations made by any recipients, intende

[redacted]

Quality Assurance Officer
DLZ Laboratories, Inc.
Michigan Facility

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0146-05	C1B0146-06								
COE ID:	LCc-1-01	LCc-2-01								
Sampling Date:	2/14/01	2/14/01								
Sample Receipt Date:	2/14/01	2/14/01								
Analytical Report Entry Date:										
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Std. Aqueous for:										
Total Petroleum Hydrocarbons, mg/L	<1.0	<1.0								

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271445	271446	271447	271448		272192	272193	272194	272195
COE ID:	LKe-3-01	Ke-1-01	Ke-2-02	DPa-1-01		APe-1-1-01	APe-1-2-01	APe-1-3-01	LCe-1-01
Sampling Date:	2/7/01	2/6/01	2/6/01	2/7/01		2/15/01	2/15/01	2/15/01	2/15/01
Sample Receipt Date:	2/9/01	2/9/01	2/9/01	2/9/01		2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01		3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
VOLATILE ORGANIC COMPOUNDS, µg/L:					VOLATILE ORGANIC COMPOUNDS, µg/L:				
Acrolein	<5.0	<5.0	<5.0	<5.0	Acrolein	<5.0	<5.0	<5.0	<5.0
Acrylonitrile	<1.0	<1.0	<1.0	<1.0	Acrylonitrile	<1.0	<1.0	<1.0	<1.0
Benzene	<1.0	<1.0	<1.0	<1.0	Benzene	<1.0	<1.0	<1.0	<1.0
Bromoform	<1.0	<1.0	<1.0	<1.0	Bromoform	<1.0	<1.0	<1.0	<1.0
Dichlorobromomethane	<1.0	<1.0	<1.0	<1.0	Dichlorobromomethane	<1.0	<1.0	<1.0	<1.0
Bromomethane	<1.0	<1.0	<1.0	<1.0	Bromomethane	<1.0	<1.0	<1.0	<1.0
Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0	Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0
Chlorobenzene	<1.0	<1.0	<1.0	<1.0	Chlorobenzene	<1.0	<1.0	<1.0	<1.0
Chloroethane	<1.0	<1.0	<1.0	<1.0	Chloroethane	<1.0	<1.0	<1.0	<1.0
2-Chloroethyl Vinyl Ether	<10	<10	<10	<10	2-Chloroethyl Vinyl Ether	<10	<10	<10	<10
Chloroform	<1.0	<1.0	<1.0	<1.0	Chloroform	<1.0	<1.0	<1.0	<1.0
Chloromethane	<1.0	<1.0	<1.0	<1.0	Chloromethane	<1.0	<1.0	<1.0	<1.0
Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0	Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethylene	<1.0	<1.0	<1.0	<1.0	1,1-Dichloroethylene	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0
cis-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0	cis-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0
trans-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0	trans-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	<1.0	1.5	5.4	<1.0	Ethylbenzene	<1.0	<1.0	<1.0	<1.0
Methylene Chloride	<5.0	<5.0	<5.0	<5.0	Methylene Chloride	<5.0	<5.0	<5.0	<5.0
1,1,2,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0	1,1,2,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	<1.0	<1.0	<1.0	<1.0	Tetrachloroethene	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	5.9	27	2.2	Toluene	<1.0	<1.0	<1.0	1.3
1,2-Dichloroethylene (total)	<2.0	<2.0	<2.0	<2.0	1,2-Dichloroethylene (total)	<2.0	<2.0	<2.0	<2.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0
Trichloroethene	<1.0	<1.0	<1.0	<1.0	Trichloroethene	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	<1.0	<1.0	<1.0	<1.0	Vinyl Chloride	<1.0	<1.0	<1.0	<1.0

Quality Assurance Original Report Summary

Reported to [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	272196	271452							
COE ID:	EQUIP BLK	METHANOL BLK							
Sampling Date:	2/15/01	2/7/01							
Sample Receipt Date:	2/16/01	2/9/01							
Analytical Report Entry Date:	3/19/01	3/19/01							
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
VOLATILE ORGANIC COMPOUNDS, µg/L:									
Acrolein	<5.0	<5.0							
Acrylonitrile	<1.0	<1.0							
Benzene	<1.0	<1.0							
Bromoform	<1.0	<1.0							
Dichlorobromomethane	<1.0	<1.0							
Bromomethane	<1.0	<1.0							
Carbon tetrachloride	<1.0	<1.0							
Chlorobenzene	<1.0	<1.0							
Chloroethane	<1.0	<1.0							
2-Chloroethyl Vinyl Ether	<10	<10							
Chloroform	<1.0	<1.0							
Chloromethane	<1.0	<1.0							
Chlorodibromomethane	<1.0	<1.0							
1,1-Dichloroethane	<1.0	<1.0							
1,2-Dichloroethane	<1.0	<1.0							
1,1-Dichloroethylene	<1.0	<1.0							
1,2-Dichloropropane	<1.0	<1.0							
cis-1,3-Dichloropropene	<1.0	<1.0							
trans-1,3-Dichloropropene	<1.0	<1.0							
Ethylbenzene	<1.0	<1.0							
Methylene Chloride	<5.0	<5.0							
1,1,2,2-Tetrachloroethane	<1.0	<1.0							
Tetrachloroethene	<1.0	<1.0							
Toluene	<1.0	<1.0							
1,2-Dichloroethylene (total)	<2.0	<2.0							
1,1,1-Trichloroethane	<1.0	<1.0							
1,1,2-Trichloroethane	<1.0	<1.0							
Trichloroethene	<1.0	<1.0							
Vinyl Chloride	<1.0	<1.0							

Quality Assurance Original Report Summary

Reported to [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271486	271487	271488	271489	271490	271491	C1B0164-09	C1B0164-10	C1B0164-11	C1B0167-01
COE ID:	Kd-1-01	Kd-2-01	Kd-3-01	LKa-1-01	LKa-2-01	LKa-3-01	Ka-1-01	Ka-2-01	Ka-3-01	Kc-4-01
Sampling Date:	2/6/01	2/6/01	2/6/01	2/7/01	2/7/01	2/7/01	2/8/01	2/8/01	2/8/01	2/8/01
Sample Receipt Date:	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/9/01	2/9/01	2/9/01	2/9/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Total Solids, %	84	89	91	84	76	84	83	75	83	80
COE METALS KIT:										
Total Arsenic, mg/Kg	3.6	4.7	7.9	2.3	1.9	2.6	3.5	3.3	3.4	3.8
Total Barium, mg/Kg	40	40	70	70	66	63	96	73	76	72
Total Cadmium, mg/Kg	0.42	0.46	1.5	0.17	0.16	0.21	0.29	0.44	0.29	0.20
Total Chromium, mg/Kg	17	14	13	21	17	16	28	22	26	23
Total Copper, mg/Kg	19	33	96	20	14	16	26	26	25	20
Total Iron, mg/Kg	13800	16900	29800	36600	18500	17600	24500	18400	22900	17000
Total Lead, mg/Kg	39	62	291	7.6	5.4	5.6	17	51	10	21
Total Manganese, mg/Kg	421	394	446	488	440	508	584	539	508	380
Total Mercury, mg/Kg	0.23	<0.10	1.5	<0.10	<0.10	<0.10	<0.10	0.21	<0.10	<0.10
Total Nickel, mg/Kg	14	15	18	21	16	17	25	15	25	21
Total Selenium, mg/Kg	0.81	1.1	1.1	0.70	0.70	0.83	0.63	0.68	0.99	0.68
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc, mg/Kg	80	72	153	38	37	33	57	81	46	109

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0167-02	C1B0167-03	C1B0164-01	C1B0164-02	C1B0164-03	C1B0164-04	C1B0164-05	C1B0164-06	C1B0164-07	C1B0164-08
COE ID:	Ke-5-01	Ke-6-01	Ke-1-01	Ke-2-01	Ke-3-01	Ke-4-01	Ke-5-01	Ke-6-01	Ke-7-01	Ke-8-01
Sampling Date:	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01
Sample Receipt Date:	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Total Solids, %	78	79	78	81	79	75	73	78	80	82
COE METALS KIT:										
Total Arsenic, mg/Kg	2.3	4.4	2.6	2.7	2.9	3.4	2.8	2.6	2.9	7.1
Total Barium, mg/Kg	89	71	73	38	72	60	84	110	79	160
Total Cadmium, mg/Kg	0.18	0.27	0.16	0.085	0.088	0.30	0.12	0.14	0.20	0.11
Total Chromium, mg/Kg	26	19	22	14	24	19	23	26	23	24
Total Copper, mg/Kg	31	24	24	15	19	16	26	30	23	22
Total Iron, mg/Kg	17000	12000	18000	13000	19000	14000	20000	21000	18000	26000
Total Lead, mg/Kg	6.8	42	14	6.4	10	23	7.9	8.2	8.6	5.7
Total Manganese, mg/Kg	210	230	340	310	320	250	300	400	460	1100
Total Mercury, mg/Kg	<0.10	0.19	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	0.20	<0.10
Total Nickel, mg/Kg	23	12	19	13	20	2.2	22	25	21	22
Total Selenium, mg/Kg	0.47	0.76	0.50	0.55	0.56	0.99	0.66	0.53	0.62	1.1
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc, mg/Kg	84	80	55	43	44	86	53	77	49	46

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0165-01	C1B0165-02	C1B0165-03	C1B0165-04	C1B0165-05	C1B0165-06	C1B0165-07	C1B0165-08		
COE ID:	LCd-3-01	LCd-4-01	M-1-01	M-2-01	M-3-01	APc2-1-01	APc2-2-01	APc2-3-01		
Sampling Date:	2/12/01	2/12/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/12/01		
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01		
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01		
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**		
Total Solids, %	79	68	73	78	83	79	78	75		
COE METALS KIT:										
Total Arsenic, mg/Kg	2.3	0.40	4.1	5.0	2.5	3.9	3.3	4.1		
Total Barium, mg/Kg	77	86	33	7.6	49	30	70	67		
Total Cadmium, mg/Kg	0.085	0.10	0.11	<0.07	0.14	0.16	0.11	0.13		
Total Chromium, mg/Kg	22	20	9.8	3.0	17	6.8	21	16		
Total Copper, mg/Kg	25	26	14	4.6	18	14	20	21		
Total Iron, mg/Kg	17000	16000	8800	5000	13000	7400	18000	13000		
Total Lead, mg/Kg	5.0	5.3	24	16	19	28	6.3	23		
Total Manganese, mg/Kg	400	280	240	220	290	230	280	230		
Total Mercury, mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	0.12	<0.10	0.11		
Total Nickel, mg/Kg	24	21	2.1	2.8	14	5.4	18	15		
Total Selenium, mg/Kg	0.58	<0.20	0.62	0.69	0.60	0.72	0.56	0.70		
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		
Total Zinc, mg/Kg	42	9.1	45	82	48	49	62	62		

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0163-01	C1B0163-02	C1B0163-03	C1B0163-04	C1B0163-05	C1B0163-06	C1B0163-07	C1B0163-08	C1B0163-09	C1B0163-10
COE ID:	APa-1-01	APa-2-01	APa-3-01	APa-4-01	LCa-2-01	LCa-1-01	LCa-3-01	LCd-1-01	LCd-2-01	APa-5-01
Sampling Date:	2/14/01	2/14/01	2/14/01	2/14/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/14/01
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Total Solids, %	78	81	85	89	79	84	76	76	83	86
COE METALS KIT:										
Total Arsenic, mg/Kg	2.6	3.2	2.6	5.9	3.9	2.3	2.7	2.4	2.1	3.4
Total Barium, mg/Kg	57	51	35	95	51	73	97	110	75	24
Total Cadmium, mg/Kg	0.10	0.18	0.23	0.075	0.12	0.078	0.10	0.12	0.069	0.29
Total Chromium, mg/Kg	16	16	12	7.0	14	19	23	26	21	18
Total Copper, mg/Kg	18	16	33	13	19	21	28	33	26	23
Total Iron, mg/Kg	14000	12000	8300	7300	12000	15000	19000	20000	16000	7000
Total Lead, mg/Kg	9.6	12	58	16	12	5.0	5.2	5.4	4.2	64
Total Manganese, mg/Kg	320	330	201	250	340	360	380	410	300	260
Total Mercury, mg/Kg	<0.10	<0.10	0.23	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.33
Total Nickel, mg/Kg	15	13	8.3	1.4	12	19	24	28	23	6.9
Total Selenium, mg/Kg	0.59	0.40	0.45	1.5	0.63	0.54	0.47	0.50	0.51	0.59
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc, mg/Kg	55	41	56	51	47	30	42	58	31	107

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0148-01	C1B0148-02	C1B0148-03	C1B0148-04	C1B0148-05	C1B0148-06				
COE ID:	APc3-1-01	APc3-2-01	APc3-3-01	APc4-1-01	APc4-2-01	Lce-1-01				
Sampling Date:	2/12/01	2/12/01	2/12/01	2/14/01	2/14/01	2/13/01				
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01				
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01				
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**				
Total Solids, %	78	82	85	81	80	74				
Diesel Range Organics, mg/Kg	570	240	33	12	17	<10				
Gasoline Range Organics, mg/Kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271486	271487	271488	271489	271490	271491	271492	271493	271494	272207
COE ID:	Kd-1-01	Kd-2-01	Kd-3-01	LKa-1-01	LKa-2-01	LKa-3-01	Ka-1-01	Ka-2-01	Ka-3-01	LCd-3-01
Sampling Date:	2/6/01	2/6/01	2/6/01	2/7/01	2/7/01	2/7/01	2/8/01	2/8/01	2/8/01	2/12/01
Sample Receipt Date:	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/9/01	2/9/01	2/9/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
PCB COMPOUNDS:										
PCB-1016, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1221, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1232, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1242, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1248, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1254, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1260, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Lab ID:	272208	272209	272210	272211	272186	272188	272187	272197	272198	272199
COE ID:	LCd-4-01	M-1-01	M-2-01	M-3-01	APc5-1-01	APc5-3-01	APc5-2-01	APa-1-01	APa-2-01	APa-3-01
Sampling Date:	2/12/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/12/01	2/14/01	2/14/01	2/14/01
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
PCB COMPOUNDS:										
PCB-1016, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1221, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1232, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1242, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1248, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1254, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1260, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	272200	272201	272202	272203	272204	272205	272206			
COE ID:	APa-4-01	LCa-2-01	LCa-1-01	LCa-3-01	LCd-1-01	LCd-2-01	APa-5-01			
Sampling Date:	2/14/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/14/01			
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01			
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01			
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
PCB COMPOUNDS:										
PCB-1016, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1221, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1232, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1242, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1248, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1254, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1260, µg/Kg	<100	<100	<100	<100	<100	<100	<100			

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271449	271450	271451			272186	272188	272187	272189
COE ID:	DPb-1-01	DPb-2-01	DPb-3-01			APc5-1-01	APc5-3-01	APc5-2-01	APc1-1-01
Sampling Date:	2/7/01	2/7/01	2/7/01			2/12/01	2/12/01	2/12/01	2/14/01
Sample Receipt Date:	2/9/01	2/9/01	2/9/01			2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01			3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
VOLATILE ORGANIC COMPOUNDS, µg/Kg:					**VOLATILE ORGANIC COMPOUNDS, µg/Kg:**				
Acrolein	<58	<69	<63		**Acrolein**	<69	<82	<60	<79
Acrylonitrile	<58	<69	<63		**Acrylonitrile**	<69	<82	<60	<79
Benzene	<58	<69	<63		**Benzene**	**180**	<82	<60	<79
Bromoform	<58	<69	<63		**Bromoform**	<69	<82	<60	<79
Dichlorobromomethane	<58	<69	<63		**Dichlorobromomethane**	<69	<82	<60	<79
Bromomethane	<290	<340	<310		**Bromomethane**	<340	<82	<60	<79
Carbon tetrachloride	<58	<69	<63		**Carbon tetrachloride**	<69	<82	<60	<79
Chlorobenzene	<58	<69	<63		**Chlorobenzene**	<69	<82	<60	<79
Chloroethane	<58	<69	<63		**Chloroethane**	<69	<82	<60	<79
2-Chloroethyl Vinyl Ether	<580	<690	<630		**2-Chloroethyl Vinyl Ether**	<690	<820	<600	<790
Chloroform	<58	<69	<63		**Chloroform**	<69	<82	<60	<79
Chloromethane	<58	<69	<63		**Chloromethane**	<69	<82	<60	<79
Chlorodibromomethane	<58	<69	<63		**Chlorodibromomethane**	<69	<82	<60	<79
1,1-Dichloroethane	<58	<69	<63		**1,1-Dichloroethane**	<69	<82	<60	<79
1,2-Dichloroethane	<58	<69	<63		**1,2-Dichloroethane**	<69	<82	<60	<79
1,1-Dichloroethylene	<58	<69	<63		**1,1-Dichloroethylene**	<69	<82	<60	<79
1,2-Dichloropropane	<58	<69	<63		**1,2-Dichloropropane**	<69	<82	<60	<79
cis-1,3-Dichloropropene	<58	<69	<63		**cis-1,3-Dichloropropene**	<69	<82	<60	<79
trans-1,3-Dichloropropene	<58	<69	<63		**trans-1,3-Dichloropropene**	<69	<82	<60	<79
Ethylbenzene	<58	<69	<63		**Ethylbenzene**	**280**	<82	<60	<79
Methylene Chloride	<58	<69	<130		**Methylene Chloride**	<69	<82	<60	<79
1,1,2,2-Tetrachloroethane	<58	<69	<63		**1,1,2,2-Tetrachloroethane**	<69	<82	<60	<79
Tetrachloroethene	<58	<69	<63		**Tetrachloroethene**	<69	<82	<60	<79
Toluene	<58	<69	<63		**Toluene**	**1000**	<82	<60	<79
1,2-Dichloroethylene (total)	<58	<69	<63		**1,2-Dichloroethylene (total)**	<69	<82	<60	<79
1,1,1-Trichloroethane	<58	<69	<63		**1,1,1-Trichloroethane**	<69	<82	<60	<79
1,1,2-Trichloroethane	<58	<69	<63		**1,1,2-Trichloroethane**	<69	<82	<60	<79
Trichloroethene	<58	<69	<63		**Trichloroethene**	<69	<82	<60	<79
Vinyl Chloride	<58	<69	<63		**Vinyl Chloride**	<69	<82	<60	<79

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	272190	272191							
COE ID:	APc1-2-01	APc1-3-01							
Sampling Date:	2/14/01	2/14/01							
Sample Receipt Date:	2/16/01	2/16/01							
Analytical Report Entry Date:	3/21/01	3/21/01							
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**					
VOLATILE ORGANIC COMPOUNDS, µg/Kg:									
Acrolein	<75	<82							
Acrylonitrile	<75	<82							
Benzene	<75	<82							
Bromoform	<75	<82							
Dichlorobromomethane	<75	<82							
Bromomethane	<75	<82							
Carbon tetrachloride	<75	<82							
Chlorobenzene	<75	<82							
Chloroethane	<75	<82							
2-Chloroethyl Vinyl Ether	<750	<820							
Chloroform	<75	<82							
Chloromethane	<75	<82							
Chlorodibromomethane	<75	<82							
1,1-Dichloroethane	<75	<82							
1,2-Dichloroethane	<75	<82							
1,1-Dichloroethylene	<75	<82							
1,2-Dichloropropane	<75	<82							
cis-1,3-Dichloropropene	<75	<82							
trans-1,3-Dichloropropene	<75	<82							
Ethylbenzene	<75	<82							
Methylene Chloride	<75	<82							
1,1,2,2-Tetrachloroethane	<75	<82							
Tetrachloroethene	<75	<82							
Toluene	<75	<82							
1,2-Dichloroethylene (total)	<75	<82							
1,1,1-Trichloroethane	<75	<82							
1,1,2-Trichloroethane	<75	<82							
Trichloroethene	<75	<82							
Vinyl Chloride	<75	<82							

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

St. • Lansing, Michigan 48906-5599 6121 Huntley Rd. • Columbus, OH 43229

[redacted]0818

CL DY RECORD

REPORT PAGE	RECO... JMBER
OF	51579

SAMPLED BY E. REDDY

PROJECT NAME/TYPE: FOX RIVER - COE

LOCATION: Kaukauna, Little Kaukauna, WI

REPORT RESULTS TO:

COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.

ADDRESS: 24209 Northwestern Hwy Suite 230

CITY: SOUTHFIELD STATE: MI ZIP: 48075

P.O. #/PROJECT #: FOX RIVER

PHONE NO.: 248-353-3832

FAX NO.: 248-353-5485

INVOICE TO:

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	Michigan Metals Kit	PCBs	DLZ LAB ID
1	Kd-1-01 ✓	Soil	02-06-01	14:15	C				2						X	X	
2	Kd-2-01 ✓	Soil	02-06-01	14:25	C				2						X	X	
3	Kd-3-01 ✓	Soil	02-06-01	14:45	C				2						X	X	
4	LKa-1-01 ✓	Soil	02-07-01	15:50	C				2						X	X	
5	LKa-2-01 ✓	Soil	02-07-01	15:30	C				2						X	X	
6	LKa-3-01 ✓	Soil	02-07-01	14:20	C				2						X	X	
7																	
8	COE. Mich. Metals: As, Ba, Cd, Cr, Cu,																
9	Fe, Pb, Mn, Hg, Ni, Se, Ag, Zn																
10																	

LAB USE ONLY

ACCOUNTING

TRANSFER	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					2-8-01	14:15
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☑ YES ☐ NO

SAMPLES RECEIVED ON ICE ☑ YES ☐ NO COOLER TEMP. THESE ARE COE SAMPLES - NEED QC RUN ON THEM. 451 LIMITS.

SAMPLE INTEGRITY CHECKED ☑ YES ☐ NO

PCBs subbed to TriMatrix; As, Ag, Se, Zn also subbed to trimatris

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

DLZ LABORATORIES, INC.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	REC'D NUMBER
OF	51538

PROJECT NAME/TYPE: FOX RIVER - COE

LOCATION:

REPORT RESULTS TO

NAME: [redacted] EMAIL:

COMPANY: DLZ

ADDRESS: 1423 Keystone

CITY: STATE: ZIP:

SAMPLED BY:

P.O. #/PROJECT #:

PHONE NO.:

FAX NO.:

INVOICE TO

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y / N	PCB's	DLZ LAB ID
1	Ka-1-01 ✓	SL	2-8-01	9:10					1						X	
2	Ka-2-01 ✓	SL	2-8-01	9:40					1						X	
3	Ka-3-01 ✓	SL	2-8-01	10:10					1						X	
4																
5																
6	Please add:															
7	As, Ag, Zn, Se															
8	-2-20-01															
9																
10																

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1						
2						
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	REQUEST NUMBER
OF	51715

[redacted]

REPORT RESULTS TO

COMPANY: DLZ
ADDRESS: 1423 Keystone
CITY: Lansing STATE: MI ZIP: 48911
EMAIL
SAMPLED BY
P.O. #/PROJECT #
PHONE NO.
FAX NO.

PROJECT NAME/TYPE: For River COE
LOCATION

INVOICE TO

NAME
COMPANY
ADDRESS
CITY STATE ZIP

SAME

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y/N	As, Ag, Zn, Se	DLZ LAB ID
1	Ke-1-01 ✓	SL	7-8-01	1145											X	
2	Ke-2-01 ✓			1210												
3	Ke-3-01 ✓			1305												
4	Ke-4-01 ✓			1630												
5	Ke-5-01 ✓			1550												
6	Ke-6-01 ✓			1510												
7	Ke-7-01			1450												
8	Ke-8-01 ✓	↓	↓	1410											↓	
9																
10																

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

3120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	REPORT NUMBER
OF	51589

PROJECT NAME/TYPE: Fox River COE

LOCATION:

[redacted]

REPORT RESULTS TO

COMPANY: DLZ

ADDRESS: 1423 Keystone

CITY: STATE: ZIP:

EMAIL:

SAMPLED BY:

P.O. #/PROJECT #:

PHONE NO.:

FAX NO.:

INVOICE TO

NAME:

COMPANY:

ADDRESS: SAME

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	PCBs	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	Kd-1-01 ✓	SL	2-6-01	1415					1						X	
2	Kd-2-01 ✓	"	2-6-01	1425					1						"	
3	Kd-3-01 ✓	"	2-6-01	1445					1						"	
4	LKa-1-01 ✓	"	2-7-01	1550					1						"	
5	LKa-2-01 ✓	"	2-7-01	1530					1						"	
6	LKa-3-01 ✓	"	2-7-01	1420					1						"	
7																
8	Please add:															
9	As, Ag, Zn, Se															
10	2-20-01															

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1						
2						
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	REPORT NUMBER
OF	51587

REPORT RESULTS

[redacted]
COMPANY DLZ
ADDRESS 1423 Keystone
CITY STATE ZIP
EMAIL
SAMPLED BY
P.O. #/PROJECT #
PHONE NO.
FAX NO.

PROJECT NAME/TYPE: FOX River - COE
LOCATION

INVOICE TO

NAME
COMPANY SAME
ADDRESS
CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	VOC (8260-HRMS)	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	LKc-3-01 ✓	AQ	2-7-01	1439					1	2					X	
2	Kc-1-01 ✓	AQ	2-6-01	1500					1	2					X	
3	Kc-2-02 ✓	AQ	2-6-01	1520					1	2					X	
4	DPa-1-01 ✓	AQ	2-7-01	1240						2					X	
5	DPb-1-01 ✓	SL	2-7-01	1015			1								X	
6	DPb-2-01 ✓	SL	2-7-01	1150			1								X	
7	DPb-3-01 ✓	SL	2-7-01	1115			1								X	
8	Methanol Blank								1						X	
9																
10																

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1						
2						
3						
4						

QA / QC LEVEL: COE
REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CHAIN OF CUSTODY RECORD

REPORT PAGE	R… NUMBER
OF	51713

REPORT RESULTS TO

[redacted]
DLZ
ADDRESS 1123 Keystone Ave
CITY Lansing STATE MI ZIP 48911

EMAIL
SAMPLED BY
P.O. #/PROJECT #
PHONE NO.
FAX NO.

PROJECT NAME/TYPE: Fox River - COE
LOCATION

INVOICE TO

NAME
COMPANY
ADDRESS SAME
CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	As, Ag, Zn, Sb	PCBs	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		
1	Apa-1-01 ✓	SL	2-14-01	1330											X	X	
2	Apa-2-01 ✓			1340													
3	APa-3-01 ✓			0830													
4	APa-4-01 ✓		↓	0845													
5	LCa-2-01 ✓		2-13-01	1100													
6	LCa-1-01 ✓			1300													
7	LCa-3-01 ✓		↓	1330													
8	LCd-1-01 ✓		2-12-01	1045													
9	LCd-2-01 ✓		2-12-01	1035													
10	APa-5-01 ✓	↓	2-14-01	0910											↓	↓	

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51714

[redacted]

REPORT RESULTS

EMAIL | SAMPLED BY | PROJECT NAME/TYPE

P.O. #/PROJECT # | LOCATION

ADDRESS 1423 Keystone Ave | PHONE NO.

CITY Lansing STATE MI ZIP 48911 | FAX NO.

INVOICE TO

NAME

COMPANY

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	DLZ LAB ID
					ENTER # IN THE BOX									ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	LCd-3-01 ✓	SL	2 12 01	1015										X X	
2	LCd-4-01 ✓	"	2-12-01	0915										" "	
3	M-1-01 ✓	"	2-13-01	1655										" "	
4	M-2-01 ✓	"	"	1610										" "	
5	M-3-01 ✓	"	"	1630										" "	
6	APC2-1-01 ✓	"	2-12-01	1620										" "	
7	APC2-2-01 ✓	"	"	1655										" "	
8	APC2-3-01 ✓	"	"	1552										" "	
9															
10															

[redacted]

				DATE	TIME
2					
3					
4					

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	R... D NUMBER
OF	51712

[redacted]

EMAIL

SAMPLED BY

PROJECT NAME/TYPE: Fox River - COE

LOCATION

REPORT RESULTS TO

COMPANY: DLZ

ADDRESS: 1423 Keystone Ave

CITY: Lansing STATE: MI ZIP: 48911

P.O. #/PROJECT #: [redacted]

FAX NO.: (517) 272-6909

INVOICE TO

NAME

COMPANY: SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	[illegible]	[illegible]	DLZ LAB ID
1	APc5-1-01 ✓	SL	2-12-01	1250											X	X	
2	APc5-3-01 ✓	↓	↓	1145											↓	X	
3	APc5-2-01 ✓	↓	↓	1215											↓	X	
4	APc1-1-01 ✓	↓	2-14-01	1200											↓		
5	APc1-2-01 ✓	↓	↓	1230											↓		
6	APc1-3-01 ✓	↓	↓	1235											↓		
7	APc-1-1-01 ✓	AQ	2-15-01	1515											X		
8	APc-1-2-01 ✓	↓	↓	1530											X		
9	APC-1-3-01 ✓	↓	↓	1540											X		
10	~~APC~~ LCe-1-01 ✓	↓	↓	1415											X		
	Equipment Blank ✓	↓	↓	1540											X		

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]						[illegible]
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

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CUSTODY RECORD

REPORT PAGE	RE..D NUMBER
OF	51716

[redacted]

REPORT RESULTS TO

COMPANY DLZ | EMAIL | SAMPLED BY

ADDRESS | P.O. #/PROJECT # | PROJECT NAME/TYPE

CITY | STATE | ZIP | PHONE NO. | LOCATION

FAX NO.

INVOICE TO

NAME

COMPANY SAME

ADDRESS

CITY | STATE | ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	As, Ag, Zn, Cd	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	KC 4-01	SL	2/8/01	1600											X	
2	KC-5-01	|	|	1450											X	
3	KC-6-01	↓	↓	1338											X	
4																
5																
6																
7																
8																
9																
10																

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

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CUSTODY RECORD

[redacted]

REPORT PAGE	RECORD NUMBER
OF	51578

PROJECT NAME/TYPE: Fox River Phase II

LOCATION: Appleton, Little Chute, WI

REPORT RESULTS TO

COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.
P.O. #/PROJECT #: 9230
ADDRESS: 24209 NORTHWESTERN HWY SUITE 230
PHONE NO.: 248-353-3532
CITY: SOUTHFIELD STATE: MI ZIP: 48075
FAX NO.:

INVOICE TO

NAME:
COMPANY: SAME
ADDRESS:
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	ENTER # IN THE BOX: OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	Mercury, Metals	PCBs	DLZ LAB ID
1	Apa-1-01	Soil	02-14-01	13:30	C				6						X	X	
2	APa-2-01	Soil	02-14-01	13:00	C				2						X	X	
3	APa-3-01	Soil	02-14-01	8:30	C				2						X	X	
4	APa-4-01	Soil	02-14-01	8:45	C				2						X	X	
5	LCa-2-01	Soil	02-13-01	11:00	C				2						X	X	
6	LCa-1-01	Soil	02-13-01	13:00	C				2						X	X	
7	LCa-3-01	Soil	02-13-01	13:30	C				2						X	X	
8	LCd-1-01	Soil	02-13-01	10:45	C				2						X	X	
9	LCd-2-01	Soil	02-13-01	10:35	C				2						X	X	
10	APa-5-01	Soil	02-14-01	9:10	C				2						X	X	

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]				12:40	
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED: ACOE

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

PCB's and As, Ag, Zn, Sr doubled to matrix

DLZ

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51571

[redacted]

PROJECT NAME/TYPE: Fox River PHASE II

LOCATION: Appleton, WI

REPORT RESULTS TO

COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.
ADDRESS: 24209 NORTHWESTERN HWY SUITE 230
CITY: SOUTHFIELD STATE: MI ZIP: 48075
P.O. #/PROJECT #: 9030
PHONE: [redacted]
FAX NO.: 248-353-5485

INVOICE TO

NAME:
COMPANY: SAME
ADDRESS:
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	Volatile Organics (8260)	PCBs	DLZ LAB ID
	ENTER # IN THE BOX														ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		
1	APC5-1-01	Soil	10-13-01	9:50											X	X	
2	APC5-3-01	Soil	10-13-01	11:45											X	X	
3	APC5-5-01	Soil	10-13-01	13:15											X	X	
4	APC1-1-01	Soil	10-14-01	12:00											X		
5	APC2-2-01	Soil	10-14-01	12:30											X		
6	APC3-3-01	Soil	10-14-01	12:35											X		
7																	
8																	
9																	
10																	

TRANSFER NO	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED: ASAP

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

ALL SAMPLES WITH MATRIX

DLZ

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Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51572

PROJECT NAME/TYPE: Fox River Phase II

LOCATION: Little Chute, Menasha, WI

[redacted]

REPORT RESULTS TO

COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.

ADDRESS: 24209 NORTHWESTERN HWY SUITE 230

CITY: SOUTHFIELD STATE: MI ZIP: 48075

P.O. #/PROJECT #: 9230

PHONE NO.: 248-353-3832

[redacted]

INVOICE TO

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	M. on Metals	PCBs	DLZ LAB ID
1	LCd-3-01	Soil	02-12-01	10:15	C				2						X	X	
2	LCd-4-01	Soil	02-12-01	9:15	C				2						X	X	
3	M-1-01	Soil	02-13-01	16:55	C				2						X	X	
4	M-2-01	Soil	02-13-01	16:10	C				2						X	X	
5	M-3-01	Soil	02-13-01	16:30	C				2						X	X	
6	APC2-1-01	Soil	02-12-01	16:20	C				1						X		
7	APC2-2-01	Soil	02-12-01	16:55	C				1						X		
8	APC2-3-01	Soil	02-12-01	15:50	C				1						X		
9																	
10																	

ENTER # IN THE BOX — ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					10:40	
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

PCBs and As, Ag, Zn, Se Subbed to Trimatrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED: Acac

DLZ LABORATORIES INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

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Telephone: (517) 374-9656 • FAX: (517) 374-6910

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51569

REPORT RESULTS TO

NAME [redacted] EMAIL

COMPANY ALTECH ENVIRONMENTAL SERVICES INC.

ADDRESS 24209 NORTHWESTERN HWY SUITE 230

CITY SOUTHFIELD STATE MI ZIP 48075

SAMPLED BY [redacted]

P.O. #/PROJECT # 9230

PHONE NO. 248-353-3832

FAX NO. 248-353-5485

[redacted] NAME/TYPE Fox River PHASE II

LOCATION

INVOICE TO

NAME

COMPANY SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	DKO - GRO	Metals (Hgt)	DLZ LAB ID
1	APC3-1-01	Soil	02-12-01	15:15	C				1						X		
2	APC3-2-01	Soil	02-12-01	14:55	C				1						X		
3	APC3-3-01	Soil	02-12-01	14:35	C				1						X		
4	APC4-1-01	Soil	02-14-01	10:15	C				1						X		
5	APC4-2-01	Soil	02-14-01	10:45	C				1						X		
6	LCe-1-01	Soil	02-13-01	13:10	C				1						X	X	
7																	
8																	
9																	
10																	

ENTER # IN THE BOX — ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					2/16/01	8:00
					2/16/01	10:00
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

~~As Ag Zn Se subbed to Trimatrix~~

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51570

[redacted]

EMAIL

SAMPLED [redacted]

PROJECT NAME/TYPE: FOX RIVER PHASE II

LOCATION:

REPORT RESULTS TO

COMPANY: ALTECH ENVIRONMENTAL SERVICES

ADDRESS: 24209 NORTHWESTERN HWY. STE. 220

CITY: SOUTHFIELD STATE: MI ZIP: 48075

P.O. #/PROJECT #: 9230

PHONE NO.: 248-353-3832

FAX NO.: 248 353-5485

INVOICE TO

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	VOC 5/10/60	TPH	DLZ LAB ID
1	APC-1-1-01	H_2O	2/15/01	1515	G				1	2					X		
2	APC-1-2-01	H_2O	2/15/01	1530	G				1	2					X		
3	APC-1-3-01	H_2O	2/15/01	1540	G				1	2					X		
4	LCC-1-01	H_2O	2/15/01	1415	G					1					X		
5	LCC-1-01	H_2O	2/14/01	1700	G						1					X	
6	LCC-2-01	H_2O	2/14/01	1630	G						1					X	
7	Equip. Blanks	H_2O	2/15/01	1540	G				1						X		
8	T																
9																	
10																	

[redacted]

					DATE	TIME
					2/16/01	10:40
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

VOC's subbed to trimatrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51586

PROJECT NAME/TYPE: Fox River

LOCATION: Kaukauna, WI

REPORT RESULTS TO

NA [redacted]

COMPANY: Mitch Environmental Services Inc.

P.O. #/PROJECT #: 1030

ADDRESS: 24009 Northwestern Hwy Suite 230

PHONE NO.: 248-353-3832

CITY: Southfield STATE: MI ZIP: 48075

FA [redacted]

INVOICE TO

NAME

COMPANY: SANE

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	DLZ LAB ID
					ENTER # IN THE BOX										
					ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST										
1	Ka-3-01	Soil	9-8-01	10:10							X	X			
2															
3															
4															
5															
6															
7															
8															
9															
10															

[redacted]

	DATE	TIME
	9/11	14:30
3		
4		

QA / QC LEVEL: COE

REPORTING LIMIT: 4S1

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☒ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☒ STANDARD

DLZ

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51585

PROJECT NAME/TYPE: Fox River

LOCATION: Kaukauna.

[redacted]

REPORT RESULTS TO

COMPANY: Altech Environmental Services Inc.

ADDRESS: 24209 Northwestern Hwy Suite 230

CITY: Southfield STATE: MI ZIP: 48075

P.O. #/PROJECT #: Fox River 9230

PHONE NO.: 248-353-3832

FAX NO.: 248-353-5485

INVOICE TO

NAME

COMPANY: SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	MI METALS KIT	PCBs	DLZ LAB ID
1	Ke-1-01	soil	02-08-01	11:45											X		
2	Ke-2-01	soil	02-08-01	12:10											X		
3	Ke-3-01	soil	02-08-01	13:05											X		
4	Ke-4-01	soil	02-08-01	16:30											X		
5	Ke-5-01	soil	02-08-01	15:50											X		
6	Ke-6-01	soil	02-08-01	15:10											X		
7	Ke-7-01	soil	02-08-01	14:50											X		
8	Ke-8-01	soil	02-08-01	14:10											X		
9	Ka-1-01	soil	02-08-01	9:10											X	X	
10	Ka-2-01	soil	02-08-01	9:40											X	X	

ENTER # IN THE BOX — ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					2/9/01	16:30
3						
4						

QA / QC LEVEL: CDE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☒ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

As, Ag, Zn, Se Subbed to Tri Matrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☒ STANDARD

DLZ

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CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51574

PROJECT NAME/TYPE: Fox River

LOCATION: Kaukauna, Little Kaukauna, DePere

REPORT RESULTS TO

NAME: [redacted]

COMPANY: Allen Environmental Group LLC

ADDRESS: 2401 Northwestern Ave Suite 230

CITY: Southfield STATE: MI ZIP: 48075

P.O. #/PROJECT #: #9230

[redacted]

FAX NO: 248-353-5485

INVOICE TO

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y/N	8021-like (Aromatics)	TPH (1157)	DLZ LAB ID
1	LKc-3-01	water	10/4/01	14:39	G				1	2					X		
2	Kc-1-01	water	10/4/01	15:00	G				1	2					X		
3	Kc-2-02	water	10/4/01	15:20	G				1	2					X		
4	DPa-1-01	water	10/4/01	10:40	G				1	2					X		
5	DPb-1-01	soil	10/4/01	10:15	C		1		1						X		
6	DPb-2-01	soil	10/4/01	11:50	C		1		1						X		
7	DPb-3-01	soil	10/4/01	11:15	C		1		1						X		
8	Methanol Blank																
9																	
10																	

TRANSFER	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]				10-9-01	10:30
2						
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☑ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

All subbed to Trimatrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

Certification of Independent Technical Review

Significant concerns and the explanation of the resolution are as follows:

The Fox River Draft Phase II Assessment Report was thoroughly reviewed. No significant issues were identified. However, several revisions were suggested to more clearly address suitability to transfer issues. These suggested revisions to the original draft document were relayed electronically, using the "track changes feature" in MSWord™. All suggested revisions were accepted and incorporated into the Final Draft Phase II Assessment Report

As noted above, all concerns resulting from independent technical review of the project have been considered.

[redacted]

4/17/01
(Date)

(Principal w/ A-E firm or Engineer of Record with Gov Ctr)

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc3-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 04-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								Dark brown FILL with gravel, rocks, bricks and cinders, trace of sand and silty clay, hard and dry. No odor.	
1									
2	SS-1	1							
3									
4									
5								Dark brown FILL with coarse sand, rocks and cinders, wood, very hard and dry. No odor. Sandstone fragments at the bottom of the boring.	
6	SS-2	2							
7								Refusal at 7.5 feet.	
8								End of boring at 7.5 feet below ground surface	
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APC3-2-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc-3-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0–2	SS-1	1						Black FILL with rock fragments, gravel, sand and cinders, dry.	
2–3						CL		Reddish brown SILTY CLAY with rock fragments, gravel, medium hard and dry. No odor. Refusal at 3 feet.	

End of boring at 3 feet below ground surface

04-12-2001 C:\MTECH5\APC3-3-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc4-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-14-01	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Dark brown ORGANIC SOIL with some roots.	
1	SS-1	1	12/12			SC		Reddish brown SANDY CLAY with some gravel, moist.	
2									
3	SS-2	2	8/12					Reddish brown SANDY CLAY with increasing gravel and rock fragments, medium hard and moist.	
4									
5	SS-3	3	8/12					Reddish brown SANDY CLAY with some gravel and traces of silt, medium hard and moist.	
6									
7	SS-4	4	12/12					Same as above with increasing gravel and rock fragments.	
8								Refusal at 8 feet.	
								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APC4-1-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc4-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		ORGANIC SOIL with roots.	
1	SS-1	1	6/12			SC		Brown FILL with medium to coarse sand, gravel, cinders, rock fragments, paint chips, loose and dry	
2								Same as above and with some fragments of brick.	
3	SS-2	2	7/12					Reddish brown SANDY CLAY with some gravel, trace of silt, medium hard and moist.	
4						CL			
5	SS-3	3	7/12					Reddish brown SILTY CLAYwith increasing gravel, hard and moist.	
6									
7									
8	SS-4	4	8/12					Same as above.	
9									
10								Refusal at 10 feet.	
11								End of boring at 10 feet below ground surface	
12									

04-12-2001 C:\MTECH5\APC4-2-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc5-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0	SS-1	1	8/12					Brown FILL with some gravel and rock fragments, loose and dry.	
1						GP		Black medium - coarse grained SAND & GRAVEL, with some cinders, loose and dry. Sandstone fragments at the bottom of the boring.	
2	SS-2	2	10/12					Refusal at 3 feet.	
3								End of boring at 3 feet below ground surface	
4									
5									
6									
7									
8									
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APC5-1-0.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Apc5-2-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : E.Reddy Date : 02-12-2001 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller : Greg Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0–2	SS-1	1	24/48			GW		0-2' Black and brown coarse SAND & GRAVEL, loose and dry.	
2–4	SS-2	2	24/48			CL		Reddish brown SILTY CLAY with some gravel, rock fragments, medium hard and moist.	
4–6	SS-3	3	36/48			GP		Grayish brown GRAVELwith trace of sand, loose and dry. No odor.	
6–8	SS-4	4	40/48			SP		Reddish brown SAND with some gravel, moist to wet. Refusal at 8 feet.	

End of boring at 8 feet below ground surface

04-12-2001 C:\MTECH5\APC5-2-0.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Apc5-3-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : E.Reddy Date : 02-12-2001 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller : Greg Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0									
1	SS-1	1	12/12					Black FILL with medium - coarse grained sand, rock fragments, cinders and gravel, loose and dry. No odor.	
2									
3	SS-2	2	12/12			CL		Reddish brown SILTY CLAY with some gravel, hard and moist. No odor.	
4									
5	SS-3	3	10/12			SC		Reddish brown SANDY CLAY with some gravel, medium hard and moist.	
6									
7	SS-4	4	12/12					7-8 feet Dark brown to black medium to coarse grained SAND with some gravel, trace of silt, medium hard and moist. No odor.	
8									
9						SP			
10	SS-5	5	30/36					8-11.5 feet Dark brown medium grained SAND, soft and moist. Increasing to wet at 10 feet. No odor.	
11								Refusal at 11.5 feet.	
12								End of boring at 11.5 feet below ground surface	

04-12-2001 C:\MTECH5\APC5-3-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Dpa-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-07-2001	Ground Elevation	: NA
Location	: De pere		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL with sand and gravel, moist.	
1								Temporary well set at a depth of 9 feet. No water was present in the well at this time.	
2									
3									
4	SS-1	1							
5								12:35 pm. Water level was measured at 8.5 feet. Water depth of five inches.	
6									
7									
8									
9								End of boring at 9 feet below ground surface	
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING M-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Menasha		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Brown ORGANIC SOIL with roots.	
1	SS-1	1	6/12			SP		Dark brown SAND with a few gravel particles, moist.	
2									
3	SS-2	2	6/12					Same as above.	
4						SC		Reddish brown SANDY CLAYwith some gravel, soft and moist. No odor.	
5	SS-3	3	8/12			SP		Dark brown coarse SAND with some gravel, loose and saturated.	
6									
7	SS-4	4	10/12			SC		Reddish brown SANDY CLAY with some gravel, loose and more wet.	
8								Dark brown to black SANDY CLAY with gravel, loose and saturated.	
9	SS-5	5	12/12			PT		Black PEAT with saw dust, soft and saturated.	
10								End of boring at 10 feet below ground surface	
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING M-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Menasha		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6" ORGANIC SOIL	
1	SS-1	1	4/12			SP		Dark brown med. SAND, loose and moist.	
2						PT		Black SANDY PEAT with wood chips and roots, loose, soft and moist.	
3	SS-2	2	6/12			SP		Brown coarse SAND with some gravel, loose, poorly sorted and wet.	
4								Brown SAND with some gravel, loose and saturated.	
5	SS-3	3	6/12						
6						PT		Black SANDY PEAT with wood fragments, loose and wet.	
7	SS-4	4	6/12						
8						SP		Brown coarse SAND with some gravel, loose, poorly sorted and wet.	
9	SS-5	5	10/12			CL		Reddish brown SILTY CLAY with a few gravel particles, wet.	
10								End of boring at 10 feet below ground surface	
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING M-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: E.Reddy	Driller	: Greg
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Menasha		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6 inch ORGANIC SOIL with roots.	
1	SS-1	1				SC		Reddish brown SANDY CLAY with some gravel, medium hard and moist.	
2									
3	SS-2	2						Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
4						CL			
5	SS-3	3							
6								Same as above.	
	SS-4	4							
7								Refusal at 7 feet.	

End of boring at 7 feet below ground surface

8
9
10
11
12

04-13-2001 C:\MTECH5\M-3-01.BOR

ALTECH ENVIRONMNETAL SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: [redacted]

Date: 2/7/01 Well Number: DPa-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]y

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.42

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: NA Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH: 1). 2). 3).

Temperature: 1). 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/7/01 Sampling Method: Stainless Bailer

Time: 12:40 Field Filtration?: ( ) Yes (x) No Type:

pH: Temperature: Conductivity:

Sample Appearance: Brown and Cloudy

Weather Conditions: Sunny Temp (F): -5°F Wind Speed:

EQUIPMENT USED: Stainless bailer.

COMMENTS AND OBSERVATIONS: There was insufficient water and recharge to develop the well or to collect sufficient water volumes to measure pH, temperature or conductivity.

24209 Northwestern Highway, Suite 230 • Southfield, Michigan 48075 • (248) 353-3832 • FAX (248) 353- 5485

ALTECH ENVIRONMNETAL SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Kaukauna

Date: 2/07/01 Well Number: LKc-3-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.5

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: NA Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH: 1). 2). 3).

Temperature: 1). 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 14:39 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.4 Temperature: 40.8°F Conductivity:

Sample Appearance: Brown and Cloudy

Weather Conditions: Sunny Temp (F): 22°F Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter and thermometer.

COMMENTS AND OBSERVATIONS: Not enough water in the well to sample three required vials. Only collected one vial. Very slow recovery, waited 48 hours for well to charge.

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ALTECH ENVIRONMNETAL SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Kaukauna

Date: 2/26/01 Well Number: Kc-1-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.42

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: NA Time: _____ Purge Method: None

Purge Water Appearance: _____ Purge Water Odor: _____

pH: 1). _____ 2). _____ 3). _____

Temperature: 1). _____ 2). _____ 3). _____

Conductivity: 1). _____ 2). _____ 3). _____

SAMPLING DATA:

Date: 2/26/01 Sampling Method: Stainless Bailer

Time: 15:05 Field Filtration?: ( ) Yes (x) No Type: _____

pH: 7.5 Temperature: 41.8° F Conductivity: 1650

Sample Appearance: Brown and Cloudy

Weather Conditions: Partly Cloudy Temp (F): -5°F Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: There was insufficient water and recharge to develop the well.

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ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Kaukauna

Date: 2/26/01 Well Number: Kc-2-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (TOC) (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/7/01 Time: _____ Purge Method: None

Purge Water Appearance: _____ Purge Water Odor: _____

pH: 1). _____ 2). _____ 3). _____

Temperature: 1). _____ 2). _____ 3). _____

Conductivity: 1). _____ 2). _____ 3). _____

SAMPLING DATA:

Date: 2/26/01 Sampling Method: Stainless Bailer

Time: 15:20 Field Filtration?: ( ) Yes (x) No Type: _____

pH: 7.6 Temperature: 41.7° F Conductivity: 890

Sample Appearance: Brown and Cloudy

Weather Conditions: Partly Cloudy Temp (F): -5°F Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: _____

24209 Northwestern Highway, Suite 230 • Southfield, Michigan 48075 • (248) 353-3832 • FAX (248) 353- 5485

ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Kaukauna

Date: 2/7/01 Well Number: Kc-3-01

Site Location: Kaukauna

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (TOC) (ft): 10.25 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.75

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/7/01 Time: Purge Method: Bailer

Purge Water Appearance: Dark brown Purge Water Odor: None

pH: 1). 7.4 2). 3).

Temperature: 1). 40.8 F 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/7/01 Sampling Method: Stainless Bailer

Time: 14:39 Field Filtration?: ( ) Yes (x) No Type:

pH: NA Temperature: NA Conductivity: NA

Sample Appearance: Brown and Cloudy

Weather Conditions: Temp (F): Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS:

24209 Northwestern Highway, Suite 230 • Southfield, Michigan 48075 • (248) 353-3832 • FAX (248) 353- 5485

ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Chute

Date: 2/14/01 Well Number: LCb-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: TPH

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 5.21

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/14/01 Time: 16:50 Purge Method: Bailer

Purge Water Appearance: Brown Purge Water Odor: None

pH:	1). 7.5	2). River 7.4	3).
Temperature:	1). 34°F	2). River 34.2°F	3).
Conductivity:	1). 970	2) River 560	3).

SAMPLING DATA:

Date: 2/14/01 Sampling Method: Peristaltic pump

Time: 16:30 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.5 Temperature: 34.9°F Conductivity: 970

Sample Appearance: Brown and Cloudy

Weather Conditions: Cloudy Temp (F): 29.5°F Wind Speed:

EQUIPMENT USED: Peristaltic pump, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: Enough water and fast recovery.

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ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Chute

Date: 2/14/01 Well Number: LCb-2-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: TPH

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 1.51

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/14/01 Time: 16:50 Purge Method: Peristaltic pump

Purge Water Appearance: Dark brown Purge Water Odor: None

pH:	1). 7.4	2).	3).
Temperature:	1). 34.2°F	2).	3).
Conductivity:	1). 1230	2). 1120	3).

SAMPLING DATA:

Date: 2/14/01 Sampling Method: Peristaltic pump

Time: 16:30 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.4 Temperature: 34.2°F Conductivity: 1230

Sample Appearance: Brown and Cloudy

Weather Conditions: Temp (F): 27.3°F Wind Speed:

EQUIPMENT USED: Peristaltic pump, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: Slow recovery.

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ALTECH
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SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Chute

Date: 2/15/01 Well Number: LCe-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.25

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/15/01 Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH: 1). ,.2). ,.3).

Temperature: 1). ,.2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 13:53 Field Filtration?: ( ) Yes (x) No Type:

pH: NA Temperature: NA Conductivity: NA

Sample Appearance: Brown and Cloudy

Weather Conditions: Sunny Temp (F): 22°F Wind Speed:

EQUIPMENT USED: Stainless bailer

COMMENTS AND OBSERVATIONS: Not enough water in the well to sample three require vials. Only collected one vial. Very slow recovery, waited 48 hours for well to charge.

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ALTECH ENVIRONMNETAL SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Appleton

Date: 2/15/01 Well Number: APc1-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 5.75

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/15/01 Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH:	1). 7.7	2). 7.6	3). 7.6
Temperature:	1). 36.3°F	2). 36°F	3). 36°F
Conductivity:	1). 570	2). 540	3). 540

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 15:15 Field Filtration?: ( ) Yes (x) No Type:

pH: Temperature: Conductivity:

Sample Appearance: Black and Cloudy

Weather Conditions: Temp (F): Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: Enough water

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ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Appleton

Date: 2/15/01 Well Number: APc1-2-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 5.65

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/15/01 Time: 15:25 Purge Method: Bailer

Purge Water Appearance: Black Purge Water Odor: None

pH:	1). 7.4	2). 7.5	3). 7.6
Temperature:	1). 34°F	2). 36.7°F	3). 37.2°F
Conductivity:	1). 760	2). 780	3). 810

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 15:30 Field Filtration?: ( ) Yes (x) No Type: _____

pH: _____ Temperature: _____ Conductivity: _____

Sample Appearance: Brown and Cloudy

Weather Conditions: _____ Temp (F): _____ Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer

COMMENTS AND OBSERVATIONS: _____

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ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Appleton

Date: 2/15/01 Well Number: APc1-3-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 4.41

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/15/01 Time: 15:35 Purge Method: Bailer

Purge Water Appearance: Brown Purge Water Odor: None

pH:	1). 7.6	2). 7.7	3). 7.7
Temperature:	1). 35.6°F	2). 37.2°F	3). 37.8°F
Conductivity:	1). 580	2). 620	3). 620

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 15:40 Field Filtration?: ( ) Yes (x) No Type: _____

pH: NA Temperature: NA Conductivity: NA

Sample Appearance: Brown and Cloudy

Weather Conditions: _____ Temp (F): _____ Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer

COMMENTS AND OBSERVATIONS: _____

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APPENDIX C – ANALYTICAL RESULTS AND QA/QC REPORTS

DLZ
LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

ANALYTICAL RESULTS AND QUALITY ASSURANCE REPORT

FOX RIVER PHASE II

Contract Number:
Delivery Order Number:

DLZ LAB ID NUMBERS: C1B0146-01*07, C1B0148-01*06, C1B0164-01*11, C1B0163-01*10, C1B0165-01*14, C1B0167-01*03.

Document 1 of 3 03/28/2001

SUBMITTED TO:

[redacted]
US Department of the Army
Detroit District, Corps of Engineers
477 Michigan Avenue
P.O. Box 1027
Detroit, Michigan 48231-1027

SUBMITTED BY:

DLZ LABORATORIES, INC.
1423 KEYSTONE AVE.
LANSING, MICHIGAN 48911
Tel: (517)393-4444
Fax: (517)272-6909

TABLE OF CONTENTS

Document 1

Section A **General Information**

Case Narrative
Laboratory Report of Analytical Results
Chain-of-Custody Documentation

Document 2
DLZ Laboratories, Inc.
Laboratory Report of Batch QC Related Analytical Results Summaries

Section B **QA/QC Support Documentation**
GRO/DRO Analysis (EPA Method 8015)

Sample Hold Time Table
GRO System Monitoring Compounds Tables
Surrogate Recovery Summaries
DRO System Monitoring Compounds Tables
Surrogate Recovery Summaries
GRO QA/QC Summary Report Form
Matrix Spike/Matrix Spike Duplicate Summary
Method Blank Results
Laboratory Control Sample Results
DRO QA/QC Summary Report Form
Matrix Spike/Matrix Spike Duplicate Summary
Method Blank Results
Laboratory Control Sample Results

Section C **QA/QC Support Documentation-Metals Kit**

Sample Hold Time Tables
Total Mercury
(Atomic Absorption, Cold Vapor Technique)
(EPA Method 7471A)
Total Michigan 10 Metals (Cr, Cu, Zn, As, Se, Cd, Ba, & Pb),
Total DLZ List II Metals (Ni), and
with Inductively Coupled Plasma-MS
(EPA Method 3005B,3050B, & 6020)
Total Metals (Fe, Ag, Ba, and Mn)
with Inductively Coupled Plasma-AE
(EPA Method 3005B, 3050B & 6010B)

Section D **QA/QC Support Inorganics**

Total Solids (Gravimetric) (SM2540G)
Total Recoverable Petroleum Hydrocarbons (418.1)

Document 3

Trimatrix Laboratory
Quality Control Report Packages

SECTION A

GENERAL INFORMATION

CASE NARRATIVE

A total of fifty three (53) grab soil samples, ten (10) grab aqueous samples, and one (1) equipment blank aqueous sample were collected by Altech Environmental Services, Inc. on behalf of the Detroit District USACE on February 6, 7, 8, and 12-15, 2001. Samples for volatiles analysis along with a methanol trip blank were received by DLZ Laboratories, Inc. Michigan facility on February 09, 2001. (Four (4) methanol preserved samples and four (4) aqueous samples.) Seventeen soil samples were received by DLZ Laboratories, Inc. Michigan facility on February 09, 2001 for PCB and COE Metals Kit analysis. Four (4) aqueous samples along with an equipment blank for volatiles analysis were received by DLZ Laboratories, Inc. Michigan facility on February 16, 2001. Two aqueous samples for TPH analysis along with thirty three (33) soil samples for varied analytical requests were received by DLZ Laboratories, Inc. Michigan facility on February 16, 2001. In all eleven (11) aqueous sample sources and fifty four (54) sediment sample sources were analyzed in this sampling event. These sample sources were analyzed for: PPO Volatile compounds, PCBs, DRO-GRO, Total Petroleum Hydrocarbons, Total Solids, and The Michigan Metals Kit (As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, and Zn). Analysis assigned to each sample source submitted is given in Table I with corresponding laboratory ID and subcontract laboratory IDs. Analysis for PPO Volatiles, PCBs, and selected metals was subcontracted to Trimatrix Laboratory.

These analysis were performed in accordance with USEPA/ACE 81-1 procedures, Standard Methods for the Examination of Water and Wastewater, USEPA/600/R-94/024, ASTM D421/422, and USEPA SW846 Methods as specified in the work plan.

A discussion of each element present in documents 2 and 3 of this final report/quality control package follows.

Table I

Cross Reference to Sample Source and Analytical Parameters

COE ID	LAB ID	Analytical Kits and determinations					
		PPO-Vol	PCB	DRO GRO	Total Solids	TPH	MI Metals
LCc-1-01	C1B0146-05					x	
LCc-2-01	C1B0146-06					x	
LKc-3-01	271445	x					
Kc-1-01	271446	x					
Kc-2-02	271447	x					
DPa-1-01	271448	x					
Apc-1-1-01 aq	272192	x					
APc-1-2-01	272193	x					
APc-1-3-01	272194	x					
LC'c-1-01	272195	x					
Equipment blk	272196	x					
MeOH blk	271452	x					
Kd-1-01	271486		x		x		x
Kd-2-01	271487		x		x		x
Kd-3-01	271488		x		x		x
LKa-1-01	271489		x		x		x
LKa-2-01	271490		x		x		x
LKa-3-01	271491		x		x		x
Ka-1-01	C'1B0164-09		x		x		x
Ka-2-01	C'1B0164-10		x		x		x
Ka-3-01	C'1B0164-11		x		x		x
Kc-4-01	C'1B0167-01				x		x
Kc-5-01	C'1B0167-02				x		x
Kc-6-01	C'1B0167-03				x		x
Kc-1-01	C'1B0164-01				x		x
Kc-2-01	C'1B0164-02				x		x
Kc-3-01	C'1B0164-03				x		x
Kc-4-01	C'1B0164-04				x		x
Kc-5-01	C'1B0164-05				x		x
Kc-6-01	C'1B0164-06				x		x
Kc-7-01	C'1B0164-07				x		x
Kc-7-01	C'1B0164-08				x		x
LC'd-3-01	C'1B0165-01				x		x
LC'd-4-01	C'1B0165-02				x		x
M-1-01	C'1B0165-03		x		x		x
M-2-01	C'1B0165-04		x		x		x
M-3-01	C'1B0165-05		x		x		x

Table I

Cross Reference to Sample Source and Analytical Parameters

COE ID	LAB ID	Analytical Kits and determinations					
		PPO-Vol	PCB	DRO GRO	Total Solids	TPH	MI Metals
APc2-1-01	C1B0165-06				x		x
APc2-2-01	C1B0165-07				x		x
APc2-3-01	C1B0165-08				x		x
APa-1-01	C1B0163-01		x		x		x
APa-2-01	C1B0163-02		x		x		x
APa-3-01	C1B0163-03		x		x		x
APa-4-01	C1B0163-04		x		x		x
APa-5-01	C1B0163-10		x		x		x
LCa-1-01	C1B0163-05		x		x		x
LCa-2-01	C1B0163-06		x		x		x
LCa-3-01	C1B0163-07		x		x		x
LCd-1-01	C1B0163-08		x		x		x
LCd-2-01	C1B0163-09		x		x		x
APc3-1-01	C1B0148-01			x	x		
APc3-2-01	C1B0148-02			x	x		
APc3-3-01	C1B0148-03			x	x		
APc4-1-01	C1B0148-04			x	x		
APc4-2-01	C1B0148-05			x	x		
LCe-1-01	C1B0148-06			x	x		
LCd-3-01	272207		x		x		
LCd-4-01	272208		x		x		
APc5-1-01	272186	x	x		x		
APc5-3-01	272188	x	x		x		
APc5-2-01	272187	x	x		x		
DPb-1-01	271449	x			x		
DPb-2-01	271450	x			x		
DPb-3-01	271451	x			x		
Apc1-1-01 (s)	272189	x			x		
Apc1-2-01 (s)	272190	x			x		
Apc1-3-01 (s)	272191	x			x		

Sample Identification Cross Reference

Altech/COE Sample ID	DLZ Sample ID	Trimatrix Sample ID	Matrix	Date Sampled	Time Sampled
Kd-1-01		271486	Soil	2/6/01	14:15
Kd-2-01		271487	Soil	2/6/01	14:25
Kd-3-01		271488	Soil	2/6/01	14:45
LKa-1-01		271489	Soil	2/7/01	15:50
LKa-2-01		271490	Soil	2/7/01	15:30
LKa-3-01		271491	Soil	2/7/01	14:20
LKc-3-01		271445	Aqueous	2/7/01	14:39
Kc-1-01		271446	Aqueous	2/6/01	15:00
Kc-2-02		271447	Aqueous	2/6/01	15:20
DPa-1-01		271448	Aqueous	2/7/01	12:40
DPb-1-01		271449	Soil	2/7/01	10:15
DPb-2-01		271450	Soil	2/7/01	11:50
DPb-3-01		271451	Soil	2/7/01	11:15
Methanol Blank		271452	MeOH	2/7/01	
Ke-1-01	C1B0164-01	272215	Soil	2/8/01	11:45
Ke-2-01	C1B0164-02	272216	Soil	2/8/01	12:10
Ke-3-01	C1B0164-03	272217	Soil	2/8/01	13:05
Ke-4-01	C1B0164-04	272218	Soil	2/8/01	16:30
Ke-5-01	C1B0164-05	272219	Soil	2/8/01	15:50
Ke-6-01	C1B0164-06	272220	Soil	2/8/01	15:10
Ke-7-01	C1B0164-07	272221	Soil	2/8/01	14:50
Ke-8-01	C1B0164-08	272222	Soil	2/8/01	14:10
Ka-1-01	C1B0164-09	271492	Soil	2/8/01	9:10
Ka-2-01	C1B0164-10	271493	Soil	2/8/01	9:40
Ka-3-01	C1B0164-11	271494	Soil	2/8/01	10:10
APc-1-1-01		272192	Aqueous	2/15/01	15:15
APc-1-2-01		272193	Aqueous	2/15/01	15:30
APc-1-3-01		272194	Aqueous	2/15/01	15:40
LCe-1-01		272195	Aqueous	2/15/01	14:15
LCc-1-01	C1B0146-05		Aqueous	2/14/01	17:00
LCc-2-01	C1B0146-06		Aqueous	2/14/01	16:30
Equip. Blank		272196	Aqueous	2/15/01	15:40
APc3-1-01	C1B0148-01		Soil	2/12/01	15:15
APc3-2-01	C1B0148-02		Soil	2/12/01	14:55
APc3-3-01	C1B0148-03		Soil	2/12/01	14:35
APc4-1-01	C1B0148-04		Soil	2/14/01	10:15
APc4-2-01	C1B0148-05		Soil	2/14/01	10:45
LCe-1-01	C1B0148-06		Soil	2/13/01	13:10
LCd-3-01	C1B0165-01	272207	Soil	2/12/01	10:15
LCd-4-01	C1B0165-02	272208	Soil	2/12/01	9:15
M-1-01	C1B0165-03	272209	Soil	2/13/01	16:55
M-2-01	C1B0165-04	272210	Soil	2/13/01	16:10
M-3-01	C1B0165-05	272211	Soil	2/13/01	16:30
APc2-1-01	C1B0165-06	272212	Soil	2/12/01	16:20
APc2-2-01	C1B0165-07	272213	Soil	2/12/01	16:55
APc2-3-01	C1B0165-08	272214	Soil	2/12/01	15:50
APc5-1-01		272186	Soil	2/12/01	12:50
APc5-3-01		272187	Soil	2/12/01	11:45

Sample Identification Cross Reference

Altech/COE Sample ID	DLZ Sample ID	Trimatrix Sample ID	Matrix	Date Sampled	Time Sampled
APc5-2-01		272188	Soil	2/12/01	12:15
APc1-1-01		272189	Soil	2/14/01	12:00
APc1-2-01		272190	Soil	2/14/01	12:30
APc1-3-01		272191	Soil	2/14/01	12:35
APa-1-01	C1B0163-01	272197	Soil	2/14/01	13:30
APa-2-01	C1B0163-02	272198	Soil	2/14/01	13:00
APa-3-01	C1B0163-03	272199	Soil	2/14/01	8:30
APa-4-01	C1B0163-04	272200	Soil	2/14/01	8:45
LCa-2-01	C1B0163-05	272201	Soil	2/13/01	11:00
LCa-1-01	C1B0163-06	272202	Soil	2/13/01	13:00
LCa-3-01	C1B0163-07	272203	Soil	2/13/01	13:30
LCd-1-01	C1B0163-08	272204	Soil	2/12/01	10:45
LCd-2-01	C1B0163-09	272205	Soil	2/12/01	10:35
APa-5-01	C1B0163-10	272206	Soil	2/14/01	9:10
Kc-4-01	C1B0167-01	272223	Soil	2/8/01	16:00
Kc-5-01	C1B0167-02	272224	Soil	2/8/01	14:50
Kc-6-01	C1B0167-03	272225	Soil	2/8/01	13:38

APPENDIX B – BORING LOGS AND GROUNDWATER SAMPLING DATA

ALTECH
Environmental Services, Inc.

LOG OF BORING Dpa-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: De pere		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL with sand and grave, moist.	
1	SS-1	1						Geoprobe sampling tube refusal occurred at a depth of two feet during the initial attempt. Three subsequvent attempts also resulted in refusal at a depth of two feet. A temporary well was set at a depth of two feet.	
2								8:45 am. Water level measurement indicated that there was no water present.	
3								12:50 pm. Water level was measurment indicated that there was no water present. Well was considered to be dry.	
4								End of boring at 2 feet below ground surface	
5									
6									
7									
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\PA-2-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Dpb-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: De Pere		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1	SS-1	1				CL		Reddish brown SILTY CLAY with some gravel, very hard and dry. No odor.	
2								Same as above.	
3	SS-2	2						Refusal at 3.5 feet.	
4								End of boring at 3.5 feet below ground surface	
5									
6									
7									
8									
9									
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Dpb-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	: [redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: De Pere		
Sample/Drill Method	: Geoprobe		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1	SS-1	1	8/12					Reddish brown SILTY CLAY, medium hard and dry. No odor.	
2									
3	SS-2	2	10/12			CL		Reddish brown SILTY CLAY, with some gravel and wood chips, soft and moist. No odor.	
4									
5	SS-3	3	10/12					Same as above.	
6								Black PEAT, with some gravel, moist. No odor.	
7	SS-4	4	12/12			PT			
8								Same as above.	
9	SS-5	5	12/12						
10						CL		Dark brown SILTY CLAY, soft and more moist.	
11								End of boring at 10 feet below ground surface	
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Dpb-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: De pere		
Sample/Drill Method	: Geoprobe		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1	SS-1	1	10/12					Reddish brown SILTY CLAY, very hard and dry.	
2								Same as above.	
3	SS-2	2	8/12			CL		Reddish brown SILTY CLAY, soft and moist. No odor.	
4								Reddish borwn SILTY CLAY, medium hard and more moist. No odor.	
5	SS-3	3	6/12						
6								Same as above.	
7	SS-4	4	6/12			PT		Black fine grained SAND with trace of organic peat, some sandstone fragments, very soft and dry. No odor.	
8									
9	SS-5	5	12/12					Black PEAT with trace of clay and wood fragments, soft and moist. No odor.	
10								Refusal at 10 feet	
11								End of boring at 10 feet below ground surface	
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Lka-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: Little Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1	SS-1	1	3/12			GP		Brown fine to medium grained SAND & GRAVEL, trace of rock fragments, loose and dry. No odor.	
2						CL		Reddish brown SILTY CLAY, medium hard with trace of gravel and rock fragments, moist. No odor.	
3	SS-2	2	2/12					Reddish brown SILTY CLAY, medium hard with more gravel, moist. No odor.	
4									
5	SS-3	3	6/12					Dark borwn SANDY CLAY with trace of silt, gravel and rock fragments, loose and dry. No odor.	
6									
7	SS-4	4	12/12					Reddish brown SILTY CLAY with trace of sand, rock fragments and gravel, medium hard and moist. No odor.	
8								Same as above and increased moisture.	
9	SS-5	5	12/12			PT		Black PEAT with wood fragments, soft and moist. No odor.	
10								End of boring at 10 feet below ground surface	
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Lka-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: Little Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1	SS-1	1	8/12			CL		Reddish brown SILTY CLAY with trace of gravel medium hard and moist. No odor	
2								Dark brown SILTY CLAY with trace of gravel, and rock fragments, loose and dry. No odor.	
3	SS-2	2	6/12						
4								Same as above.	
5	SS-3	3	6/12					Reddish brown SILTY CLAY, hard and moist. No odor.	
6									
7	SS-4	4	10/12					Reddish brown SILTY CLAY with trace of rock fragments, gravel and cinders, medium hard and moist. No odor.	
8								Same as above.	
9	SS-5	5	10/12			SC		Black SANDY CLAY with trace of gravel and rock fragments, medium hard and moist to wet. The bottom 2 inches are reddish sandy clay. No odor.	
10									
11								Same as above but becoming wet.	
12						PT		Black PEAT with trace of wood, soft and moist. No odor.	
13								End of boring at 12 feet below ground surface	

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ALTECH
Environmental Services, Inc.

LOG OF BORING Lka-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: Little Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GP		3 inch Brown surface SAND & GRAVEL, loose and dry.	
1	SS-1	1	8/12			CL		Reddish brown SILTY CLAY medium hard and moist. No odor.	
2								Same as above.	
3	SS-2	2	10/12			SC		Dark brown SANDY CLAY with gravel, loose and dry.	
4								Same as above and with increasing amount of sandstone fragments and gravel, dry.	
5	SS-3	3	7/12			CL		Reddish brown SILTY CLAY, medium hard and moist. No odor.	
6									
7	SS-4	4	6/12					Dark brown SILTY CLAY wtih increased amount of rock fragments, medium hard and more moist at the bottom. No odor.	
8						SC		Dark brown to gray SANDY CLAY with gravel, medium hard and moist to wet. No odor.	
9	SS-5	5	11/12						
10								Same as above.	
11						PT		Black peat, soft and moist. No odor.	
12								End of boring at 12 feet below ground surface	
13									

04-13-2001 C:\MTECH5\LKA-3-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lkc-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: Little Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL with grass roots, sand and gravel, moist.	
1								Geoprobe sampling tube refusal occurred at a depth of ten feet, a temporary well was set at a depth of ten feet.	
2									
3								1:15 pm.Temporary well set a depth of ten feet. No water was present in the well at this time.	
4								5:00 pm. Water level was measured and no water was present in the well at this time.	
5	SS-1	1							
6									
7									
8									
9									
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\LKC-1-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Ka-1-01 (Page 1 of 1)

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL.	
						GP		Dark brown SAND & GRAVEL, loose, and dry.	
1	SS-1	1	8/12			CL		Reddish brown SILTY CLAY, medium hard and moist. No odor.	
2						GP		Dark brown SAND & GRAVEL, with trace of silty clay, dry.	
3	SS-2	2	7/12						
4								Same as above with increasing amount of gravel.	
5	SS-3	3	5/12						
6								Dark brown SAND & GRAVEL with trace of rock fragments, loose and dry. No odor.	
7	SS-4	4	6/12						
8						SC		Dark brown to black SANDY CLAY with trace of gravel, medium hard and moist. No odor.	
9	SS-5	5	7/12						
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KA-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Ka-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL.	
1	SS-1	1	7/12					Dark brown SANDY CLAY with a trace of rock fragments, gravel, medium hard and moist. No odor.	
2								Same as above but decreasing amount of gravel and increasing moisture.	
3	SS-2	2	6/12						
4								Dark brown SANDY CLAY with trace of rock fragments, medium hard and moist. The bottom 2 inches are reddish brown clay.	
5	SS-3	3	4/12			SC			
6								Same as above.	
7	SS-4	4	7/12						
8								Dark brown to reddish brown SANDY CLAY with trace of gravel, medium hard and moist. No odor.	
	SS-5	5	6/12					Refusal at 9 feet.	
9								End of boring at 9 feet below ground surface	
10									
11									
12									

04-13-2001 C:\MTECH5\KA-2-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Ka-3-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-08-2001 Location : Kaukauna Sample/Drill Method : Direct Push Drilling Company : EDS Driller : [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1	SS-1	1	6/12					Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
2								Reddish brown SILTY CLAY with some gravel and rock fragments, medium hard and moist. No odor.	
3	SS-2	2	8/12						
4								Same as above.	
5	SS-3	3	8/12			CL			
6								Reddish brown SILTY CLAY with rock fragments. Medium hard and moist with sandy clay at the bottom of the boring. No odor.	
7	SS-4	4	7/12						
8								Same as above.	
9	SS-5	5	8/12						
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KA-3-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kc-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	[redacted]
Date	: 02-06-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL.	
1								Geoprobe sampling tube refusal occurred at a depth of ten feet.	
2								1:20 pm. Temporary well set at a depth of ten feet. No water was present in the well at this time.	
3								3:05 pm. Water level was measured at 9.5 feet. Water depth of five inches. Recovery was very slow.	
4									
5	SS-1	1							
6									
7									
8									
9									
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KC-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kc-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-06-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL with sand and gravel and moist.	
1								Geoprobe sampling tube refusal occurred at a depth of 9.5 feet.	
2								8:00 am. Temporary well set at a depth of 9.5 feet. No water was present in the well at this time.	
3								3:20 pm. Water level was measured at 9 feet. Water depth of 5 inches. Recovery was slow.	
4									
5	SS-1	1							
6									
7									
8									
9									
10								End of boring at 9.5 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KC-2-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kc-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-06-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL.	
1								Geoprobe sampling tube refusal occurred at a depth of 9.5 feet.	
2									
3								10:00 am. Temporary well set at a depth of 9.5 feet. No water was present in the well at this time	
4								2:50 pm. Water level measured and indicated that there was no water present. Well was considered to be dry.	
5	SS-1	1							
6									
7									
8									
9									
10								End of boring at 9.5 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KC-3-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kc-4-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Geoprobe		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0	SS-1	1				OL		6" Dark brown SILTY CLAY with gravel and roots at the surface. 15% silt. This interval is forzen.	
1						CL		Reddish brown SILTY CLAY. 10% silt, very hard and dry. No odor.	
2	SS-2	2						Reddish brown SILTY CLAY as above.	
3	SS-3	3						Dark brown SANDY CLAY, 10% medium to coarse grained sand, moderately hard, wet. No odor.	
4	SS-4	4				SS		Angular fragments of SANDSTONE bedrock up to 2 inches in size with interstial powdered standstone. Fragments extend into cutting shoe.	
5	SS-5	5				CL		Reddish brown SILTY CLAY, 10 % silt, very hard and dry. No odor.	
6								End of boring at 6 feet below ground surface.	
7									
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\KC-4-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kc-5-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0	SS-1	1				OL		6" Dark brown SILTY CLAY, 15% silt, 10% angular sandstone fragments up to 1cm in size, this interval is frozen. No odor.	
1	SS-2	2				CL		Reddish brown SILTY CLAY, 10% silt very hard and dry. No odor.	
2	SS-3	3						Reddish brown CLAY as above but with 50% coal (clinkers) and metal fragments.	
3	SS-4	4						Reddish brown CLAY as above.	
4	SS-5	5						Reddish brown SILTY CLAY as above.	
5	SS-6	6				SS		Angular SANDSTONE fragments up to 3 cm in size with interstial sandstone powder.	
6	SS-7	7				CL		Black CLAY, moderately hard, moist. No odor	
7								Reddish brown SILTY CLAY, 10% silt, very hard and dry. No odor.	
8	SS-8	8				SS		Angular SANDSTONE fragments up to 3 cm in size with interstial sandstone powder.	
9								End of boring at 9 feet below ground surface	
10									
11									
12									

04-13-2001 C:\MTECH5\KC-5-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kc-6-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	: [redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Geoprobe		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0	SS-1	1				OL		Dark brown SILTY CLAYwith grass roots, 15% silt with 10% angular gravel fragments up to 4 cm.This interval is frozen. No odor.	
1									
2	SS-2	2						Reddish brown SILTY CLAY, damp, medium plasticity.	
3								Bottom 4 inches black odorless we' clay. Low plasticity, 10 % gravel up to 1/2 cm and 10% silt.	
4						CL			
5								Dark brown SILTY CLAY as above.	
6	SS-3	3						Reddish brown SILTY CLAY as above.	
7								Reddish brown grading into dark brown SILTY CLAY.	
8								End of boring at 8 feet below ground surface.	
9									
10									
11									
12									

04-13-2001 C:\MTECH5\KC-6-01.BOR

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Environmental Services, Inc.

LOG OF BORING Kd-1-01

(Page 1 of 1)

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-06-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Geoprobe		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with sand and gravel, moist.	
1						CL		Reddish brown SILTY CLAY with some gravel, hard and moist. No odor.	
2	SS-1	1				GP		Black and brown fill with SAND & GRAVEL, wood chips and rock fragments, dry. No odor.	
3									
4									
5								Fill same as above.	
6	SS-2	2				BR		Light grey medium GRAVEL with sandstone fragments, dry.	
7								Refusal at 7 feet.	
8								End of boring at 7 feet below ground surface	
9									
10									
11									
12									

04-13-2001 C:\MTECH5\KD-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Kd-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-06-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Geoprobe		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL with grass.	
1	SS-1	1	8/36			CL		Reddish brown SILTY CLAY with some gravel, hard and moist. No odor.	
2									
3									
4	SS-1	2				GP		Dark brown to black SAND & GRAVEL with some rock fragments, loose and moist.	
5								Refusal at 5 feet.	
								End of boring at 5 feet below ground surface	
6									
7									
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\KD-2-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Kd-3-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist [redacted] Date [redacted] Location : Kaukauna Sample/D.[1] Method : Geoprobe Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL.	
						CL		Reddish brown SILTY CLAY, hard and moist. No odor.	
1	SS-1	1	15/30						
2								Black fill with SAND & GRAVEL, cinders, rock fragments and wood chips, moist. No odor.	
3									
4	SS-2	2	15/30			GP		Brown SAND & GRAVEL with trace of silty clay. Increasing amount of gravel with depth, dry. Sandstone rock fragments at the bottom of the boring. No odor.	
5								Refusal at 5 feet.	
								End of boring at 5 feet below ground surface	
6									
7									
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\KD-3-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Ke-1-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-08-2001 Location : Kaukauna Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL.	
1	SS-1	1	8/12			SC		3"-1.5' Dark brown SANDY CLAY with some rock fragments, gravel, loose and dry.	
2						CL		1.5'-2' Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
3	SS-2	2	9/12					Same as above.	
4									
5	SS-3	3	11/12					Same as above.	
6									
7	SS-4	4	11/12					Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
8									
9	SS-5	5	12/12					Same as above.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KE-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Ke-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL.	
1	SS-1	1				CL		Reddish brown SILTY CLAY with gravel, medium hard and moist. No odor.	
2	SS-2	2						Same as above.	
3								Refusal at 3 feet.	
								End of boring at 3 feet below ground surface	
4									
5									
6									
7									
8									
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10									
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ALTECH
Environmental Services, Inc.

LOG OF BORING Ke-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL.	
1	SS-1	1				GP		Dark brown SAND & GRAVEL, loose and dry. No odor.	
2								Reddish brown SILTY CLAY with some gravel, hard and moist. No odor.	
3	SS-2	2							
4						CL			
5	SS-3	3						Same as above.	
6								Reddish brown SILTY CLAY with some gravel, moist. No odor.	
7	SS-3	4						Refusal at 7 feet.	
								End of boring at 7 feet below ground surface	
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\KE-3-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Ke-4-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist [redacted] Date : 02-08-2001 Location : Kaukauna Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Brown coarse grained SAND & GRAVEL with some rock fragments, loose and dry.	
1	SS-1	1	8/12			GP		Black coarse grained SAND & GRAVEL with some cinders, rock fragments and wood chips, medium hard and moist. No odor.	
2								2-3' Same as above.	
3	SS-2	2	8/12					3-4' Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
4									
5	SS-3	3	11/12			CL		Same as above.	
6								Reddish brown SILTY CLAY with a few gravel particles, moist. No odor.	
7	SS-4	4	11/12						
8								Same as above and soft peat at the bottom of the boring.	
9	SS-5	5	10.12			PT		Refusal at 9 feet.	
								End of boring at 9.2 feet below ground surface	
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Ke-5-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GP		8 inch Brown coarse grained SAND & GRAVEL, loose and dry.	
1	SS-1	1	5/12			CL		Reddish brown SILTY CLAY with gravel, medium hard and moist. No odor.	
2								Reddish brown SILTY CLAY with a few gravle particles, moist. No odor.	
3	SS-2	2	3/12						
4								Same as above.	
5	SS-3	3	6/12			PT		Black PEAT, very soft, loose and moist. No odor.	
6								Refusal at 6 feet.	
								End of boring at 6.2 feet below ground surface	
7									
8									
9									
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Ke-6-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						SP		0-1' Black and brown SAND with some gravel and roots, loose and dry.	
1	SS-1	1	8/12					Bbrown SILTY CLAY with some gravel, medium hard and moist.	
2									
3	SS-2	2	7/12					Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
4									
5	SS-3	3	6/12			CL		Same as above.	
6									
7	SS-4	4	4/12					Reddish brown SILTY CLAY, medium hard and moist. No odor.	
8									
9	SS-6	5	3/12					Same as above. Refusal at 9 feet.	
10								End of boring at 9 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KE-6-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Ke-7-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-08-2001	Ground Elevation	: NA
Location	: Kaukauna		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0–1	SS-1	1	6/12			SP		Dark brown organic SAND with some gravel, loose and moist. No odor, light brown coarse grained sand and gravel at the bottom of the boring.	
2–3	SS-2	2	4/12			SW		Dark brown SAND with some gravel, rock fragments, cinders and wood chips, medium hard and moist. No odor	
4–5	SS03	3	5/12			SW		4-5' same as above.	
5–6						CL		Reddish brown SILTY CLAY medium hard and moist. No odor.	
7	SS-4	4	3/12			CL		Reddish brown SILTY CLAY, medium hard and moist No odor.	
8	SS-5	5	6/12			CL		Reddish brown SILTY CLAY as above, gravel at the bottom of the boring. Refusal at 9 feet.	
9								End of boring at 9 feet below ground surface	
10–12									

04-13-2001 C:\MTECH5\KE-7-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Ke-8-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-08-2001 Location : Kaukauna Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						SC		Dark brown SANDY CLAY with gravel, rock fragments, medium hard and moist. No odor.	
1	SS-1	1	8/12						
2						CL		Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
3	SS-2	2	4/12					Same as above and with increasing gravel.	
4						SC		Dark brown SANDY CLAY, medium hard and dry.	
5	SS-3	3	6/12			CL		Reddish brown SILTY CLAY, medium hard and dry. No odor.	
6						SC		Dark brown SANDY CLAY with some gravel, medium hard and moist. No odor.	
7	SS-4	4	8/12						
8						GM		Dark brown to black SAND & GRAVEL, loose and dry.	
9	SS-5	5	8/12					Brown coarse SAND with some gravel, loose and dry. No odor.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\KE-8-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Lca-1-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-13-2001 Location : Lttle Chute Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3 inch Brown ORGANIC SOIL.	
1	SS-1	1	18/24			CL		Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
2									
3	SS-2	2	20/24					Same as above.	
4									
5	SS-2	3	22/24					Reddish brown SILTY CLAY with gravel, medium hard and moist. No odor.	
6									
7	SS-4	4	18/24					Same as above.	
8									
9	SS-5	5	20/24					Same as above.	
10								Reddish brown SILTY CLAY with some gravel, very hard and moist.	
	SS-6	6	12/12					Refusal at 11 feet.	
11								End of boring at 11 feet below ground surface	
12									

04-13-2001 C:\MTECH5\LCA-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lca-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GW		6" Fill with GRAVEL.	
1	SS-1	1				GP		Dark brown SAND & GRAVEL with some rock fragments, loose and dry.	
2									
3	SS-2	2						Grayish brown SAND & GRAVEL with some cinders, loose, and moist.	
4						CL		Reddish brown SILTY CLAY with some gravel, medium hard and dry.	
5	SS-3	3							
6						PT		Black PEAT with wood chips, soft and moist.	
7	SS-4	4						No recovery.	
8								Refusal at 8 feet.	
9								End of boring at 8 feet below ground surface	
10									
11									
12									

04-13-2001 C:\MTECH5\LCA-2-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lca-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								6" Reddish brown SILTY CLAY, 30% silt, 10% angular gravel to 3 cm. This interval is frozen.	
1	SS-1	1							
2						CL			
3	SS-2	2						Same as above with no gravel, dry.	
4								Same as above but with increased moisture.	
						SS		Angular sandstone fragments to 3 cm filling cutting shoe.	
5	SS-3	3						End of boring at 4.6 feet below ground surface	
6									
7									
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\LCA-3-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Lcc-1-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-13-2001 Location : Little Chute Sample/Drill Method : Direct Push Drilling Company : EDS Driller : [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6 inch ORGANIC SOIL.	
1	SS-1	1				GM		Dark brown SAND with some gravel, wet. No odor.	
2						SC		Dark brown SANDY CLAY with some gravel, saturated. No odor	
3	SS-2	2							
4						SM		Reddish brown medium SAND with trace of silty clay, loose and saturated. No odor.	
5	SS-3	3							
6								Same as above.	
7	SS-4	4				CL		Reddish brown SILTY CLAY, soft and saturated. Refusal at 8 feet.	
8								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

04-13-2001 C:\MTECH5\LCC-101.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lcc-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6 inch ORGANIC SOIL.	
1	SS-1	1	18/24			CL		Reddish brown SILTY CLAY with trace of sand and some gravel, medium hard and moist.	
2									
3	SS-2	2	0/24					No Recovery.	
4									
5	SS-3	3	16/24					Reddish brown SILTY CLAY with a few gravel particles, soft and saturated. No odor.	
6								Refusal at 8 feet.	
								End of boring at 6 feet below ground surface	
7									
8									
9									
10									
11									
12									

04-13-2001 C:\MTECH5\LCC-2-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lcd-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GW		1 foot, Fill with GRAVEL, loose and dry.	
1									
2	SS-1	1				SC		Dark brown SANDY CLAY with some gravel, medium hard and moist.	
3								Reddish brown SILTY CLAY, medium hard and moist. No odor.	
4									
5						CL			
6	SS-2	2						Same as above.	
7									
8								Refusal at 8 feet.	

End of boring at 8 feet below ground surface

9
10
11
12

04-13-2001 C:\MTECH5\LCD-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lcd-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GW		6 inch, Fill with GRAVEL.	
1						CL		Reddish brown SILTY CLAY with some gravel, hard and moist. No odor.	
2	SS-1	1	48/48						
3								Same as above.	
4									
5	SS-2	2	24/36						
6								Reddish brown SILTY CLAY with increasing amount of gravel and some rock fragments, medium hard and moist.	
7								Refusal at 7 feet.	
8								End of boring at 7 feet below ground surface	
9									
10									
11									
12									

04-13-2001 C:\MTECH5\LCD-2-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Lcd-3-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-12-2001 Location : Little Chute Sample/Drill Method : Direct Push Drilling Company : EDS Driller : [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GW		6 inch, Fill with GRAVEL.	
1						CL		Reddish brown SILTY CLAY, hard and moist. No odor.	
2	SS-1	1	36/48						
3									
4									
5									
6	SS-2	2	40/48					Reddish brown SILTY CLAY, medium hard and less moist. No odor.	
7									
8								Refusal at 8 feet.	
								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

04-13-2001 C:\MTECH5\LCD-3-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lcd-4-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: Altech
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GW		Fill with GRAVEL.	
1									
2	SS-1	1	40/48						
3								Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
4						CL			
5									
6	SS-2	2	48/48					Same as above.	
7									
8								Refusal at 8 feet.	

End of boring at 8 feet below ground surface

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12

04-13-2001 C:\MTECH5\LCD-4-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Lce-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Little Chute		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6 inch ORGANIC SOIL,	
1	SS-1	1	7/12			CL		Reddish brown SILTY CLAY with a few gravel particles, medium hard and moist.	
2									
3	SS-2	2	3/12					Dark brown to reddish brown SILTY CLAY, medium hard and moist.	
4									
5	SS-3	3	6/12					Reddish brown SILTY CLAY with some gravel, medium hard and moist.	
6									
7	SS-4	4	8/12					No recovery.	
8									
9	SS-5	5	12/12					Dark brown SILTY CLAY, soft and moist to wet.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\LCE-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apa-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	[redacted]
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						GC		Dark Brown SANDY CLAY with some gravel and rock fragments, medium hard and moist.	
1	SS-1	1	8/12			CL		Reddish brown SILTY CLAY with some gravel, medium hard and moist.	
2									
3	SS-2	2	12/12					Reddish brown SILTY CLAY with a few gravel particles, medium hard and moist.	
4								4-5.5' Same as above. Lower 6 inches has yellowish sandstone fragments and is dry.	
5	SS-3	3	10/12						
6								6-7.5' Reddish brown SILTY CLAY with a few gravel particles, medium hard and moist.	
7	SS-4	4	10/12					7.5-8' Dark brown SILTY CLAY with a few gravel particles, increasingly moist with depth.	
8								8-8.5' Same as above.	
9	SS-5	5	10/12					Reddish brown SILTY CLAY with a few gravel particles, soft and increasingly moist.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-12-2001 C:\MTECH5\APA-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apa-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	: [redacted]
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								0-1' Dark brown SILTY CLAY with some gravel and rock fragments, dry	
1	SS-1	1	5/12					1-2' Reddish brown SILTY CLAY with a few rock fragments and gravel particles, medium hard and dry.	
2									
3	SS-2	2	8/12					Reddish brown SILTY CLAY with some gravel, medium hard and moist.	
4								Same as above.	
5	SS-3	3	8/12			CL			
6								Reddish brown SILTY CLAY with some gravel, medium hard and moist.	
7	SS-4	4	10/12						
8								Reddish brown SILTY CLAY, soft and increasingly moist.	
9	SS-5	5	12/12						
10								End of boring at 10 feet below ground surface	
11									
12									

04-12-2001 C:\MTECH5\APA-2-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apa-3-01

(Page 1 of 1)

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0–1	SS-1	1	8/12			SP		Dark brown medium to coarse SAND with some gravel, rock fragments and cinders. Loose, poorly sorted and dry. No odor.	
2								2-3' Same as above.	
3–4	SS-2	2	10/12			CL		Reddish brown SILTY CLAY, medium hard and moist.	
5–7	SS-3	3	8/12			SP		Dark brown coarse SAND, loose, poorly sorted and wet. Refusal at 8 feet.	
8								End of boring at 8 feet below ground surface	
9–12									

04-12-2001 C:\MTECH5\APA-3-01.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Apa-4-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-14-2001 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller : [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0									
1	SS-1	1	3/12			GW		Dark brown coarse SAND & GRAVEL, loose and moist.	
2								Same as above.	
3	SS-2	2	14/36						
4								4-5' Brown SANDY CLAY with some gravel, medium hard and moist.	
5						SC		Reddish brown SANDY CLAY, with trace of silt and more gravel, medium hard and moist.	
6	SS-3	3	2/12						
7								Refusal at 7 feet.	
								End of boring at 7 feet below ground surface	
8									
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APA-4-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apa-5-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		0-1' Black ORGANIC SOIL with roots, moist.	
1	SS-1	1	3/12						
2						CL		No recovery, reddish brown SILTY CLAY with some rock fragments, dry.	
3									
4	SS-2	2	5/36						
5								Reddish brown SILTY CLAY with some gravel, rock fragments, medium hard and moist.	
6	SS-3	3	3/12						
7								Refusal at 7 feet.	
								End of boring at 7 feet below ground Surface	
8									
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APA-5-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc1-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	[redacted]
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Black ORGANIC SOIL.	
1	SS-1	1	12/12			SC		Reddish brown SANDY CLAY with some gravel, hard and moist.	
2									
3	SS-2	2	8/12						
4								4-5 ' FILL with rock fragments, some sand and cinders, moist.	
5	SS-3	3	10/12			CL		5-6' Reddish brown SILTY CLAY with some gravel, medium hard and moist.	
6								Dark brown SILTY CLAY with a few gravel particles, medium hard and moist.	
7	SS-4	4	12/12						
8								8-9' Black FILL with some sand & gravel, rock fragments and cinders, poorly sorted and wet.	
9	SS-5	5	6/12			SP		9-10' Black fine to medium grained SAND, loose and moist to wet.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-12-2001 C:\MTECH5\APC1-1-0.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Apc1-2-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist [redacted] Date : 02-14-2001 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Black ORGANIC SOIL.	
1	SS-1	1	8/12			CL		Reddish brown SILTY CLAY with some gravel, medium hard and moist	
2								Reddish brown SILTY CLAY wtih some gravel and rock fragments, moist.	
3	SS-2	2	10/12						
4								Same as above.	
5	SS-3	3	7/12						
6								6-7' Reddish brown SILTY CLAY, hard and moist.	
7	SS-4	4	9/12					7-8' Dark brown to black SILTY CLAY, soft and increasingly moist. Slight odor	
8								same as above.	
9	SS-5	5	9/12						
10								End of boring at 10 feet below ground surface	
11									
12									

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ALTECH Environmental Services, Inc.	LOG OF BORING Apc1-3-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-14-2001 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Black ORGANIC SOIL.	
1	SS-1	1				SC		Reddish brown SILTY CLAY with some gravle and black cinders, hard and moist.	
2								Reddish brown SANDY CLAY with some gravel, medium hard and moist.	
3	SS-2	2							
4						GC		Reddish brown SANDY CLAY with some gravel and increased moisture.	
5	SS-3	3							
6								6-7' Same as above but saturated.	
7	SS-4	4						7-8' Reddish brown SILTY CLAY, medium hard with increased moisture.	
8						SC		8-9' Reddish brown SILTY CLAY with some gravel, saturated.	
9	SS-5	5						9-10' Black SILTY CLAY very soft and increasingly moist.	
10								End of boring at 10 feet below ground surface	
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Apc2-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								Dark brown FILL with coarse sand & gravel, cinders, roots, loose, no odor and dry.	
1									
2	SS-1	1						2-4' Black FILL with sand & cinders, gravels, rocks, loose and dry. No odor.	
3									
4								Same as above.	
5									
6	SS-2	2				SC		Reddish brown SANDY CLAYwith a few gravel particles, medium hard and moist to wet.	
7									
8								Refusal at 8 feet.	
								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Apc2-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	: [redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								Grey FILL with sand & gravel, dry.	
1	SS-1	1						1-3 feet Dark brown FILL with coarse sand & gravel, loose and dry.	
2									
3	SS-2	2						3-4' Reddish brown SANDY CLAY wtih gravel, hard, brown moist sand at the bottom of the boring.	
4						SC			
5	SS-3	3						Reddish brown SANDY CLAY with some gravel, trace of silty clay, medium hard and moist.	
6									
7	SS-4	4				CL		Reddish brown SILTY CLAY with a few gravel particles, medium hard and increasing moisture with depth. No odor. Refusal at 7.5 feet.	
8								End of boring at 7.5 feet below ground surface	
9									
10									
11									
12									

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ALTECH Environmental Services, Inc.	LOG OF BORING Apc2-3-1 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist : [redacted] Date : 02-12 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller : [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								Dark brown to black FILL with cinders, rock fragments, gravel, loose and dry. No odor.	
1									
2	SS-1	1							
3								Black FILL with sand, cinders and gravle, loose and dry. No odor.	
4									
5								Same as above.	
6	SS-2	2				CL		5-8' Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
7									
8								Refusal at 8 feet.	
								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Apc3-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								Black FILL with some gravel, rock fragments, cinders, wood chips, trace of coarse sand, dry. Strong hydrocarbon odor.	
1									
2	SS-1	1							
3									
4								Same as above.	
5									
6	SS-2	2							
7								Black FILL with sand, increasing moisture and sandstone fragments at the bottom of the boring	
8								Refusal at 8 feet.	
								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APC3-1-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc3-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 04-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0								Dark brown FILL with gravel, rocks, bricks and cinders, trace of sand and silty clay, hard and dry. No odor.	
1									
2	SS-1	1							
3									
4								Dark brown FILL with coarse sand, rocks and cinders, wood, very hard and dry. No odor. Sandstone fragments at the bottom of the boring.	
5									
6	SS-2	2							
7								Refusal at 7.5 feet.	
8								End of boring at 7.5 feet below ground surface	
9									
10									
11									
12									

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Environmental Services, Inc.

LOG OF BORING Apc-3-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: [redacted]
Geologist	[redacted]	Driller	: Greg
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0–1	SS-1	1						Black FILL with rock fragments, gravel, sand and cinders, dry.	
2–3						CL		Reddish brown SILTY CLAY with rock fragments, gravel, medium hard and dry. No odor. Refusal at 3 feet.	

End of boring at 3 feet below ground surface

04-12-2001 C:\MTECH5\APC3-3-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Apc4-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-14-01	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Dark brown ORGANIC SOIL with some roots.	
1	SS-1	1	12/12			SC		Reddish brown SANDY CLAY with some gravel, moist.	
2									
3	SS-2	2	8/12					Reddish brown SANDY CLAY with increasing gravel and rock fragments, medium hard and moist.	
4									
5	SS-3	3	8/12					Reddish brown SANDY CLAY with some gravel and traces of silt, medium hard and moist.	
6									
7	SS-4	4	12/12					Same as above with increasing gravel and rock fragments.	
8								Refusal at 8 feet.	
								End of boring at 8 feet below ground surface	
9									
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Apc4-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	[redacted]
Date	: 02-14-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		ORGANIC SOIL with roots.	
1	SS-1	1	6/12			SC		Brown FILL with medium to coarse sand, gravel, cinders, rock fragments, paint chips, loose and dry	
2								Same as above and with some fragments of brick.	
3	SS-2	2	7/12					Reddish brown SANDY CLAY with some gravel, trace of silt, medium hard and moist.	
4						CL			
5	SS-3	3	7/12					Reddish brown SILTY CLAYwith increasing gravel, hard and moist.	
6									
7									
8	SS-4	4	8/12					Same as above.	
9									
10								Refusal at 10 feet.	
11								End of boring at 10 feet below ground surface	
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING Apc5-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0	SS-1	1	8/12					Brown FILL with some gravel and rock fragments, loose and dry.	
1						GP		Black medium - coarse grained SAND & GRAVEL, with some cinders, loose and dry. Sandstone fragments at the bottom of the boring.	
2	SS-2	2	10/12					Refusal at 3 feet.	
3								End of boring at 3 feet below ground surface	
4									
5									
6									
7									
8									
9									
10									
11									
12									

04-12-2001 C:\MTECH5\APC5-1-0.BOR

ALTECH Environmental Services, Inc.	LOG OF BORING Apc5-2-01 (Page 1 of 1)
U.S. Army Corps of Engineers Detroit District Altech Project # 9230	Client : USACE Geologist [redacted] Date : 02-12-2001 Location : Appleton Sample/Drill Method : Direct Push Drilling Company : EDS Driller [redacted] Ground Elevation : NA

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0–1	SS-1	1	24/48			GW		0-2' Black and brown coarse SAND & GRAVEL, loose and dry.	
2–3	SS-2	2	24/48			CL		Reddish brown SILTY CLAY with some gravel, rock fragments, medium hard and moist.	
4–5	SS-3	3	36/48			GP		Grayish brown GRAVELwith trace of sand, loose and dry. No odor.	
6–7	SS-4	4	40/48			SP		Reddish brown SAND with some gravel, moist to wet.	
8								Refusal at 8 feet.	

End of boring at 8 feet below ground surface

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ALTECH
Environmental Services, Inc.

LOG OF BORING Apc5-3-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-12-2001	Ground Elevation	: NA
Location	: Appleton		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0									
1	SS-1	1	12/12					Black FILL with medium - coarse grained sand, rock fragments, cinders and gravel, loose and dry. No odor.	
2									
3	SS-2	2	12/12			CL		Reddish brown SILTY CLAY with some gravel, hard and moist. No odor.	
4									
5	SS-3	3	10/12			SC		Reddish brown SANDY CLAY with some gravel, medium hard and moist.	
6									
7	SS-4	4	12/12					7-8 feet Dark brown to black medium to coarse grained SAND with some gravel, trace of silt, medium hard and moist. No odor.	
8									
9						SP			
10	SS-5	5	30/36					8-11.5 feet Dark brown medium grained SAND, soft and moist. Increasing to wet at 10 feet. No odor.	
11								Refusal at 11.5 feet.	
12								End of boring at 11.5 feet below ground surface	

04-12-2001 C:\MTECH5\APC5-3-0.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING Dpa-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-07-2001	Ground Elevation	: NA
Location	: De pere		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		3" Brown ORGANIC SOIL with sand and gravel, moist.	
1								Temporary well set at a depth of 9 feet. No water was present in the well at this time.	
2									
3									
4	SS-1	1							
5								12:35 pm. Water level was measured at 8.5 feet. Water depth of five inches.	
6									
7									
8									
9								End of boring at 9 feet below ground surface	
10									
11									
12									

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ALTECH
Environmental Services, Inc.

LOG OF BORING M-1-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	: [redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Menasha		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		Brown ORGANIC SOIL with roots.	
1	SS-1	1	6/12			SP		Dark brown SAND with a few gravel particles, moist.	
2									
3	SS-2	2	6/12					Same as above.	
4						SC		Reddish brown SANDY CLAYwith some gravel, soft and moist. No odor.	
5	SS-3	3	8/12			SP		Dark brown coarse SAND with some gravel, loose and saturated.	
6									
7	SS-4	4	10/12			SC		Reddish brown SANDY CLAY with some gravel, loose and more wet.	
8								Dark brown to black SANDY CLAY with gravel, loose and saturated.	
9	SS-5	5	12/12			PT		Black PEAT with saw dust, soft and saturated.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\M-1-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING M-2-01

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	[redacted]	Driller	[redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Menasha		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6" ORGANIC SOIL	
1	SS-1	1	4/12			SP		Dark brown med. SAND, loose and moist.	
2						PT		Black SANDY PEAT with wood chips and roots, loose, soft and moist.	
3	SS-2	2	6/12			SP		Brown coarse SAND with some gravel, loose, poorly sorted and wet.	
4									
5	SS-3	3	6/12					Brown SAND with some gravel, loose and saturated.	
6						PT		Black SANDY PEAT with wood fragments, loose and wet.	
7	SS-4	4	6/12						
8						SP		Brown coarse SAND with some gravel, loose, poorly sorted and wet.	
9	SS-5	5	10/12			CL		Reddish brown SILTY CLAY with a few gravel particles, wet.	
10								End of boring at 10 feet below ground surface	
11									
12									

04-13-2001 C:\MTECH5\M-2-01.BOR

ALTECH
Environmental Services, Inc.

LOG OF BORING M-3-01

(Page 1 of 1)

U.S. Army Corps of Engineers
Detroit District
Altech Project # 9230

Client	: USACE	Drilling Company	: EDS
Geologist	: [redacted]	Driller	[redacted]
Date	: 02-13-2001	Ground Elevation	: NA
Location	: Menasha		
Sample/Drill Method	: Direct Push		

Depth in feet	Samp. Type	Samples	Rec. (in)	PID (ppm)	Blow Count	USCS	GRAPHIC	DESCRIPTION	REMARKS
0						OL		6 inch ORGANIC SOIL with roots.	
1	SS-1	1				SC		Reddish brown SANDY CLAY with some gravel, medium hard and moist.	
2									
3	SS-2	2						Reddish brown SILTY CLAY with some gravel, medium hard and moist. No odor.	
4						CL			
5	SS-3	3							
6								Same as above.	
7	SS-4	4						Refusal at 7 feet.	
8								End of boring at 7 feet below ground surface	
9									
10									
11									
12									

04-13-2001 C:\MTECH5\M-3-01.BOR

ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: De Pere

Date: 2/7/01 Well Number: DPa-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.42

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: NA Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH: 1). 2). 3).

Temperature: 1). 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/7/01 Sampling Method: Stainless Bailer

Time: 12:40 Field Filtration?: ( ) Yes (x) No Type:

pH: Temperature: Conductivity:

Sample Appearance: Brown and Cloudy

Weather Conditions: Sunny Temp (F): -5°F Wind Speed:

EQUIPMENT USED: Stainless bailer.

COMMENTS AND OBSERVATIONS: There was insufficient water and recharge to develop the well or to collect sufficient water volumes to measure pH, temperature or conductivity.

24209 Northwestern Highway, Suite 230 • Southfield, Michigan 48075 • (248) 353-3832 • FAX (248) 353- 5485

ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Kaukauna

Date: 2/07/01 Well Number: LKc-3-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.5

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: NA Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH: 1). 2). 3).

Temperature: 1). 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 14:39 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.4 Temperature: 40.8°F Conductivity:

Sample Appearance: Brown and Cloudy

Weather Conditions: Sunny Temp (F): 22°F Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter and thermometer.

COMMENTS AND OBSERVATIONS: Not enough water in the well to sample three required vials. Only collected one vial. Very slow recovery, waited 48 hours for well to charge.

24209 Northwestern Highway, Suite 230 • Southfield, Michigan 48075 • (248) 353-3832 • FAX (248) 353- 5485

ALTECH ENVIRONMNETAL SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Kaukauna

Date: 2/26/01 Well Number: Kc-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.42

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: NA Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH: 1). 2). 3).

Temperature: 1). 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/26/01 Sampling Method: Stainless Bailer

Time: 15:05 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.5 Temperature: 41.8° F Conductivity: 1650

Sample Appearance: Brown and Cloudy

Weather Conditions: Partly Cloudy Temp (F): -5°F Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: There was insufficient water and recharge to develop the well.

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ALTECH
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GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Kaukauna

Date: 2/26/01 Well Number: Kc-2-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (TOC) (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/7/01 Time: _____ Purge Method: None

Purge Water Appearance: _____ Purge Water Odor: _____

pH: 1). _____ 2). _____ 3). _____

Temperature: 1). _____ 2). _____ 3). _____

Conductivity: 1). _____ 2). _____ 3). _____

SAMPLING DATA:

Date: 2/26/01 Sampling Method: Stainless Bailer

Time: 15:20 Field Filtration?: ( ) Yes (x) No Type: _____

pH: 7.6 Temperature: 41.7° F Conductivity: 890

Sample Appearance: Brown and Cloudy

Weather Conditions: Partly Cloudy Temp (F): -5°F Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: _____

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ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Kaukauna

Date: 2/7/01 Well Number: Kc-3-01

Site Location: Kaukauna

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (TOC) (ft): 10.25 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.75

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/7/01 Time: Purge Method: Bailer

Purge Water Appearance: Dark brown Purge Water Odor: None

pH: 1). 7.4 2). 3).

Temperature: 1). 40.8 F 2). 3).

Conductivity: 1). 2). 3).

SAMPLING DATA:

Date: 2/7/01 Sampling Method: Stainless Bailer

Time: 14:39 Field Filtration?: ( ) Yes (x) No Type:

pH: NA Temperature: NA Conductivity: NA

Sample Appearance: Brown and Cloudy

Weather Conditions: Temp (F): Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS:

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ALTECH
ENVIRONMNETAL
SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Chute

Date: 2/14/01 Well Number: LCb-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: TPH

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 5.21

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/14/01 Time: 16:50 Purge Method: Bailer

Purge Water Appearance: Brown Purge Water Odor: None

pH: 1). 7.5 2). River 7.4 3).

Temperature: 1). 34°F 2). River 34.2°F 3).

Conductivity: 1). 970 2) River 560 3).

SAMPLING DATA:

Date: 2/14/01 Sampling Method: Peristaltic pump

Time: 16:30 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.5 Temperature: 34.9°F Conductivity: 970

Sample Appearance: Brown and Cloudy

Weather Conditions: Cloudy Temp (F): 29.5°F Wind Speed:

EQUIPMENT USED: Peristaltic pump, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: Enough water and fast recovery.

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ALTECH
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GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Chute

Date: 2/14/01 Well Number: LCb-2-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: TPH

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 10 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 1.51

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/14/01 Time: 16:50 Purge Method: Peristaltic pump

Purge Water Appearance: Dark brown Purge Water Odor: None

pH: 1). 7.4 2). 3).

Temperature: 1). 34.2°F 2). 3).

Conductivity: 1). 1230 2). 1120 3).

SAMPLING DATA:

Date: 2/14/01 Sampling Method: Peristaltic pump

Time: 16:30 Field Filtration?: ( ) Yes (x) No Type:

pH: 7.4 Temperature: 34.2°F Conductivity: 1230

Sample Appearance: Brown and Cloudy

Weather Conditions: Temp (F): 27.3°F Wind Speed:

EQUIPMENT USED: Peristaltic pump, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: Slow recovery.

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ALTECH
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GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Little Chute

Date: 2/15/01 Well Number: LCe-1-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 9.25

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/15/01 Time: _____ Purge Method: None

Purge Water Appearance: _____ Purge Water Odor: _____

pH: 1). _____ .2). _____ .3). _____

Temperature: 1). _____ .2). _____ 3). _____

Conductivity: 1). _____ 2). _____ 3). _____

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 13:53 Field Filtration?: ( ) Yes (x) No Type: _____

pH: NA Temperature: NA Conductivity: NA

Sample Appearance: Brown and Cloudy

Weather Conditions: Sunny Temp (F): 22°F Wind Speed: _____

EQUIPMENT USED: Stainless bailer

COMMENTS AND OBSERVATIONS: Not enough water in the well to sample three require vials. Only collected one vial. Very slow recovery, waited 48 hours for well to charge.

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ALTECH
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GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Appleton

Date: 2/15/01 Well Number: APc1-1-01

Site Location:

Site Contact:

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition:

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 5.75

Water Column (ft): X 0.163 = X 3 vols. = Gal.purg

PURGING DATA:

Date: 2/15/01 Time: Purge Method: None

Purge Water Appearance: Purge Water Odor:

pH:	1). 7.7	2). 7.6	3). 7.6
Temperature:	1). 36.3°F	2). 36°F	3). 36°F
Conductivity:	1). 570	2). 540	3). 540

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 15:15 Field Filtration?: ( ) Yes (x) No Type:

pH: Temperature: Conductivity:

Sample Appearance: Black and Cloudy

Weather Conditions: Temp (F): Wind Speed:

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer.

COMMENTS AND OBSERVATIONS: Enough water

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ALTECH
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SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Appleton

Date: 2/15/01 Well Number: APc1-2-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 5.65

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/15/01 Time: 15:25 Purge Method: Bailer

Purge Water Appearance: Black Purge Water Odor: None

pH:	1). 7.4	2). 7.5	3). 7.6
Temperature:	1). 34°F	2). 36.7°F	3). 37.2°F
Conductivity:	1). 760	2). 780	3). 810

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 15:30 Field Filtration?: ( ) Yes (x) No Type: _____

pH: _____ Temperature: _____ Conductivity: _____

Sample Appearance: Brown and Cloudy

Weather Conditions: _____ Temp (F): _____ Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer

COMMENTS AND OBSERVATIONS: _____

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ALTECH ENVIRONMNETAL SERVIVECS, INC

GROUDWATER SAMPLING FIELD DATA SHEET

SITE LOCATION: Appleton

Date: 2/15/01 Well Number: APc1-3-01

Site Location: _____

Site Contact: _____

Personnel Present: [redacted]

Parameters to be Analyzed: VOCs

WELL DATA:

Well Secure Upon Arrival?: ( )Yes ( )No Well Condition: _____

Casing Materials: PVC Casing Diameter: 3/4 " I.D

Well Depth (ft): 9.5 Secure Upon Departure?: ( )Yes ( )No

Depth to Water (ft) (-): 4.41

Water Column (ft): _____ X 0.163 = _____ X 3 vols. = _____ Gal.purg

PURGING DATA:

Date: 2/15/01 Time: 15:35 Purge Method: Bailer

Purge Water Appearance: Brown Purge Water Odor: None

pH:	1). 7.6	2). 7.7	3). 7.7
Temperature:	1). 35.6°F	2). 37.2°F	3). 37.8°F
Conductivity:	1). 580	2). 620	3). 620

SAMPLING DATA:

Date: 2/15/01 Sampling Method: Stainless Bailer

Time: 15:40 Field Filtration?: ( ) Yes (x) No Type: _____

pH: NA Temperature: NA Conductivity: NA

Sample Appearance: Brown and Cloudy

Weather Conditions: _____ Temp (F): _____ Wind Speed: _____

EQUIPMENT USED: Stainless bailer, pH, conductivity meter, and thermometer

COMMENTS AND OBSERVATIONS: _____

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APPENDIX C – ANALYTICAL RESULTS AND QA/QC REPORTS

DLZ LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

ANALYTICAL RESULTS AND QUALITY ASSURANCE REPORT

FOX RIVER PHASE II

Contract Number:
Delivery Order Number:

DLZ LAB ID NUMBERS: C1B0146-01*07, C1B0148-01*06, C1B0164-01*11, C1B0163-01*10, C1B0165-01*14, C1B0167-01*03.

Document 1 of 3 03/28/2001

SUBMITTED TO:

[redacted]
US Department of the Army
Detroit District, Corps of Engineers
477 Michigan Avenue
P.O. Box 1027
Detroit, Michigan 48231-1027

SUBMITTED BY:

DLZ LABORATORIES, INC.
1423 KEYSTONE AVE.
LANSING, MICHIGAN 48911
Tel: (517)393-4444
Fax: (517)272-6909

TABLE OF CONTENTS

Document 1

Section A **General Information**

Case Narrative
Laboratory Report of Analytical Results
Chain-of-Custody Documentation

Document 2
DLZ Laboratories, Inc.
Laboratory Report of Batch QC Related Analytical Results Summaries

Section B **QA/QC Support Documentation**
GRO/DRO Analysis (EPA Method 8015)

Sample Hold Time Table
GRO System Monitoring Compounds Tables
Surrogate Recovery Summaries
DRO System Monitoring Compounds Tables
Surrogate Recovery Summaries
GRO QA/QC Summary Report Form
Matrix Spike/Matrix Spike Duplicate Summary
Method Blank Results
Laboratory Control Sample Results
DRO QA/QC Summary Report Form
Matrix Spike/Matrix Spike Duplicate Summary
Method Blank Results
Laboratory Control Sample Results

Section C **QA/QC Support Documentation-Metals Kit**

Sample Hold Time Tables
Total Mercury
(Atomic Absorption, Cold Vapor Technique)
(EPA Method 7471A)
Total Michigan 10 Metals (Cr, Cu, Zn, As, Se, Cd, Ba, & Pb),
Total DLZ List II Metals (Ni), and
with Inductively Coupled Plasma-MS
(EPA Method 3005B,3050B, & 6020)
Total Metals (Fe, Ag, Ba, and Mn)
with Inductively Coupled Plasma-AE
(EPA Method 3005B, 3050B & 6010B)

Section D **QA/QC Support Inorganics**

Total Solids (Gravimetric) (SM2540G)
Total Recoverable Petroleum Hydrocarbons (418.1)

Document 3

Trimatrix Laboratory
Quality Control Report Packages

SECTION A

GENERAL INFORMATION

CASE NARRATIVE

A total of fifty three (53) grab soil samples, ten (10) grab aqueous samples, and one (1) equipment blank aqueous sample were collected by Altech Environmental Services, Inc. on behalf of the Detroit District USACE on February 6, 7, 8, and 12-15, 2001. Samples for volatiles analysis along with a methanol trip blank were received by DLZ Laboratories, Inc. Michigan facility on February 09, 2001. (Four (4) methanol preserved samples and four (4) aqueous samples.) Seventeen soil samples were received by DLZ Laboratories, Inc. Michigan facility on February 09, 2001 for PCB and COE Metals Kit analysis. Four (4) aqueous samples along with an equipment blank for volatiles analysis were received by DLZ Laboratories, Inc. Michigan facility on February 16, 2001. Two aqueous samples for TPH analysis along with thirty three (33) soil samples for varied analytical requests were received by DLZ Laboratories, Inc. Michigan facility on February 16, 2001. In all eleven (11) aqueous sample sources and fifty four (54) sediment sample sources were analyzed in this sampling event. These sample sources were analyzed for: PPO Volatile compounds, PCBs, DRO-GRO, Total Petroleum Hydrocarbons, Total Solids, and The Michigan Metals Kit (As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, and Zn). Analysis assigned to each sample source submitted is given in Table I with corresponding laboratory ID and subcontract laboratory IDs. Analysis for PPO Volatiles, PCBs, and selected metals was subcontracted to Trimatrix Laboratory.

These analysis were performed in accordance with USEPA/ACE 81-1 procedures, Standard Methods for the Examination of Water and Wastewater, USEPA/600/R-94/024, ASTM D421/422, and USEPA SW846 Methods as specified in the work plan.

A discussion of each element present in documents 2 and 3 of this final report/quality control package follows.

Table I

Cross Reference to Sample Source and Analytical Parameters

COE ID	LAB ID	Analytical Kits and determinations					
		PPO-Vol	PCB	DRO GRO	Total Solids	TPH	MI Metals
LCc-1-01	C1B0146-05					x	
LCc-2-01	C1B0146-06					x	
LKc-3-01	271445	x					
Kc-1-01	271446	x					
Kc-2-02	271447	x					
DPa-1-01	271448	x					
Apc-1-1-01 aq	272192	x					
APc-1-2-01	272193	x					
APc-1-3-01	272194	x					
LCc-1-01	272195	x					
Equipment blk	272196	x					
MeOH blk	271452	x					
Kd-1-01	271486		x		x		x
Kd-2-01	271487		x		x		x
Kd-3-01	271488		x		x		x
LKa-1-01	271489		x		x		x
LKa-2-01	271490		x		x		x
LKa-3-01	271491		x		x		x
Ka-1-01	C1B0164-09		x		x		x
Ka-2-01	C1B0164-10		x		x		x
Ka-3-01	C1B0164-11		x		x		x
Kc-4-01	C1B0167-01				x		x
Kc-5-01	C1B0167-02				x		x
Kc-6-01	C1B0167-03				x		x
Kc-1-01	C1B0164-01				x		x
Kc-2-01	C1B0164-02				x		x
Kc-3-01	C1B0164-03				x		x
Kc-4-01	C1B0164-04				x		x
Kc-5-01	C1B0164-05				x		x
Kc-6-01	C1B0164-06				x		x
Kc-7-01	C1B0164-07				x		x
Kc-7-01	C1B0164-08				x		x
LCd-3-01	C1B0165-01				x		x
LCd-4-01	C1B0165-02				x		x
M-1-01	C1B0165-03		x		x		x
M-2-01	C1B0165-04		x		x		x
M-3-01	C1B0165-05		x		x		x

Table I
Cross Reference to Sample Source and Analytical Parameters

COE ID	LAB ID	Analytical Kits and determinations					
		PPO-Vol	PCB	DRO GRO	Total Solids	TPH	MI Metals
APc2-1-01	C1B0165-06				x		x
APc2-2-01	C1B0165-07				x		x
APc2-3-01	C1B0165-08				x		x
APa-1-01	C1B0163-01		x		x		x
APa-2-01	C1B0163-02		x		x		x
APa-3-01	C1B0163-03		x		x		x
APa-4-01	C1B0163-04		x		x		x
APa-5-01	C1B0163-10		x		x		x
LCa-1-01	C1B0163-05		x		x		x
LCa-2-01	C1B0163-06		x		x		x
LCa-3-01	C1B0163-07		x		x		x
LCd-1-01	C1B0163-08		x		x		x
LCd-2-01	C1B0163-09		x		x		x
APc3-1-01	C1B0148-01			x	x		
APc3-2-01	C1B0148-02			x	x		
APc3-3-01	C1B0148-03			x	x		
APc4-1-01	C1B0148-04			x	x		
APc4-2-01	C1B0148-05			x	x		
LCc-1-01	C1B0148-06			x	x		
LCd-3-01	272207		x		x		
LCd-4-01	272208		x		x		
APc5-1-01	272186	x	x		x		
APc5-3-01	272188	x	x		x		
APc5-2-01	272187	x	x		x		
DPb-1-01	271449	x			x		
DPb-2-01	271450	x			x		
DPb-3-01	271451	x			x		
Apc1-1-01 (s)	272189	x			x		
Apc1-2-01 (s)	272190	x			x		
Apc1-3-01 (s)	272191	x			x		

Sample Identification Cross Reference

Altech/COE Sample ID	DLZ Sample ID	Trimatrix Sample ID	Matrix	Date Sampled	Time Sampled
Kd-1-01		271486	Soil	2/6/01	14:15
Kd-2-01		271487	Soil	2/6/01	14:25
Kd-3-01		271488	Soil	2/6/01	14:45
LKa-1-01		271489	Soil	2/7/01	15:50
LKa-2-01		271490	Soil	2/7/01	15:30
LKa-3-01		271491	Soil	2/7/01	14:20
LKc-3-01		271445	Aqueous	2/7/01	14:39
Kc-1-01		271446	Aqueous	2/6/01	15:00
Kc-2-02		271447	Aqueous	2/6/01	15:20
DPa-1-01		271448	Aqueous	2/7/01	12:40
DPb-1-01		271449	Soil	2/7/01	10:15
DPb-2-01		271450	Soil	2/7/01	11:50
DPb-3-01		271451	Soil	2/7/01	11:15
Methanol Blank		271452	MeOH	2/7/01	
Ke-1-01	C1B0164-01	272215	Soil	2/8/01	11:45
Ke-2-01	C1B0164-02	272216	Soil	2/8/01	12:10
Ke-3-01	C1B0164-03	272217	Soil	2/8/01	13:05
Ke-4-01	C1B0164-04	272218	Soil	2/8/01	16:30
Ke-5-01	C1B0164-05	272219	Soil	2/8/01	15:50
Ke-6-01	C1B0164-06	272220	Soil	2/8/01	15:10
Ke-7-01	C1B0164-07	272221	Soil	2/8/01	14:50
Ke-8-01	C1B0164-08	272222	Soil	2/8/01	14:10
Ka-1-01	C1B0164-09	271492	Soil	2/8/01	9:10
Ka-2-01	C1B0164-10	271493	Soil	2/8/01	9:40
Ka-3-01	C1B0164-11	271494	Soil	2/8/01	10:10
APc-1-1-01		272192	Aqueous	2/15/01	15:15
APc-1-2-01		272193	Aqueous	2/15/01	15:30
APc-1-3-01		272194	Aqueous	2/15/01	15:40
LCe-1-01		272195	Aqueous	2/15/01	14:15
LCc-1-01	C1B0146-05		Aqueous	2/14/01	17:00
LCc-2-01	C1B0146-06		Aqueous	2/14/01	16:30
Equip. Blank		272196	Aqueous	2/15/01	15:40
APc3-1-01	C1B0148-01		Soil	2/12/01	15:15
APc3-2-01	C1B0148-02		Soil	2/12/01	14:55
APc3-3-01	C1B0148-03		Soil	2/12/01	14:35
APc4-1-01	C1B0148-04		Soil	2/14/01	10:15
APc4-2-01	C1B0148-05		Soil	2/14/01	10:45
LCe-1-01	C1B0148-06		Soil	2/13/01	13:10
LCd-3-01	C1B0165-01	272207	Soil	2/12/01	10:15
LCd-4-01	C1B0165-02	272208	Soil	2/12/01	9:15
M-1-01	C1B0165-03	272209	Soil	2/13/01	16:55
M-2-01	C1B0165-04	272210	Soil	2/13/01	16:10
M-3-01	C1B0165-05	272211	Soil	2/13/01	16:30
APc2-1-01	C1B0165-06	272212	Soil	2/12/01	16:20
APc2-2-01	C1B0165-07	272213	Soil	2/12/01	16:55
APc2-3-01	C1B0165-08	272214	Soil	2/12/01	15:50
APc5-1-01		272186	Soil	2/12/01	12:50
APc5-3-01		272187	Soil	2/12/01	11:45

Sample Identification Cross Reference

Altech/COE Sample ID	DLZ Sample ID	Trimatrix Sample ID	Matrix	Date Sampled	Time Sampled
APc5-2-01		272188	Soil	2/12/01	12:15
APc1-1-01		272189	Soil	2/14/01	12:00
APc1-2-01		272190	Soil	2/14/01	12:30
APc1-3-01		272191	Soil	2/14/01	12:35
APa-1-01	C1B0163-01	272197	Soil	2/14/01	13:30
APa-2-01	C1B0163-02	272198	Soil	2/14/01	13:00
APa-3-01	C1B0163-03	272199	Soil	2/14/01	8:30
APa-4-01	C1B0163-04	272200	Soil	2/14/01	8:45
LCa-2-01	C1B0163-05	272201	Soil	2/13/01	11:00
LCa-1-01	C1B0163-06	272202	Soil	2/13/01	13:00
LCa-3-01	C1B0163-07	272203	Soil	2/13/01	13:30
LCd-1-01	C1B0163-08	272204	Soil	2/12/01	10:45
LCd-2-01	C1B0163-09	272205	Soil	2/12/01	10:35
APa-5-01	C1B0163-10	272206	Soil	2/14/01	9:10
Kc-4-01	C1B0167-01	272223	Soil	2/8/01	16:00
Kc-5-01	C1B0167-02	272224	Soil	2/8/01	14:50
Kc-6-01	C1B0167-03	272225	Soil	2/8/01	13:38

GRO ANALYSIS SUMMARY SECTION B

Sample Holding Times

All samples from this set were analyzed within hold time criteria specified in SW846 for 8015 analysis.

System Monitoring Compound Recovery

All system monitoring compounds met established laboratory generated as well as SW846 recommended control limit criteria for Volatile analysis.

Matrix Spike/Matrix Spike Duplicate Recovery

All Matrix Spike, Matrix Spike Duplicate and RPD recovery results met established laboratory generated as well as SW846 recommended control limit criteria for the GRO scan.

Method Blank Summary

No selected volatile compounds were detected at or above the Contract Required Detection Limit (CRDL) in the Method Blanks corresponding to this sample set.

Initial Calibration

A minimum (5) point calibration was performed for each volatile surrogate and the targeted volatile compound mix. Each targeted analyte met SW846 Method 8015 RSD criteria.

Continuing Calibration

The Continuing Calibration Standards analyzed with this sample set all met laboratory generated and SW846 Method 8015 continuing calibration criteria.

Reportable Detection Limit

The Reportable Detection Limit for the selected volatile components met the Contract Required Detection Limits (CRDLs).

DRO ANALYSIS SUMMARY SECTION B

Sample Holding Times

All samples from this set were analyzed within hold time criteria specified in SW846 for 8015 analysis.

System Monitoring Compound Recovery

All system monitoring compounds met established laboratory generated as well as SW846 recommended control limit criteria for DRO analysis.

Matrix Spike/Matrix Spike Duplicate Recovery

All Matrix Spike, Matrix Spike Duplicate and RPD recovery results met established laboratory generated as well as SW846 recommended control limit criteria for the DRO scan.

Method Blank Summary

No selected volatile compounds were detected at or above the Contract Required Detection Limit (CRDL) in the Method Blanks corresponding to this sample set.

Initial Calibration

A minimum (5) point calibration was performed for each semi-volatile surrogate and the targeted DRO compound mix. Each targeted analyte met SW846 Method 8015 RSD criteria.

Continuing Calibration

The Continuing Calibration Standards analyzed with this sample set all met laboratory generated and SW846 Method 8015 continuing calibration criteria.

Reportable Detection Limit

The Reportable Detection Limit for the selected DRO components met the Contract Required Detection Limits (CRDLs).

METALS SUMMARY SECTION C

Selected analysis for Metals was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.

The metals analysis performed by DLZ Laboratories, Inc. QC summaries have all applicable QC limits specified on the forms. The SW846 QC criteria were met for this sample set.

INORGANICS SUMMARY SECTION D

The various inorganic parameters are submitted as a composite QA summary with all applicable QC limits specified on the forms. All SW846 and laboratory QC criteria were met for this sample set.

TRIMATRIX LABORATORY QA CONCERNS

Selected analysis for Metals was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.

There were some problems encountered with Se analysis in that the duplicate injection/aspiration precision was greater than 20% RSD for the following samples: APa-3-01, Kc-5-01, LCd-2-01, M-2-01, and M-1-01. This is traceable to ICP-MS matrix interference of the space charge especially evident with soil digests and regulatory insistence for very low reporting limits for Se. Therefore the results for Se for these samples must be considered as estimated.

The Method Blank for Zinc had a positive value above the project reporting limit. The corresponding sample results for LCd-4-01 is less than five times the result obtained for the Method Blank. Therefore the result for LCd-4-01 must be considered as estimated.

Matrix QC results for total iron are unavailable for sample LKa-1-01 due to high analyte concentration resulting in dilution of the sample to yield a determination of concentration.

Analysis for PPO Volatiles was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.

The matrix spike duplicate (MSD) RPD for this sample fell outside the laboratory established control limits for this method and matrix. The corresponding sample result for APc-1-1-01 must be considered estimated for 1,1-Dichloroethene.

Reporting detection limits were raised for Bromoethane due to contamination of the analytical system caused by trap degradation. The following samples are affected: LKC-3-01, KC-1-01, KC-2-02, DPa-1-01, and the Methanol Blank.

Positive results must be considered estimated and quantitation limits considered approximate for Acrolein and Acrylonitrile. The sample was not preserved at a pH of 4-5 at the time of collection, as specified in SW-846 revision 2, September 1994, Chapter 2, Table 2-33. The following samples are affected: LKC-3-01, KC-1-01, KC-2-02, and DPa-1-01.

Analysis for PCBs was subcontracted to Trimatrix Laboratory which provided a Quality Assurance report provided in document 3.
No problems associated with the PCB analysis were reported by Trimatrix Laboratory for these project samples.

The data presented as part of this report meets the minimum quality standards in the referenced analytical methods. Any exceptions have been noted. DLZ Laboratories, Inc and its officers and employees, assume no responsibility and make no warranty, express or implied, for uses or interpretations made by any recipients, intended or unintended, of this report.

[redacted]

Quality Assurance Officer
DLZ Laboratories, Inc.
Michigan Facility

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0146-05	C1B0146-06								
COE ID:	LCc-1-01	LCc-2-01								
Sampling Date:	2/14/01	2/14/01								
Sample Receipt Date:	2/14/01	2/14/01								
Analytical Report Entry Date:										
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Std. Aqueous for:										
Total Petroleum Hydrocarbons, mg/L	<1.0	<1.0								

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271445	271446	271447	271448		272192	272193	272194	272195
COE ID:	LKc-3-01	Kc-1-01	Kc-2-02	DPa-1-01		APc-1-1-01	APc-1-2-01	APc-1-3-01	LCc-1-01
Sampling Date:	2/7/01	2/6/01	2/6/01	2/7/01		2/15/01	2/15/01	2/15/01	2/15/01
Sample Receipt Date:	2/9/01	2/9/01	2/9/01	2/9/01		2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01		3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
VOLATILE ORGANIC COMPOUNDS, µg/L:					VOLATILE ORGANIC COMPOUNDS, µg/L:				
Acrolein	<5.0	<5.0	<5.0	<5.0	Acrolein	<5.0	<5.0	<5.0	<5.0
Acrylonitrile	<1.0	<1.0	<1.0	<1.0	Acrylonitrile	<1.0	<1.0	<1.0	<1.0
Benzene	<1.0	<1.0	<1.0	<1.0	Benzene	<1.0	<1.0	<1.0	<1.0
Bromoform	<1.0	<1.0	<1.0	<1.0	Bromoform	<1.0	<1.0	<1.0	<1.0
Dichlorobromomethane	<1.0	<1.0	<1.0	<1.0	Dichlorobromomethane	<1.0	<1.0	<1.0	<1.0
Bromomethane	<1.0	<1.0	<1.0	<1.0	Bromomethane	<1.0	<1.0	<1.0	<1.0
Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0	Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0
Chlorobenzene	<1.0	<1.0	<1.0	<1.0	Chlorobenzene	<1.0	<1.0	<1.0	<1.0
Chloroethane	<1.0	<1.0	<1.0	<1.0	Chloroethane	<1.0	<1.0	<1.0	<1.0
2-Chloroethyl Vinyl Ether	<10	<10	<10	<10	2-Chloroethyl Vinyl Ether	<10	<10	<10	<10
Chloroform	<1.0	<1.0	<1.0	<1.0	Chloroform	<1.0	<1.0	<1.0	<1.0
Chloromethane	<1.0	<1.0	<1.0	<1.0	Chloromethane	<1.0	<1.0	<1.0	<1.0
Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0	Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethylene	<1.0	<1.0	<1.0	<1.0	1,1-Dichloroethylene	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0
cis-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0	cis-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0
trans-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0	trans-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	<1.0	1.5	5.4	<1.0	Ethylbenzene	<1.0	<1.0	<1.0	<1.0
Methylene Chloride	<5.0	<5.0	<5.0	<5.0	Methylene Chloride	<5.0	<5.0	<5.0	<5.0
1,1,2,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0	1,1,2,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	<1.0	<1.0	<1.0	<1.0	Tetrachloroethene	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	5.9	27	2.2	Toluene	<1.0	<1.0	<1.0	1.3
1,2-Dichloroethylene (total)	<2.0	<2.0	<2.0	<2.0	1,2-Dichloroethylene (total)	<2.0	<2.0	<2.0	<2.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0
Trichloroethene	<1.0	<1.0	<1.0	<1.0	Trichloroethene	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	<1.0	<1.0	<1.0	<1.0	Vinyl Chloride	<1.0	<1.0	<1.0	<1.0

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	272196	271452							
COE ID:	EQUIP BLK	METHANOL BLK							
Sampling Date:	2/15/01	2/7/01							
Sample Receipt Date:	2/16/01	2/9/01							
Analytical Report Entry Date:	3/19/01	3/19/01							
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
VOLATILE ORGANIC COMPOUNDS, µg/L:									
Acrolein	<5.0	<5.0							
Acrylonitrile	<1.0	<1.0							
Benzene	<1.0	<1.0							
Bromoform	<1.0	<1.0							
Dichlorobromomethane	<1.0	<1.0							
Bromomethane	<1.0	<1.0							
Carbon tetrachloride	<1.0	<1.0							
Chlorobenzene	<1.0	<1.0							
Chloroethane	<1.0	<1.0							
2-Chloroethyl Vinyl Ether	<10	<10							
Chloroform	<1.0	<1.0							
Chloromethane	<1.0	<1.0							
Chlorodibromomethane	<1.0	<1.0							
1,1-Dichloroethane	<1.0	<1.0							
1,2-Dichloroethane	<1.0	<1.0							
1,1-Dichloroethylene	<1.0	<1.0							
1,2-Dichloropropane	<1.0	<1.0							
cis-1,3-Dichloropropene	<1.0	<1.0							
trans-1,3-Dichloropropene	<1.0	<1.0							
Ethylbenzene	<1.0	<1.0							
Methylene Chloride	<5.0	<5.0							
1,1,2,2-Tetrachloroethane	<1.0	<1.0							
Tetrachloroethene	<1.0	<1.0							
Toluene	<1.0	<1.0							
1,2-Dichloroethylene (total)	<2.0	<2.0							
1,1,1-Trichloroethane	<1.0	<1.0							
1,1,2-Trichloroethane	<1.0	<1.0							
Trichloroethene	<1.0	<1.0							
Vinyl Chloride	<1.0	<1.0							

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271486	271487	271488	271489	271490	271491	C1B0164-09	C1B0164-10	C1B0164-11	C1B0167-01
COE ID:	Kd-1-01	Kd-2-01	Kd-3-01	LKa-1-01	LKa-2-01	LKa-3-01	Ka-1-01	Ka-2-01	Ka-3-01	Kc-4-01
Sampling Date:	2/6/01	2/6/01	2/6/01	2/7/01	2/7/01	2/7/01	2/8/01	2/8/01	2/8/01	2/8/01
Sample Receipt Date:	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/9/01	2/9/01	2/9/01	2/9/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Total Solids, %	84	89	91	84	76	84	83	75	83	80
COE METALS KIT:										
Total Arsenic, mg/Kg	3.6	4.7	7.9	2.3	1.9	2.6	3.5	3.3	3.4	3.8
Total Barium, mg/Kg	40	40	70	70	66	63	96	73	76	72
Total Cadmium, mg/Kg	0.42	0.46	1.5	0.17	0.16	0.21	0.29	0.44	0.29	0.20
Total Chromium, mg/Kg	17	14	13	21	17	16	28	22	26	23
Total Copper, mg/Kg	19	33	96	20	14	16	26	26	25	20
Total Iron, mg/Kg	13800	16900	29800	36600	18500	17600	24500	18400	22900	17000
Total Lead, mg/Kg	39	62	291	7.6	5.4	5.6	17	51	10	21
Total Manganese, mg/Kg	421	394	446	488	440	508	584	539	508	380
Total Mercury, mg/Kg	0.23	<0.10	1.5	<0.10	<0.10	<0.10	<0.10	0.21	<0.10	<0.10
Total Nickel, mg/Kg	14	15	18	21	16	17	25	15	25	21
Total Selenium, mg/Kg	0.81	1.1	1.1	0.70	0.70	0.83	0.63	0.68	0.99	0.68
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc, mg/Kg	80	72	153	38	37	33	57	81	46	109

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0167-02	C1B0167-03	C1B0164-01	C1B0164-02	C1B0164-03	C1B0164-04	C1B0164-05	C1B0164-06	C1B0164-07	C1B0164-08
COE ID:	Ke-5-01	Ke-6-01	Ke-1-01	Ke-2-01	Ke-3-01	Ke-4-01	Ke-5-01	Ke-6-01	Ke-7-01	Ke-8-01
Sampling Date:	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01
Sample Receipt Date:	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01	2/9/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Total Solids, %	78	79	78	81	79	75	73	78	80	82
COE METALS KIT:										
Total Arsenic, mg/Kg	2.3	4.4	2.6	2.7	2.9	3.4	2.8	2.6	2.9	7.1
Total Barium, mg/Kg	89	71	73	38	72	60	84	110	79	160
Total Cadmium, mg/Kg	0.18	0.27	0.16	0.085	0.088	0.30	0.12	0.14	0.20	0.11
Total Chromium, mg/Kg	26	19	22	14	24	19	23	26	23	24
Total Copper, mg/Kg	31	24	24	15	19	16	26	30	23	22
Total Iron, mg/Kg	17000	12000	18000	13000	19000	14000	20000	21000	18000	26000
Total Lead, mg/Kg	6.8	42	14	6.4	10	23	7.9	8.2	8.6	5.7
Total Manganese, mg/Kg	210	230	340	310	320	250	300	400	460	1100
Total Mercury, mg/Kg	<0.10	0.19	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	0.20	<0.10
Total Nickel, mg/Kg	23	12	19	13	20	2.2	22	25	21	22
Total Selenium, mg/Kg	0.47	0.76	0.50	0.55	0.56	0.99	0.66	0.53	0.62	1.1
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc, mg/Kg	84	80	55	43	44	86	53	77	49	46

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0165-01	C1B0165-02	C1B0165-03	C1B0165-04	C1B0165-05	C1B0165-06	C1B0165-07	C1B0165-08		
COE ID:	LCd-3-01	LCd-4-01	M-1-01	M-2-01	M-3-01	APc2-1-01	APc2-2-01	APc2-3-01		
Sampling Date:	2/12/01	2/12/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/12/01		
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01		
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01		
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**		
Total Solids, %	79	68	73	78	83	79	78	75		
COE METALS KIT:										
Total Arsenic, mg/Kg	2.3	0.40	4.1	5.0	2.5	3.9	3.3	4.1		
Total Barium, mg/Kg	77	86	33	7.6	49	30	70	67		
Total Cadmium, mg/Kg	0.085	0.10	0.11	<0.07	0.14	0.16	0.11	0.13		
Total Chromium, mg/Kg	22	20	9.8	3.0	17	6.8	21	16		
Total Copper, mg/Kg	25	26	14	4.6	18	14	20	21		
Total Iron, mg/Kg	17000	16000	8800	5000	13000	7400	18000	13000		
Total Lead, mg/Kg	5.0	5.3	24	16	19	28	6.3	23		
Total Manganese, mg/Kg	400	280	240	220	290	230	280	230		
Total Mercury, mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	0.12	<0.10	0.11		
Total Nickel, mg/Kg	24	21	2.1	2.8	14	5.4	18	15		
Total Selenium, mg/Kg	0.58	<0.20	0.62	0.69	0.60	0.72	0.56	0.70		
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		
Total Zinc, mg/Kg	42	9.1	45	82	48	49	62	62		

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0163-01	C1B0163-02	C1B0163-03	C1B0163-04	C1B0163-05	C1B0163-06	C1B0163-07	C1B0163-08	C1B0163-09	C1B0163-10
COE ID:	APa-1-01	APa-2-01	APa-3-01	APa-4-01	LCa-2-01	LCa-1-01	LCa-3-01	LCd-1-01	LCd-2-01	APa-5-01
Sampling Date:	2/14/01	2/14/01	2/14/01	2/14/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/14/01
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
Total Solids, %	78	81	85	89	79	84	76	76	83	86
COE METALS KIT:										
Total Arsenic, mg/Kg	2.6	3.2	2.6	5.9	3.9	2.3	2.7	2.4	2.1	3.4
Total Barium, mg/Kg	57	51	35	95	51	73	97	110	75	24
Total Cadmium, mg/Kg	0.10	0.18	0.23	0.075	0.12	0.078	0.10	0.12	0.069	0.29
Total Chromium, mg/Kg	16	16	12	7.0	14	19	23	26	21	18
Total Copper, mg/Kg	18	16	33	13	19	21	28	33	26	23
Total Iron, mg/Kg	14000	12000	8300	7300	12000	15000	19000	20000	16000	7000
Total Lead, mg/Kg	9.6	12	58	16	12	5.0	5.2	5.4	4.2	64
Total Manganese, mg/Kg	320	330	201	250	340	360	380	410	300	260
Total Mercury, mg/Kg	<0.10	<0.10	0.23	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.33
Total Nickel, mg/Kg	15	13	8.3	1.4	12	19	24	28	23	6.9
Total Selenium, mg/Kg	0.59	0.40	0.45	1.5	0.63	0.54	0.47	0.50	0.51	0.59
Total Silver, mg/Kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc, mg/Kg	55	41	56	51	47	30	42	58	31	107

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	C1B0148-01	C1B0148-02	C1B0148-03	C1B0148-04	C1B0148-05	C1B0148-06				
COE ID:	APc3-1-01	APc3-2-01	APc3-3-01	APc4-1-01	APc4-2-01	Lce-1-01				
Sampling Date:	2/12/01	2/12/01	2/12/01	2/14/01	2/14/01	2/13/01				
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01				
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01				
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**				
Total Solids, %	78	82	85	81	80	74				
Diesel Range Organics, mg/Kg	570	240	33	12	17	<10				
Gasoline Range Organics, mg/Kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to [redacted]
[redacted] Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271486	271487	271488	271489	271490	271491	271492	271493	271494	272207
COE ID:	Kd-1-01	Kd-2-01	Kd-3-01	LKa-1-01	LKa-2-01	LKa-3-01	Ka-1-01	Ka-2-01	Ka-3-01	LCd-3-01
Sampling Date:	2/6/01	2/6/01	2/6/01	2/7/01	2/7/01	2/7/01	2/8/01	2/8/01	2/8/01	2/12/01
Sample Receipt Date:	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/8/01	2/9/01	2/9/01	2/9/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
PCB COMPOUNDS:										
PCB-1016, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1221, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1232, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1242, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1248, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1254, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1260, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Lab ID:	272208	272209	272210	272211	272186	272188	272187	272197	272198	272199
COE ID:	LCd-4-01	M-1-01	M-2-01	M-3-01	APc5-1-01	APc5-3-01	APc5-2-01	APa-1-01	APa-2-01	APa-3-01
Sampling Date:	2/12/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/12/01	2/14/01	2/14/01	2/14/01
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
PCB COMPOUNDS:										
PCB-1016, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1221, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1232, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1242, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1248, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1254, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB-1260, µg/Kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	272200	272201	272202	272203	272204	272205	272206			
COE ID:	APa-4-01	LCa-2-01	LCa-1-01	LCa-3-01	LCd-1-01	LCd-2-01	APa-5-01			
Sampling Date:	2/14/01	2/13/01	2/13/01	2/13/01	2/12/01	2/12/01	2/14/01			
Sample Receipt Date:	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01	2/16/01			
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01	3/19/01			
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
PCB COMPOUNDS:										
PCB-1016, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1221, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1232, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1242, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1248, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1254, µg/Kg	<100	<100	<100	<100	<100	<100	<100			
PCB-1260, µg/Kg	<100	<100	<100	<100	<100	<100	<100			

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	271449	271450	271451			272186	272188	272187	272189
COE ID:	DPb-1-01	DPb-2-01	DPb-3-01			APc5-1-01	APc5-3-01	APc5-2-01	APc1-1-01
Sampling Date:	2/7/01	2/7/01	2/7/01			2/12/01	2/12/01	2/12/01	2/14/01
Sample Receipt Date:	2/9/01	2/9/01	2/9/01			2/16/01	2/16/01	2/16/01	2/16/01
Analytical Report Entry Date:	3/19/01	3/19/01	3/19/01			3/19/01	3/19/01	3/19/01	3/19/01
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**	**Conc.**
VOLATILE ORGANIC COMPOUNDS, µg/Kg:					**VOLATILE ORGANIC COMPOUNDS, µg/Kg:**				
Acrolein	<58	<69	<63		**Acrolein**	<69	<82	<60	<79
Acrylonitrile	<58	<69	<63		**Acrylonitrile**	<69	<82	<60	<79
Benzene	<58	<69	<63		**Benzene**	**180**	<82	<60	<79
Bromoform	<58	<69	<63		**Bromoform**	<69	<82	<60	<79
Dichlorobromomethane	<58	<69	<63		**Dichlorobromomethane**	<69	<82	<60	<79
Bromomethane	<290	<340	<310		**Bromomethane**	<340	<82	<60	<79
Carbon tetrachloride	<58	<69	<63		**Carbon tetrachloride**	<69	<82	<60	<79
Chlorobenzene	<58	<69	<63		**Chlorobenzene**	<69	<82	<60	<79
Chloroethane	<58	<69	<63		**Chloroethane**	<69	<82	<60	<79
2-Chloroethyl Vinyl Ether	<580	<690	<630		**2-Chloroethyl Vinyl Ether**	<690	<820	<600	<790
Chloroform	<58	<69	<63		**Chloroform**	<69	<82	<60	<79
Chloromethane	<58	<69	<63		**Chloromethane**	<69	<82	<60	<79
Chlorodibromomethane	<58	<69	<63		**Chlorodibromomethane**	<69	<82	<60	<79
1,1-Dichloroethane	<58	<69	<63		**1,1-Dichloroethane**	<69	<82	<60	<79
1,2-Dichloroethane	<58	<69	<63		**1,2-Dichloroethane**	<69	<82	<60	<79
1,1-Dichloroethylene	<58	<69	<63		**1,1-Dichloroethylene**	<69	<82	<60	<79
1,2-Dichloropropane	<58	<69	<63		**1,2-Dichloropropane**	<69	<82	<60	<79
cis-1,3-Dichloropropene	<58	<69	<63		**cis-1,3-Dichloropropene**	<69	<82	<60	<79
trans-1,3-Dichloropropene	<58	<69	<63		**trans-1,3-Dichloropropene**	<69	<82	<60	<79
Ethylbenzene	<58	<69	<63		**Ethylbenzene**	**280**	<82	<60	<79
Methylene Chloride	<58	<69	<130		**Methylene Chloride**	<69	<82	<60	<79
1,1,2,2-Tetrachloroethane	<58	<69	<63		**1,1,2,2-Tetrachloroethane**	<69	<82	<60	<79
Tetrachloroethene	<58	<69	<63		**Tetrachloroethene**	<69	<82	<60	<79
Toluene	<58	<69	<63		**Toluene**	**1000**	<82	<60	<79
1,2-Dichloroethylene (total)	<58	<69	<63		**1,2-Dichloroethylene (total)**	<69	<82	<60	<79
1,1,1-Trichloroethane	<58	<69	<63		**1,1,1-Trichloroethane**	<69	<82	<60	<79
1,1,2-Trichloroethane	<58	<69	<63		**1,1,2-Trichloroethane**	<69	<82	<60	<79
Trichloroethene	<58	<69	<63		**Trichloroethene**	<69	<82	<60	<79
Vinyl Chloride	<58	<69	<63		**Vinyl Chloride**	<69	<82	<60	<79

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

Quality Assurance Original Report Summary

Reported to: [redacted]
Altech Enviromental Services
24209 Northwestern Hwy., Suite 230
Southfield, MI 48414

Reported by: DLZ Laboratories, Inc.
1425 Keystone Avenue
Lansing, MI 48911

Lab ID:	272190	272191							
COE ID:	APc1-2-01	APc1-3-01							
Sampling Date:	2/14/01	2/14/01							
Sample Receipt Date:	2/16/01	2/16/01							
Analytical Report Entry Date:	3/21/01	3/21/01							
Parameter, units	**Conc.**	**Conc.**	**Conc.**	**Conc.**					
VOLATILE ORGANIC COMPOUNDS, µg/Kg:									
Acrolein	<75	<82							
Acrylonitrile	<75	<82							
Benzene	<75	<82							
Bromoform	<75	<82							
Dichlorobromomethane	<75	<82							
Bromomethane	<75	<82							
Carbon tetrachloride	<75	<82							
Chlorobenzene	<75	<82							
Chloroethane	<75	<82							
2-Chloroethyl Vinyl Ether	<750	<820							
Chloroform	<75	<82							
Chloromethane	<75	<82							
Chlorodibromomethane	<75	<82							
1,1-Dichloroethane	<75	<82							
1,2-Dichloroethane	<75	<82							
1,1-Dichloroethylene	<75	<82							
1,2-Dichloropropane	<75	<82							
cis-1,3-Dichloropropene	<75	<82							
trans-1,3-Dichloropropene	<75	<82							
Ethylbenzene	<75	<82							
Methylene Chloride	<75	<82							
1,1,2,2-Tetrachloroethane	<75	<82							
Tetrachloroethene	<75	<82							
Toluene	<75	<82							
1,2-Dichloroethylene (total)	<75	<82							
1,1,1-Trichloroethane	<75	<82							
1,1,2-Trichloroethane	<75	<82							
Trichloroethene	<75	<82							
Vinyl Chloride	<75	<82							

The above samples are sediment samples.
Results reported as dry weight values for the above samples.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

St. • Lansing, Michigan 48906-5599 • (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229 • Telephone (614) 848-4333 • FAX: (614) 841-0818

CL DY RECORD

REPORT PAGE	RECO.. JMBER
OF	51579

PROJECT NAME/TYPE: Fox River - COE

LOCATION: Kaukauna, Little Kaukauna, WI

[redacted]

REPORT RESULTS TO

COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.

ADDRESS: 24209 Northwestern Hwy Suite 230

CITY: SOUTHFIELD STATE: MI ZIP: 48075

P.O. #/PROJECT #: FOX RIVER

PHONE NO.: 248-353-3830

FAX NO.: 248-353-5485

INVOICE TO

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	Mich. Metals As	PCBs	DLZ LAB ID
1	Kd-1-01 ✓	Soil	02-06-01	14:15	C				2						X	X	
2	Kd-2-01 ✓	Soil	02-06-01	14:25	C				2						X	X	
3	Kd-3-01 ✓	Soil	02-06-01	14:45	C				2						X	X	
4	LKa-1-01 ✓	Soil	02-07-01	15:50	C				2						X	X	
5	LKa-2-01 ✓	Soil	02-07-01	15:30	C				2						X	X	
6	LKa-3-01 ✓	Soil	02-07-01	14:20	C				2						X	X	
7																	
8	COE: Mich. Metals: As, Ba, Cd, Cr, Cu,																
9	Fe, Pb, Mn, Hg, Ni, Se, Ag, Zn																
10	[redacted]																

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANS NO.	DATE	TIME
1		
2	2-8-01	14:15
3		
4		

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☑ YES ☐ NO COOLER TEMP. ____

SAMPLE INTEGRITY CHECKED ☑ YES ☐ NO

THESE ARE COE SAMPLES - NEED QC RUN ON THEM. 451 LIMITS.

PCBs subbed to TriMatrix; As, Ag, Se, Zn also subbed to Trimatrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

ACCOUNTING

DLZ LABORATORIES, INC.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RE[illegible] NUMBER
OF	51538

PROJECT NAME/TYPE: FOX RIVER - COE

LOCATION:

[redacted] EMAIL

SAMPLED BY:

P.O. #/PROJECT #:

PHONE NO.:

FAX NO.:

REPORT RESULTS TO

COMPANY: DLZ

ADDRESS: 1423 Keystone

CITY: STATE: ZIP:

INVOICE TO

NAME:

COMPANY:

ADDRESS: SAME

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	PCBs	DLZ LAB ID
	ENTER # IN THE BOX														ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	Ka-1-01 ✓	SL	2-8-01	9:10					1						X	
2	Ka-2-01 ✓	SL	2-8-01	9:40					1						X	
3	Ka-3-01 ✓	SL	2-8-01	10:10					1						X	
4																
5																
6	Please add:															
7	As, Ag, Zn, Se															
8	-2-20-01															
9																
10																

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1						
2						
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RE[illegible] NUMBER
OF	51715

[redacted]

REPORT RESULTS TO

COMPANY DLZ

ADDRESS 1423 Keystone

CITY Lansing STATE MI ZIP 48911

EMAIL

SAMPLED BY

P.O. #/PROJECT #

PHONE NO.

FAX NO.

PROJECT NAME/TYPE For River COE

LOCATION

INVOICE TO

NAME

COMPANY SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	As, Ag, Zn, Se	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	Ke-1-01 ✓	SL	2-8-01	1145											X	
2	Ke-2-01 ✓			1210												
3	Ke-3-01 ✓			1305												
4	Ke-4-01 ✓			1630												
5	Ke-5-01 ✓			1550												
6	Ke-6-01 ✓			1510												
7	Ke-7-01 ✓			1450												
8	Ke-8-01 ✓	↓	↓	1410											↓	
9																
10																

TRANSFER	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]			[redacted]	/ /	:
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC.

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

3120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	REPORT NUMBER
OF	51589

[redacted]

REPORT RESULTS TO

COMPANY DLZ
ADDRESS 1423 Keystone
CITY STATE ZIP
E-MAIL
SAMPLED BY
P.O. #/PROJECT #
PHONE NO.
FAX NO.

PROJECT NAME/TYPE: Fox River COE
LOCATION

INVOICE TO

NAME
COMPANY
ADDRESS SAME
CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y / N	PCBs	DLZ LAB ID
1	Kd-1-01 ✓	SL	2-6-01	1415					1						X	
2	Kd-2-01 ✓	"	2-6-01	1425					1						"	
3	Kd-3-01 ✓	"	2-6-01	1445					1						"	
4	LKa-1-01 ✓	"	2-7-01	1550					1						"	
5	LKa-2-01 ✓	"	2-7-01	1530					1						"	
6	LKa-3-01 ✓	"	2-7-01	1420					1						"	
7																
8	Please add:															
9	As, Ag, Zn, Se															
10	2-20-01															

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1						
2						
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

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Telephone: (517) 374-9656 • FAX: (517) 374-6910

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51587

[redacted]

REPORT RESULTS TO

EMAIL

SAMPLED BY

COMPANY DLZ

P.O. #/PROJECT #

ADDRESS 1423 Keystone

PHONE NO.

CITY STATE ZIP

FAX NO.

PROJECT NAME/TYPE: FOX River - COE

LOCATION

INVOICE TO

NAME

COMPANY SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y/N	VOC (8260 PRIOR)	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST	
1	LKc-3-01 ✓	AQ	2-7-01	1439				1	2						X	
2	Kc-1-01 ✓	AQ	2-6-01	1500				1	2						X	
3	Kc-2-02 ✓	AQ	2-6-01	1520				1	2						X	
4	DPa-1-01 ✓	AQ	2-7-01	1240					2						X	
5	DPb-1-01 ✓	SL	2-7-01	1015		1									X	
6	DPb-2-01 ✓	SL	2-7-01	1150		1									X	
7	DPb-3-01 ✓	SL	2-7-01	1115		1									X	
8	Methanol Blank							1							X	
9																
10																

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1						
2						
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

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CUSTODY RECORD

REPORT PAGE	R… NUMBER
OF	51713

PROJECT NAME/TYPE: Fox River - COE

LOCATION:

[redacted]

REPORT RESULTS TO
COMPANY: DLZ
ADDRESS: 1123 Keystone Ave
CITY: Lansing STATE: MI ZIP: 48911
P.O. #/PROJECT #:
PHONE NO.:
FAX NO.:

INVOICE TO
NAME:
COMPANY:
ADDRESS: SAME
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y/N	As, Ag, Zn, Se	BCBS	DLZ LAB ID
	ENTER # IN THE BOX														ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		
1	Apa-1-01 ✓	SL	2-14-01	1330											X	X	
2	Apa-2-01 ✓			1300													
3	APa-3-01 ✓			0630													
4	APa-4-01 ✓		↓	0845													
5	LCa-2-01 ✓		2-13-01	1100													
6	LCa-1-01 ✓			1300													
7	LCa-3-01 ✓		↓	1330													
8	LCd-1-01 ✓		2-12-01	1045													
9	LCd-2-01 ✓		2-12-01	1035													
10	APa-5-01 ✓	↓	2-14-01	0910											↓	↓	

TRANSFER NO	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC

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CUSTODY RECORD

REPORT PAGE	RE[illegible]D NUMBER
OF	51714

[redacted]

REPORT RESULTS TO

EMAIL | SAMPLED BY

COMPANY DLZ | P.O. #/PROJECT #

ADDRESS 1423 Keystone Ave | PHONE NO.

CITY Lansing STATE MI ZIP 48911 | FAX NO.

PROJECT NAME/TYPE

LOCATION

INVOICE TO

NAME

COMPANY

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	Ag, As, Zn, Se	Pb, Ba	DLZ LAB ID
					ENTER # IN THE BOX										ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		
1	LCd-3-01 ✓	SL	2 12 01	1015											X	X	
2	LCd-4-01 ✓	"	2-12-01	0915											"	"	
3	M-1-01 ✓	"	2-13-01	1655											"		
4	M-2-01 ✓	"	"	1610											"		
5	M-3-01 ✓	"	"	1630											"		
6	APC2-1-01 ✓	"	2-12-01	1620											"		
7	APC2-2-01 ✓	"	"	1655											"		
8	APC2-3-01 ✓	"	"	1552											"		
9																	
10																	

TRANSFER NO	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]			[illegible]	[illegible]	[illegible]
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

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CUSTODY RECORD

REPORT PAGE	R... D NUMBER
OF	51712

PROJECT NAME/TYPE: Fox River - COE

LOCATION:

[redacted] EMAIL

SAMPLED BY

REPORT RESULTS TO

COMPANY: DLZ

ADDRESS: 1423 Keystone Ave

CITY: Lansing STATE: MI ZIP: 48911

P.O. #/PROJECT #

PHONE NO. (517) 393 4444

FAX NO. (517) 272-6909

INVOICE TO

NAME

COMPANY

ADDRESS: SAME

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	VOC (Method)	PCBs	DLZ LAB ID
1	APc5-1-01 ✓	SL	2-12-01	1250											X	X	
2	APc5-3-01 ✓	↓	↓	1145											↓	X	
3	APc5-2-01 ✓	↓	↓	1215											↓	X	
4	APc1-1-01 ✓	↓	2-14-01	1200											↓		
5	APc1-2-01 ✓	↓	↓	1230											↓		
6	APc1-3-01 ✓	↓	↓	1235											↓		
7	APc-1-1-01 ✓	AQ	2-15-01	1515											X		
8	APc-1-2-01 ✓	↓	↓	1530											X		
9	APC-1-3-01 ✓	↓	↓	1540											X		
10	~~APC~~ LCe-1-01 ✓	↓	↓	1415											X		
	Equipment Blank ✓	↓	↓	1540											X		

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					[illegible]	[illegible]
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RE[illegible]D NUMBER
OF	51716

[redacted]

REPORT RESULTS TO

COMPANY DLZ
ADDRESS
CITY STATE ZIP
EMAIL
SAMPLED BY
P.O. #/PROJECT #
PHONE NO.
FAX NO.

PROJECT NAME/TYPE [illegible]
LOCATION

INVOICE TO

NAME
COMPANY SAME
ADDRESS
CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	As As Zn Cd	DLZ LAB ID
1	KC 4-01	GW	2/8/01	1600											X	
2	KC-5-01	GW	2/8/01	1450											X	
3	KC-6-01	GW	2/8/01	1338											X	
4																
5																
6																
7																
8																
9																
10																

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR. ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES, INC

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CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51578

[redacted]

PROJECT NAME/TYPE: Fox River Phase II

LOCATION: Appleton, Little Chute, WI

REPORT RESULTS TO

COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.
P.O. #/PROJECT #: 9230
ADDRESS: 24709 NORTHWESTERN HWY SUITE 230
PHONE NO.: 248-353-3832
CITY: SOUTHFIELD STATE: MI ZIP: 48075
FAX NO.:

INVOICE TO

NAME:
COMPANY: SAME
ADDRESS:
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y/N	Mrch. Metals	PCBs	DLZ LAB ID
	ENTER # IN THE BOX														ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		
1	Apa-1-01	Soil	08-14-01	13:30	C			6							X	X	
2	APa-2-01	Soil	08-14-01	13:00	C			2							X	X	
3	APa-3-01	Soil	08-14-01	8:30	C			2							X	X	
4	APa-4-01	Soil	08-14-01	8:45	C			2							X	X	
5	LCa-2-01	Soil	08-13-01	11:00	C			2							X	X	
6	LCa-1-01	Soil	08-13-01	13:00	C			2							X	X	
7	LCa-3-01	Soil	08-13-01	13:30	C			2							X	X	
8	LCd-1-01	Soil	08-13-01	10:45	C			2							X	X	
9	LCd-2-01	Soil	08-13-01	10:35	C			2							X	X	
10	APa-5-01	Soil	08-14-01	9:10	C			2							X	X	

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]					
2						
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED: ACOE

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

PCB's and As, Ag, Zn, Sr subbed to this matrix

DLZ LABORATORIES INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

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Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51571

NAME: IAN KERR
EMAIL: [illegible]
SAMPLED BY: C. KEDDY, [illegible]

[redacted]

CITY: SOUTHFIELD STATE: MI. ZIP: 48075
FAX NO. 248-353-5485

PROJECT NAME/TYPE: Fox River PHASE II
LOCATION: Appleton, WI

INVOICE TO
NAME
COMPANY: SAME
ADDRESS
CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE: GRAB (G)/COMP (C) | OTHER | METHANOL KIT | ENCORE | NONE | HCL | SULFURIC (H2SO4) | NaOH | NITRIC (HNO3) | FILTERED Y/N | Volatile Organics (8260) | PCBs

DLZ LAB ID

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	ENTER # IN THE BOX	ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		DLZ LAB ID
1	APC5-1-01	Soil	02-12-01	12:50		X	X	
2	APC5-3-01	Soil	02-12-01	11:45		X	X	
3	APC5-2-01	Soil	02-12-01	12:15		X	X	
4	APC1-1-01	Soil	02-14-01	12:00		X		
5	APC1-2-01	Soil	02-14-01	12:30		X		
6	APC1-3-01	Soil	02-14-01	12:35		X		
7								
8								
9								
10								

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					0:40	
3						
4						

QA / QC LEVEL:
REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO
SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____
SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

ALL SLIPPED IN TRIMATRIX

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED: ACOE

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ LABORATORIES INC

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Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51572

PROJECT NAME/TYPE: Fox River Phase II

LOCATION: Little Chute, Manitoba, WI

[redacted]

REPORT RESULTS TO:
COMPANY: ALTECH ENVIRONMENTAL SERVICES INC.
ADDRESS: 24209 NORTHWESTERN HWY SUITE 230
CITY: SOUTHFIELD STATE: MI ZIP: 48075

P.O. #/PROJECT #: 9230
[redacted]
FAX NO. 248-353-5485

INVOICE TO:
NAME:
COMPANY: SAME
ADDRESS:
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	M. on Metals	PCBs	DLZ LAB ID
1	LCd-3-01	Soil	02-12-01	10:15	C				2						X	X	
2	LCd-4-01	Soil	02-12-01	9:15	C				2						X	X	
3	M-1-01	Soil	02-13-01	16:55	C				2						X	X	
4	M-2-01	Soil	02-13-01	16:10	C				2						X	X	
5	M-3-01	Soil	02-13-01	16:30	C				2						X	X	
6	APC2-1-01	Soil	02-12-01	16:20	C				1						X		
7	APC2-2-01	Soil	02-12-01	16:55	C				1						X		
8	APC2-3-01	Soil	02-12-01	15:50	C				1						X		
9																	
10																	

ENTER # IN THE BOX — ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					10:40	
3						
4						

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

PCBs and As, Ag, Zn, Se Subbed to Trimatrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED: Acc

DLZ LABORATORIES, INC

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51569

REPORT RESULTS TO

[redacted]

COMPANY ALTECH ENVIRONMENTAL SERVICES INC.

ADDRESS 24709 NORTHWESTERN HWY/ SUITE 230

[redacted]

P.O. #/PROJECT # 9230

[redacted]

PROJECT NAME/TYPE Fox River PHASE II

LOCATION

INVOICE TO

NAME

COMPANY SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	DRO - GRO	METALS (TOTAL)	DLZ LAB ID
	ENTER # IN THE BOX														ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST		
1	APC3-1-01	Soil	02-12-01	15:15	C			1							X		
2	APC3-2-01	Soil	02-13-01	14:55	C			1							X		
3	APC3-3-01	Soil	02-13-01	14:35	C			1							X		
4	APC4-1-01	Soil	02-14-01	10:15	C			1							X		
5	APC4-2-01	Soil	02-14-01	10:45	C			1							X		
6	LLE-1-01	Soil	02-13-01	13:10	C			1							X	X	
7																	
8																	
9																	
10																	

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
	[redacted]				2/16/01	8:00
					2/16/01	10:40

QA / QC LEVEL:

REPORTING LIMIT:

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR. ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

As Agreed Per Submitted Proposal

DLZ

ENVIRONMENTAL TESTING • COMPLIANCE ANALYSIS • INDUSTRIAL HYGIENE

1120 May St. • Lansing, Michigan 48906-5599
Telephone: (517) 374-9656 • FAX: (517) 374-6910

6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51570

[redacted]

REPORT RESULTS TO
COMPANY: ACTECH ENVIRONMENTAL SERVICES
ADDRESS: 24209 NORTHWESTERN HWY. STE. 220
CITY: SOUTHFIELD STATE: MI ZIP: 48075
P.O. #/PROJECT #: 4230
[redacted]
FAX NO.: 248 353-5405

PROJECT NAME/TYPE: FOX RIVER PHASE II
LOCATION:

INVOICE TO
NAME:
COMPANY: SAME
ADDRESS:
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	VOC's 8260	TPH	DLZ LAB ID
1	APC-1-1-01	H_2O	2/15/01	1515	G				1	2					X		
2	APC-1-2-01	H_2O	2/15/01	1530	G				1	2					X		
3	APC-1-3-01	H_2O	2/15/01	1540	G				1	2					X		
4	LCC-1-01	H_2O	2/15/01	1415	G					1					X		
5	LCC-1-01	H_2O	2/14/01	1000	G						1					X	
6	LCC-2-01	H_2O	2/14/01	1630	G						1					X	
7	EQUIP. BLANK	H_2O	2/15/01	1540	G				1						X		
8	T																
9																	
10																	

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	TIME
1	[redacted]				
2					
3					
4					

QA / QC LEVEL:

REPORTING LIMIT:

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☐ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

VOC's subbed to TI matrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☐ STANDARD

DLZ

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6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51586

[redacted]

PROJECT NAME/TYPE: Fox River

LOCATION: Kaukauna, WI

REPORT RESULTS TO

COMPANY: Mich Environmental Services Inc.
P.O. #/PROJECT #: 7033

ADDRESS: 24009 Northwestern Hwy Suite 230
PHONE: [redacted]

CITY: Southfield STATE: MI ZIP: 48075
FAX NO.: 248-353-5415

INVOICE TO

NAME:
COMPANY: SANE
ADDRESS:
CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

| ITEM NO. | CLIENT SAMPLE IDENTIFICATION | MATRIX MEDIA | DATE SAMPLED | TIME SAMPLED | GRAB (G)/COMP (C) | OTHER | METHANOL KIT | ENCORE | NONE | HCL | SULFURIC (H_2SO_4) | NaOH | NITRIC (HNO_3) | FILTERED Y / N | | |

DLZ

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Telephone: (517) 374-9656 • FAX: (517) 374-6910

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Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51585

PROJECT NAME/TYPE: F. R. River

LOCATION: Kaukauna,

[redacted]

REPORT RESULTS

COMPANY: Atech Environmental Services Inc.

ADDRESS: 4809 Northwestern Hwy Suite 230

CITY: Southfield STATE: MI ZIP: 48075

PHONE: [redacted]

FAX NO.: 248-353-5445

INVOICE TO

NAME:

COMPANY: SAME

ADDRESS:

CITY: STATE: ZIP:

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H_2SO_4)	NaOH	NITRIC (HNO_3)	FILTERED Y / N	10 METALS KIT RCRA	DLZ LAB ID
1	Ke-1-01	soil	01-08-01	11:45											X	
2	Ke-2-01	soil	01-08-01	12:10											X	
3	Ke-3-01	soil	01-09-01	13:05											X	
4	Ke-4-01	soil	01-08-01	16:30											X	
5	Ke-5-01	soil	01-08-01	15:50											X	
6	Ke-6-01	soil	01-08-01	15:10											X	
7	Ke-7-01	soil	01-08-01	14:50											X	
8	Ke-8-01	soil	01-08-01	14:10											X	
9	Ka-1-01	soil	01-08-01	9:10											X	X
10	Ka-2-01	soil	01-08-01	9:40											X	X

ENTER # IN THE BOX

ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
1	[redacted]				1/9/01	16:30
2						
3						
4						

QA / QC LEVEL: CDE

REPORTING LIMIT: 4/51

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED:

☐ 24 HR ☐ 48 HR ☐ 5 DAYS ☒ STANDARD

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION)

PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☒ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

As, Ag, Zn, Se Subbed to Tri Matrix

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6121 Huntley Rd. • Columbus, OH 43229
Telephone (614) 848-4333 • FAX: (614) 841-0818

CUSTODY RECORD

REPORT PAGE	RECORD NUMBER
OF	51574

PROJECT NAME/TYPE: Fox River

LOCATION: Kankakee Little Kankakee De Pere

[redacted]

REPORT RESULTS TO

COMPANY: Allah Environmental Services Inc.

ADDRESS: [redacted] Northwester [redacted]

CITY: Southfield STATE: Mi ZIP: 48075

P.O. #/PROJECT #: [illegible] #9230

[redacted]

FAX NO. 248-353-5485

INVOICE TO

NAME

COMPANY: SAME

ADDRESS

CITY STATE ZIP

ANALYSIS REQUESTED

NUMBER OF CONTAINERS / PRESERVATIVE

ITEM NO.	CLIENT SAMPLE IDENTIFICATION	MATRIX MEDIA	DATE SAMPLED	TIME SAMPLED	GRAB (G)/COMP (C)	OTHER	METHANOL KIT	ENCORE	NONE	HCL	SULFURIC (H2SO4)	NaOH	NITRIC (HNO3)	FILTERED Y/N	Volatile Organics (8260)	CPPD (1st)	DLZ LAB ID
1	LKc-3-01	water	02/07/01	14:39	G				1	2					X		
2	Kc-1-01	water	02/06/01	15:00	G				1	2					X		
3	Kc-2-02	water	02/06/01	15:20	G				1	2					X		
4	DPa-1-01	water	02/07/01	12:40	G				1	2					X		
5	DPb-1-01	soil	02/07/01	10:15	C		1		1						X		
6	DPb-2-01	soil	02/07/01	11:50	C		1		1						X		
7	DPb-3-01	soil	02/07/01	11:15	C		1		1						X		
8	Methanol Blank																
9																	
10																	

ENTER # IN THE BOX — ENTER AN "X" IN THE BOX BELOW TO INDICATE REQUEST

TRANSFER NO.	RELINQUISHED BY	DATE	TIME	ACCEPTED BY	DATE	TIME
[redacted]					2-9-01	10:30
3						
4						

QA / QC LEVEL: COE

REPORTING LIMIT: 451

ADDITIONAL COMMENTS (PLEASE RECORD SPECIAL HANDLING / HAZARD INFORMATION) PAID IN FULL ☐ YES ☐ NO

SAMPLES RECEIVED ON ICE ☒ YES ☐ NO COOLER TEMP. _____

SAMPLE INTEGRITY CHECKED ☐ YES ☐ NO

All subbed to Trimatrix

IMPORTANT - TURN AROUND TIME

NOTE: RUSH RESULTS MUST BE APPROVED BY LAB PRIOR TO SUBMITTAL.

DATE RESULTS EXPECTED

Certification of Independent Technical Review

Significant concerns and the explanation of the resolution are as follows:

The Fox River Draft Phase II Assessment Report was thoroughly reviewed. No significant issues were identified. However, several revisions were suggested to more clearly address suitability to transfer issues. These suggested revisions to the original draft document were relayed electronically, using the "track changes feature" in MSWord™. All suggested revisions were accepted and incorporated into the Final Draft Phase II Assessment Report

As noted above, all concerns resulting from independent technical review of the project have been considered.

[redacted]

(Signature)

4/17/01
(Date)

(Principal w/ A-E firm or Engineer of Record with Gov Ctr)

Phase II Limited Soil Investigation
Kaukauna Power Canal, Parcel J,

420 and 440 Bicentennial Court and
410 Fox Shores Drive
Kaukauna, Wisconsin

Prepared for:

US Army Corps of Engineers
Detroit District

US Army Corps of Engineers
Detroit District
DACW35-01-D-0006

Prepared by:

Altech Environmental Services, Inc.
17350 West Ten Mile Road, Suite 200
Southfield, Michigan, 48075
248-559-5500

Altech Project No. 9201-038

July 2006

Executive Summary

This evaluation of soil and groundwater conditions in the area of the Fox River Lock and Dam structures in association with the Fox River, Wisconsin, was developed in response to a proposed property transaction of the Locks and all associated structures from the US Army Corps of Engineers (USACE) to the State of Wisconsin specifically the land located adjacent to the Kaukauna Power Canal and three apartment complexes located at the addresses of 420 and 440 Bicentennial Court and 410 Fox Shores Drive, Kaukauna, Wisconsin.

The contamination of concern on the property is lead. The source of lead contamination at the site is unknown. An initial investigation occurred in 2003, which revealed detectable concentrations of lead ranging from between 61 and 320 mg/kg. Several samples exceeded the non-industrial criteria of 250 mg/kg but not the industrial direct contact criteria of 500 mg/kg

A second investigation occurred in July 2004 to determine the extent of the contamination of lead on the property. An XRF was used to determine which samples would be sent to the laboratory for analysis. XRF lead levels ranged from less than 30 ppm to 4,000 ppm. Seventeen (17) samples were sent to the laboratory and exhibited lead concentrations ranging from 18 to 11,000 mg/kg. The highest levels of contamination were located in the eastern half of the property.

The 2005 investigation objectives were to determine the extent of the lead contamination that exists in concentrations in excess of Wisconsin clean-up criteria, and if the lead impacts in soils might be affecting groundwater quality. Tests for determining lead impacts include a synthetic leaching procedure (SPLP) for groundwater impacts and Toxic Characteristic Leaching Procedure (TCLP) for hazardous waste characteristics.

The investigation included using a Geoprobe® to perform ten (10) soil borings on September 28, 2005. Each boring was drilled to either refusal at bedrock or to a maximum depth of 10 feet below ground surface. Thirty composite soil samples were collected from three depth intervals: 0-2 feet, a middle depth, and the bottom third of the soils in each boring. The shallow sandy soils at the site were found to have the highest lead levels. The middle and bottom interval soils were found to possess a greater percentage of clay and exhibited much lower lead levels. Lead levels ranged from a high of 2,100 mg/kg to a low of 3.3 mg/kg. Industrial direct contact and default residential criteria were exceeded in two borings.

Three groundwater borings were drilled on September 29, 2005, adjacent to the soil borings from the previous day. Two borings located on the eastern half of the property were dry, while the third boring located on the western half of the property had rechargeable groundwater levels. One groundwater sample was collected on September 29, 2005 from boring KCP0507. The groundwater sample result was non-detect (i.e., < 1 ug/L), and was below the 1.5 ug/L limit prescribed by NR 140.10.

Soil samples collected in 2005 that had lead levels higher than 250 mg/kg were required to have additional TCLP and SPLP testing. TCLP analyses were conducted on two (2) lead samples

from the eastern half of the property, KCP0501 0-2 feet and KCP0502 0-2 feet. The resulting TCLP levels ranged from 0.850 mg/L to 1.10 mg/L (ppm). The lead TCLP levels were below the hazardous waste threshold of 5.0 ppm for toxicity characteristics. The highest lead level on the site was 11,000 mg/kg (KCP0404-0.5) and was not analyzed for TCLP levels. Additional TCLP testing will be required if the contaminated soils on the property are removed for disposal purposes.

These two samples plus a third sample (KCP0510 0-2 feet) were selected for SPLP testing. All three samples had detectable levels of lead leaching above the WDNR Criteria for both preventative action and enforcement standards (1.5 and 15.0 ug/L respectively).

Soils, which exceed the industrial direct contact criteria for lead or impact groundwater, will require remedial action, engineering controls, deed restrictions, and/or a combination of these remedies.

Table of Contents

1.0 Introduction ***1***

1.1 Investigation Objectives **1**

1.2 Property Location and Description **2**

1.3 Report Organization **2**

2.0 Previous Investigation ***3***

2.1 2003 Investigation **3**

2.2 2004 Investigation **3**

3.0 2005 Sampling Results ***4***

3.1 Soil Sampling Procedures **4**

3.2 Soil Characteristics **4**

3.3 Soil Analytical Results **4**

3.3.1 Direct Contact Soil Analytical Results 4
3.3.2 TCLP Extraction Soil Analytical Results 4
3.3.3 SPLP Extraction Soil Analytical Results 5

3.4 Groundwater Sampling Procedures **5**

3.5 Groundwater Characteristics **5**

3.6 Groundwater Analysis **5**

4.0 Conclusions and Recommendations ***6***

5.0 Signatures & Qualifications of Environmental Professionals ***7***

Tables

Table 1 2003 Investigation Soil Lead Results
Table 2 2004 Investigation Soil Lead Results
Table 3 2005 Investigation Soil Lead Results
Table 4 2005 Investigation Comparison of Soil TCLP and Total Lead Results
Table 5 2005 Investigation Comparison of Soil SPLP and Total Lead Results
Table 6 2005 Investigation Groundwater Lead Results
Table 7 Summary of Parcel J Lead Concentrations in Excess of WDNR Default Criteria

Figures

Figure 1 Site Location Maps
Figure 2 Topographic Map
Figure 3 Aerial Photograph
Figure 4 ACOE Provided Site Map
Figure 5 Soil Boring Locations and Soil Lead Levels
Figure 6 Soil Boring Locations and TCLP and SPLP Lead Levels
Figure 7 Water Sample Locations and Water Lead Levels

Appendices

Appendix A Site Photographs
Appendix B Soil Borings Logs
Appendix C Trace Analytical Laboratories – Soil Lead Analytical Report
Appendix D Trace Analytical Laboratories – TCLP Lead Analytical Report
Appendix E Trace Analytical Laboratories – SPLP Lead Analytical Report
Appendix F Trace Analytical Laboratories – Groundwater Lead Analytical Report

List of Acronyms

mg/kg	milligrams per kilograms
QA/QC	Quality Assurance/Quality Control
PID	Photo-ionization Detector
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxic Characteristic Leaching Procedure
ug/L	microgram per liter
USACE	United States Army Corps of Engineers – Detroit District
US EPA	United States Environmental Protection Agency
WDNR	Wisconsin Department of Natural Resources
XRF	X-ray Fluorescence Spectroscopy

1.0 Introduction

This Site Investigation report summarizes the results of a site investigation of US Government properties attached to Locks and Dams on the Fox River in Kaukauna, Wisconsin. Altech Environmental Services Inc performed the investigation under contract to the United States Army Corps of Engineers – Detroit District (USACE).

The subject properties are currently owned by;

United States Army Corps of Engineers – Detroit District
477 Michigan Avenue
Detroit, Michigan
48231-1027

Contractors involved in the Site Investigation are:

Altech Environmental Services, Inc.
17350 W. 10 Mile Road, Suite 200
Southfield, Michigan 48075

Altech Services, LLC.
37663 Schoolcraft Road
Livonia, Michigan 48150

Trace Analytical Laboratories
2241 Black Creek Road
Muskegon, Michigan 49444-2673

1.1 *Investigation Objectives*

The purpose of this investigation is to determine the nature and extent of lead impacted soil that is present at three parcels comprising the Fox River project as part of the soil remediation work being conducted at those sites. The scope of work for this parcel, identified as Kaukauna – Parcel J was to advance exploratory soil borings until bedrock was encountered and to collect soil samples for analysis of total lead at the top, middle and bottom intervals of each boring. TCLP levels were to be assessed for any soil sample that exhibited an elevated total lead concentration as defined by NR 140 and NR 720 of the Wisconsin Administrative Code (i.e., 250 ppm).

This evaluation of soil and groundwater conditions in the area of the Fox River Lock and Dam structures in association with the Fox River, Wisconsin, was developed in response to elevated levels discovered in previous samplings.

1.2 *Property Location and Description*

The property is located on the south side of the Fox River in Section 22, Township 21 North, Range 15 East in Outagamie County, Kaukauna, Wisconsin. Site location maps are included as Figure 1. Figure 2 identifies the parcel on a topographic map, while Figure 3 identifies the parcel on a 1992 aerial photograph.

Parcel J consists of two portions; an east portion and a west portion as shown on Figure 4. The eastern portion is located north of the Kaukauna Power Canal and south of the Fox River Dam on an island that is currently used as a city park and is circled on Figure 4. The eastern portion of Parcel J was not part of this investigation. The western portion of Parcel J is located adjacent to the west of the entrance to the Kaukauna Power Canal, south of the Fox River, and north of multiple apartment buildings. It is a thin strip of land, 46 feet at the widest spot and 25 feet at the narrowest along the Fox River. The western portion is adjacent to three parcels occupied by apartments. The apartments have the addressees of 410 Fox Shores Drive (two buildings), 420 Bicentennial Court (three connected buildings), and 440 Bicentennial Court (three buildings). The land is relatively flat lying, with a slight slope towards the Fox River. The land is not fenced and is accessible from all three-apartment complexes and from the river. Photographs of the property are included in Appendix A. According to a resident in the apartments, Parcel J was historically occupied by railroad tracks.

1.3 *Report Organization*

This limited soil and groundwater investigation report presents a summary and evaluation of the data collected from site activities performed on September 27, 2005. Section 1 describes the property and its surrounding environment and land use. Section 2 summarizes a previous investigation conducted on October 4, 2001. Section 3 identifies and characterizes the soil boring locations at the facility and discusses the chemical results from the analyses performed on the collected soil and groundwater samples. Section 4 summarizes the findings and conclusions of the study, discusses the quality and reliability of the supporting information, identifies areas where further action may be required, and suggests how such remedial actions could be accomplished. Section 5 contains the signatures and qualifications of the environmental professionals involved with this report. The appendices contain copies of the site photographs, soil boring logs and laboratory analytical results.

2.0 Previous Investigation

2.1 *2003 Investigation*

The project objectives for the previous investigation conducted in 2003 consisted of an evaluation of soil conditions for former Industrial/Commercial soil impacts at the USACE property north of Kaukauna Dam (Kaukauna Power Canal). This task was completed by physical collection of soil samples by hand auger from two (2) depth intervals where available (0.0-0.5' and 1.5-2.0' bsg) at three (3) locations. These samples were submitted for volatile organic compound (VOC) and metals analyses. All information concerning this investigation was discussed in the Site Survey Report dated September 2003.

Total lead analyses for the five (5) soil samples collected from three (3) sampling points located adjacent to the Kaukauna Power Canal were found to range from 61 ppm to 320 ppm. See Table 1, Total Lead Analysis for the tabled analytical results for Total Lead analysis at Kaukauna Power Canal. See Figure 4 for field sampling locations.

2.2 *2004 Investigation*

Altech collected additional lead soil samples at Kaukauna Power Canal Parcel J in 2004. Seventeen (17) soil samples were collected during this investigation using a hand auger in order to fill data gaps identified by the USACE from the 2003 investigation. Sample depths ranged from 6 inches to 4 feet below ground surface (bgs.). Refusal was often encountered in the fill material. Samples were collected along the southern edge of the parcel and screened using an X-ray Fluorescence Spectroscopy (XRF) device. Confirmation samples were collected at the maximum attainable depth. Table 2 presents the analytical data for this investigation.

Parcel J sample locations were based on "step outs" from two previous sample locations exhibiting high lead concentrations (KPC03-01 and KPC03-03). The hand auger was advanced and screening samples were collected until a XRF value of less than 250 ppm was obtained, or refusal was encountered. Table 2 presents the XRF values and the laboratory analytical data for the 2004 Parcel J samples. Figure 5 illustrates the soil boring locations on Parcel J. XRF results from the 2004 investigation varied from a high of 4,000 ppm at a depth of 1 foot to non-detect (i.e., <30 ppm). Lead laboratory analytical results varied from a high of 11,000 mg/kg at a depth of 0.5 feet (boring 0404) to 18 mg/kg (boring 0403).

3.0 2005 Sampling Results

All field-sampling activities occurred on September 28 and 29, 2005. Field sampling activities included surveying the property to locate the western-most corner of the site, and the southern edge of Parcel J. This was done to make sure all sample points were correctly located on the subject property. The 10 boring locations were placed approximately equal distance (between 60 and 80 feet) from each other, and within 20 feet of the river.

3.1 *Soil Sampling Procedures*

Soil borings were advanced and continuous samples were collected from the ground surface to termination at refusal or until a depth of 10 feet was encountered using a Geoprobe™ system for collection of environmental samples. A geologist described and characterized the soil encountered in each boring. The boring records are presented herein in Appendix B. No permanent monitoring wells were installed during this investigation. Three (3) temporary monitoring wells were installed at borings KCP0501, -0504, and –0507. All soil borings were backfilled and sealed with bentonite chips to prevent the formation of preferential migration pathways. Investigation-derived waste as well as decontamination and development water were placed in drums and disposed of appropriately.

3.2 *Soil Characteristics*

The top three to six inches of soil consists of a dark brown sandy loam. Soils located beneath the topsoil include gravelly sands, silty sands, sandy clays, gravelly clays, and silty clays. No groundwater samples were collected from the borings installed on September 28, 2005.

3.3 *Soil Analytical Results*

3.3.1 Direct Contact Soil Analytical Results

Three soil samples were collected from each boring for laboratory analysis. One sample was collected from the top (surface) of each boring, while the second sample was collected from the middle interval of the boring, and a third sample was collected from the bottom third of each boring. All samples were submitted for lead analysis (Table 3). Appendix C contains the laboratory analytical report for soils.

3.3.2 TCLP Extraction Soil Analytical Results

Only two samples, both located on the east half of the property, were found to possess lead levels higher than 250 mg/kg during the 2005 sampling event (borings 0501 and 0502). These two samples were then subsequently analyzed for Toxic Characteristic Leaching Procedure (TCLP) lead levels in accordance with USACE requirements. The TCLP analytical report is included in Appendix D. Table 4 summarizes the analytical information concerning these two borings. TCLP lead levels for borings 0501 and 0502 (depth of 0-2' both borings) were 1.10 and 0.850 mg/L (ppm), respectively. The lead TCLP levels were below hazardous waste threshold of 5.0 ppm for toxicity characteristic. No soils collected from the previous investigations were analyzed for TCLP extractions of lead. The highest level of lead was identified in 2004

(KCP0404-0.5). Additional TCLP sample analysis will be required if the soils are excavated for disposal.

3.3.3 SPLP Extraction Soil Analytical Results

The two samples selected for TCLP analysis (0501 and 0502 0-2 feet) and a third sample from the west half of the property (KCP0510 0-2 feet) were selected for Synthetic Precipitation Leaching Procedure SPLP testing. All three samples had detectable levels of lead leaching above the WDNR Criteria for both preventative action and enforcement standards (1.5 and 15.0 ug/L respectively). Analytical data is summarized in Table 5. Appendix E includes the Trace Laboratory Report for the SPLP analysis. Figure 6 shows the locations of the TCLP and SPLP sample locations and analysis data.

3.4 *Groundwater Sampling Procedures*

No permanent monitoring wells were installed on the property, however, groundwater was sampled through a 16-point stainless steel 32" retractable screen installed using the Geoprobe. Plastic tubing was then inserted through the Geoprobe equipment, and a peristaltic pump was used to pump the water from the ground. At least three gallons of groundwater was purged from each temporary well under low flow conditions.

3.5 *Groundwater Characteristics*

Three (3) borings were selected for attempts to collect groundwater samples on September 29, 2005. These groundwater sampling locations were located adjacent to KCP0501, -0504, and –0507, respectively (Figure 7 and Table 6). Each boring was probed to a depth of 15 feet bgs. and sampled if groundwater was encountered. Only boring KCP0507 produced sufficient quantities of groundwater for collection and analysis. The elevations of the groundwater table and ground surface are unknown at boring 0507. A survey of the property was not requested at the time of the investigation.

3.6 *Groundwater Analysis*

A copy of the analytical report is included in Appendix F. The result for dissolved lead in the groundwater from the sample collected on September 29, 2005 from boring KCP0507 was non-detect (i.e., < 1 ug/L).

4.0 Conclusions and Recommendations

The occurrence of elevated concentrations of lead is observed more at the surface of the property, with low levels below. The western side of Parcel J has elevated lead concentrations from near the beginning of the property line, extending 300 feet east, from the surface to a maximum of 4 feet below the ground surface. The eastern side of Parcel J has more surficial elevated lead concentrations, beginning approximately 400 feet from the beginning of the property line going east to 800 feet, from the surface to 2 feet below the ground surface. NR 140 and NR 720 of the Wisconsin Administrative Code prescribe that when lead is found in residential land use situations where it is the only contaminant present, the default cleanup criteria in soil to be used is 250 ppm. NR 720.19 further specifies a direct contact screening value of 500 ppm under industrial land use scenarios. Several locations were identified in the 2003, 2004, and 2005 investigations which contained lead concentrations in excess of both the default residential and/or industrial direct contact criteria as shown in Table 7.

The TCLP lead results 2005 were less than thresholds in 40 CFR 261.24, therefore, the soils sampled are not hazardous waste. However, the highest values of lead samples were collected in 2004, and were not tested for TCLP leaching. Therefore additional samples will be required for TCLP testing if the soils are excavated for disposal.

SPLP lead results indicated that the lead levels in the soils have the ability to leach. The values detected in three soil samples tested were above the protective action level for drinking water protection of 1.5 ug/L. Groundwater sampling results did not indicate the presence of lead at levels that exceeded criteria established under NR 140.10.

Soils, which exceed the industrial direct contact criteria for lead or impact groundwater, will require remedial action, engineering controls, deed restrictions, and/or a combination of these remedies.

5.0 Signatures & Qualifications of Environmental Professionals

Altech has completed the Phase II Limited Soil Investigation of Parcel J associated with the Kaukauna Power Canal located in Kaukauna, Wisconsin. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs.

Preparer

(Signature) July 20 2006 (Date)

Mariah G. Hope E.I.T
Environmental Engineer

Reviewer

(Signature) July 20, 2006 (Date)

Dayal Saran P.E.
Senior Engineer

Tables

Table 1

Parcel J 2003 Investigation
Soil Lead Results

Fox River, Kaukauna, Wisconsin

Sample Date: August 25, 2003

City	Sample Location	Lab ID	Sample ID	Sample Depth	Results (mg/kg)
Kaukauna Power Canal	Power Canal East End of adjacent Apt Bldg (near point)	DH307-40	KPC03-01 (0-0.5')	(0-0.5)	290
	Power Canal East End of adjacent Apt Bldg (near point)	DH307-41	KPC03-01 (1.5-2.0')	(1.5-2)	280
	Power Canal West End of adjacent Apt Bldg	DH307-42	KPC03-02 (0-0.5')	(0-0.5)	61
	Power Canal North and center of Apt Bldg Courtyard	DH307-43	KPC03-03 (0-0.5')	(0-0.5)	320
	Power Canal North and center of Apt Bldg Courtyard	DH307-44	KPC03-03 (0.5-1.0')	(0.5-1)	64

HELD - sample analysis pending

NA - sample not analyzed for listed compound

Table 2

Parcel J 2004 Investigation

Soil Lead Results

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample Date: July 2004

Sample Location	Feet from Original Sample	Sample Depth	XRF Reading (lead ppm)	Sample I.D.	Trace ID	Sample Date	Lead Analytical Results (mg/kg)
Parcel J	10' west of KCP03-01	6"	210			7/16/2004	
		1'	2900			7/16/2004	
		1.5'	1920			7/16/2004	
		2'	140			7/16/2004	
		2.5'	<30	KCP0401	EG264-05	7/16/2004	4200
	30' west of KCP03-01	6"	90			7/16/2004	
		1'	<30	KCP0402	EG264-06	7/16/2004	46
	50' west of KCP03-01	6"	132			7/16/2004	
		1'	<30	KCP0403	EG264-07	7/16/2004	18
	10' east of KCP03-01	6"	741	KCP0404	EG264-08	7/16/2004	11000
	30' east of KCP03-01	6"	180	KCP0405	EG264-09	7/16/2004	570
	50' east of KCP03-01	6"	<30			7/16/2004	
		1'	<30	KCP0406	EG264-10	7/16/2004	150
	10' west of KCP03-03	6"	175			7/16/2004	
		1'	240			7/16/2004	
		1.5'	160			7/16/2004	
		2'	240			7/16/2004	
		2.5'	340	KCP0407	EG264-11	7/16/2004	290
	30' west of KCP03-03	6"	211			7/16/2004	
		1'	222			7/16/2004	
		1.5'	276			7/16/2004	
		3'	190	KCP0408	EG264-12	7/16/2004	290
	60' west of KCP03-03	6"	114			7/16/2004	
		1'	250			7/16/2004	
		3'	310			7/16/2004	
		4'	237	KCP0409	EG264-13	7/16/2004	510
	140' west of KCP03-03	6"	240			7/16/2004	
	170' west of KCP03-03	6"	243			7/16/2004	
		2'	160	KCP0410	EG264-14	7/16/2004	420
	25' east of KCP03-03	6"	251	KCP0411	EG297-01	7/20/2004	240
		1'	134			7/20/2004	
		2'	263			7/20/2004	
		4'	221	KCP0412	EG297-02	7/20/2004	330
	100' east of KCP03-03	6"	184			7/20/2004	
		1'	800			7/20/2004	
		2'	463			7/20/2004	
		3'	71	KCP0413	EG297-03	7/20/2004	91
	200' east of KCP03-03	6"	<30			7/20/2004	
		1'	133	KCP0414	EG297-04	7/20/2004	630
	300' east of KCP03-03	6"	177			7/20/2004	
		1'	4000	KCP0415	EG297-05	7/20/2004	5700
	400' east of KCP03-03	6"	460			7/20/2004	
		1'	<30	KCP0416	EG297-06	7/20/2004	48
	500' east of KCP03-03	6"	623			7/20/2004	
		1'	540	KCP0417	EG297-07	7/20/2004	430

Table 3

Parcel J 2005 Investigation
Soil Lead Results

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample Date: September 29, 2005

SAMPLE ID	BORING DEPTH	TRACE ID	PREP DATE	ANALYSIS DATE	DILUTION	LEAD RESULT (mg/kg)
KCP0501	0 - 2	FJ328-01	10/5/2005	10/11/2005	1000	2100
KCP0501	4 - 6	FJ328-02	10/5/2005	10/10/2005	100	7.6
KCP0501	8 - 10	FJ328-03	N/A	N/A	N/A	N/A
KCP0502	0 - 2	FJ328-04	10/5/2005	10/10/2005	100	440
KCP0502	4 - 6	FJ328-05	10/5/2005	10/10/2005	100	79
KCP0502	7 - 9	FJ328-06	10/5/2005	10/11/2005	10	3.3
KCP0503	0 - 2	FJ328-07	10/5/2005	10/10/2005	100	160
KCP0503	4 - 6	FJ328-08	10/5/2005	10/10/2005	100	13
KCP0503	6 - 8	FJ328-09	10/5/2005	10/10/2005	100	6.7
KCP0504	0 - 2	FJ328-11	10/5/2005	10/10/2005	100	15
KCP0504	3 - 5	FJ328-12	10/5/2005	10/10/2005	100	9
KCP0504	7 - 9	FJ328-13	10/5/2005	10/11/2005	10	4.4
KCP0505	1 - 3	FJ328-14	10/5/2005	10/10/2005	100	91
KCP0505	4 - 6	FJ328-15	10/5/2005	10/10/2005	100	8.8
KCP0505	7 - 9	FJ328-16	10/5/2005	10/10/2005	100	7.3
KCP0506	0 - 2	FJ328-17	10/5/2005	10/10/2005	100	34
KCP0506	4 - 6	FJ328-18	10/5/2005	10/10/2005	100	5.7
KCP0506	7 - 9	FJ328-19	10/5/2005	10/10/2005	100	4.5
KCP0507	0 - 2	FJ328-21	10/6/2005	10/10/2005	100	62
KCP0507	2 - 4	FJ328-22	10/6/2005	10/10/2005	100	7.8
KCP0507	6 - 8	FJ328-23	10/6/2005	10/10/2005	100	9
KCP0508	0 - 2	FJ328-24	10/6/2005	10/10/2005	100	130
KCP0508	4 - 6	FJ328-25	10/6/2005	10/10/2005	100	10
KCP0508	7 - 9	FJ328-26	10/6/2005	10/10/2005	100	5.8
KCP0509	0 - 2	FJ328-27	10/6/2005	10/10/2005	100	67
KCP0509	4 - 6	FJ328-28	10/6/2005	10/10/2005	100	12
KCP0509	7 - 9	FJ328-29	10/6/2005	10/11/2005	10	3.5
KCP0510	0 - 2	FJ328-30	10/6/2005	10/10/2005	100	120
KCP0510	4 - 6	FJ328-31	10/6/2005	10/10/2005	100	8.9
KCP0510	6 - 8	FJ328-32	10/6/2005	10/11/2005	10	3.6
KCP	DUP 1	FJ328-10	10/5/2005	10/11/2005	10	2.5
KCP	DUP 2	FJ328-20	10/5/2005	10/10/2005	100	37
KCP	DUP 3	FJ328-33	10/6/2005	10/10/2005	100	12

N/A - not analyzed - sample arrived damaged.

Table 4
2005 Investigation Comparison of Soil TCLP and Total Lead Results
Fox River, Kaukauna, Wisconsin
Altech Project # 9201-0038
Sample Date: September 29, 2005

BORING NO	SAMPLE DEPTH feet	LEAD RESULT mg/kg	TCLP RESULT mg/L
KCP0501	0 - 2	2100	1.1
KCP0502	0 - 2	440	0.85

Table 5

Parcel J 2005 Investigation

Comparison of Soil TCLP and Total Lead Results

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample Date: September 29, 2005

SAMPLE ID	SAMPLE DEPTH	TRACE ID	PARAMETER*	RESULT	UNITS	WDNR Criteria**	
KCP0501	0 - 2	FJ328-01	Lead	**2100**	mg/kg	250	mg/kg
KCP0501	0 - 2	FK294-09	TCLP Lead	1.1	mg/L	5	mg/L
KCP0501	0 - 2	GC124-01	SPLP Lead	**330**	ug/L	1.5 / 15	ug/L
KCP0502	0 - 2	FJ328-04	Lead	**440**	mg/kg	250	mg/kg
KCP0502	0 - 2	FK294-10	TCLP Lead	0.85	mg/L	5	mg/L
KCP0502	0 - 2	GC124-02	SPLP Lead	**130**	ug/L	1.5 / 15	ug/L
KCP0510	0 - 2	FJ328-30	Lead	120	mg/kg	250	mg/kg
KCP0510	0 - 2	GC124-03	SPLP Lead	**27**	ug/L	1.5 / 15	ug/L

Note:

* There are three parameters being displayed. Lead, TCLP Extracted Lead, and SPLP Extracted Lead

** Each parameter has a diferent criteria as listed in the column and below

Parameter	Criteria
Lead	WDNR non-industrial criteria - 250 mg/Kg
	WDNR industrial direct contact criteria - 500 mg/Kg
TCLP Lead	Hazardous Waste Criteria = 5 mg/L
SPLP Lead	Public Health Groundwater Quality Standards Preventive Action Limit (PAL) = 1.5 ug/L
	Public Health Groundwater Quality Standards Enforcement Standard = 15.0 ug/L

Table 6

Parcel J 2005 Investigation

Groundwater Lead Results

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample Date: September 29, 2005

BORING NO	SAMPLE DEPTH feet	LEAD RESULT mg/L
KCP0501	Dry Well	NS
KCP0504	Dry Well	NS
KCP0507	Depth Unknown	<0.001

NS - not sampled/not analyzed

Table 7

Summary of Parcel J Lead Concentrations

In Excess of WDNR Default Criteria

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample I.D.	Sampling Depth	Sampling Date	Lead Analytical Results (mg/kg)
KPC0301	0 - 0.5'	8/25/2003	290
KPC0301	1.5 - 2'	8/25/2003	280
KPC0303	0 - 0.5'	8/25/2003	320
KCP0401	**2.5'**	**7/16/2004**	**4,200**
KCP0404	**6"**	**7/20/2004**	**11,000**
KCP0405	**6"**	**7/16/2004**	**570**
KCP0407	2.5'	7/20/2004	290
KCP0408	3'	7/16/2004	290
KCP0409	**4'**	**7/20/2004**	**510**
KCP0410	2'	7/16/2004	420
KCP0412	4'	7/20/2004	330
KCP0414	**1'**	**7/16/2004**	**630**
KCP0415	**1'**	**7/20/2004**	**5,700**
KCP0417	1'	7/16/2004	430
KCP0501	**0 - 2'**	**9/29/2005**	**2,100**
KCP0502	0 - 2'	9/29/2005	440

11000 **Result Also Exceeds Industrial Direct Contact Criteria**

Figures

FIGURE 1: SITE LOCATION MAPS

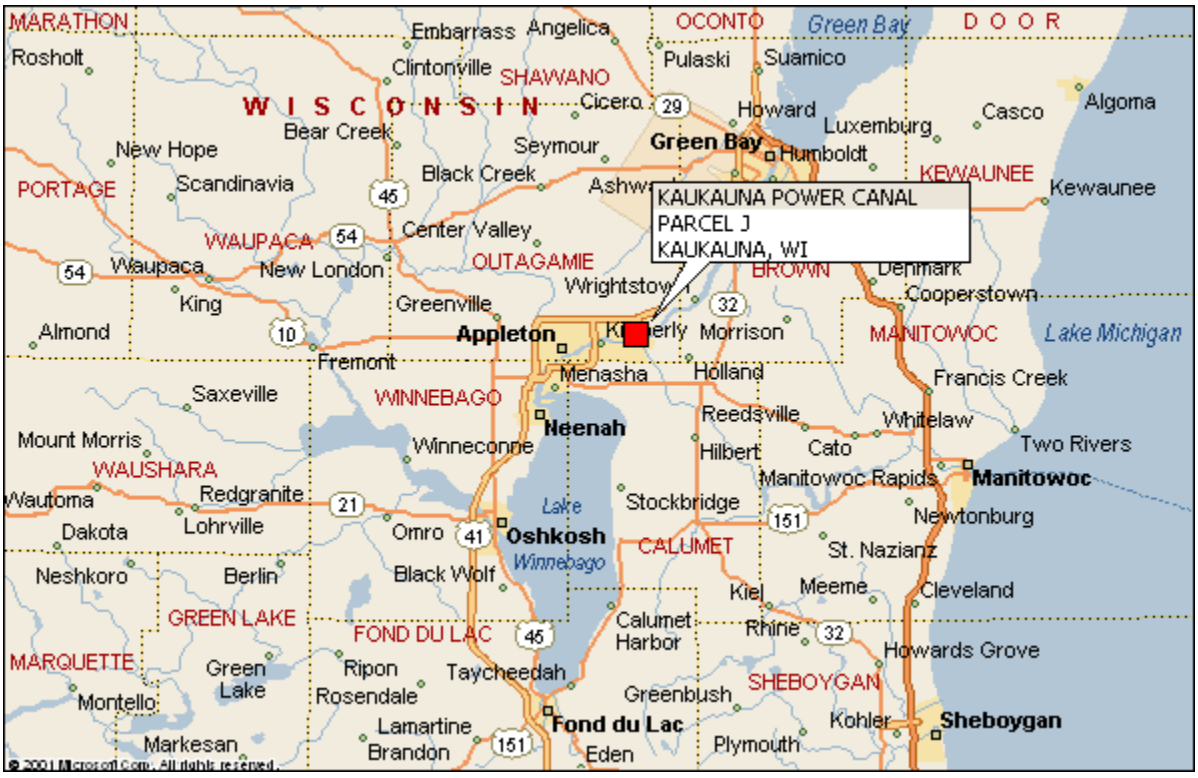




FIGURE 1: SITE LOCATION MAPS

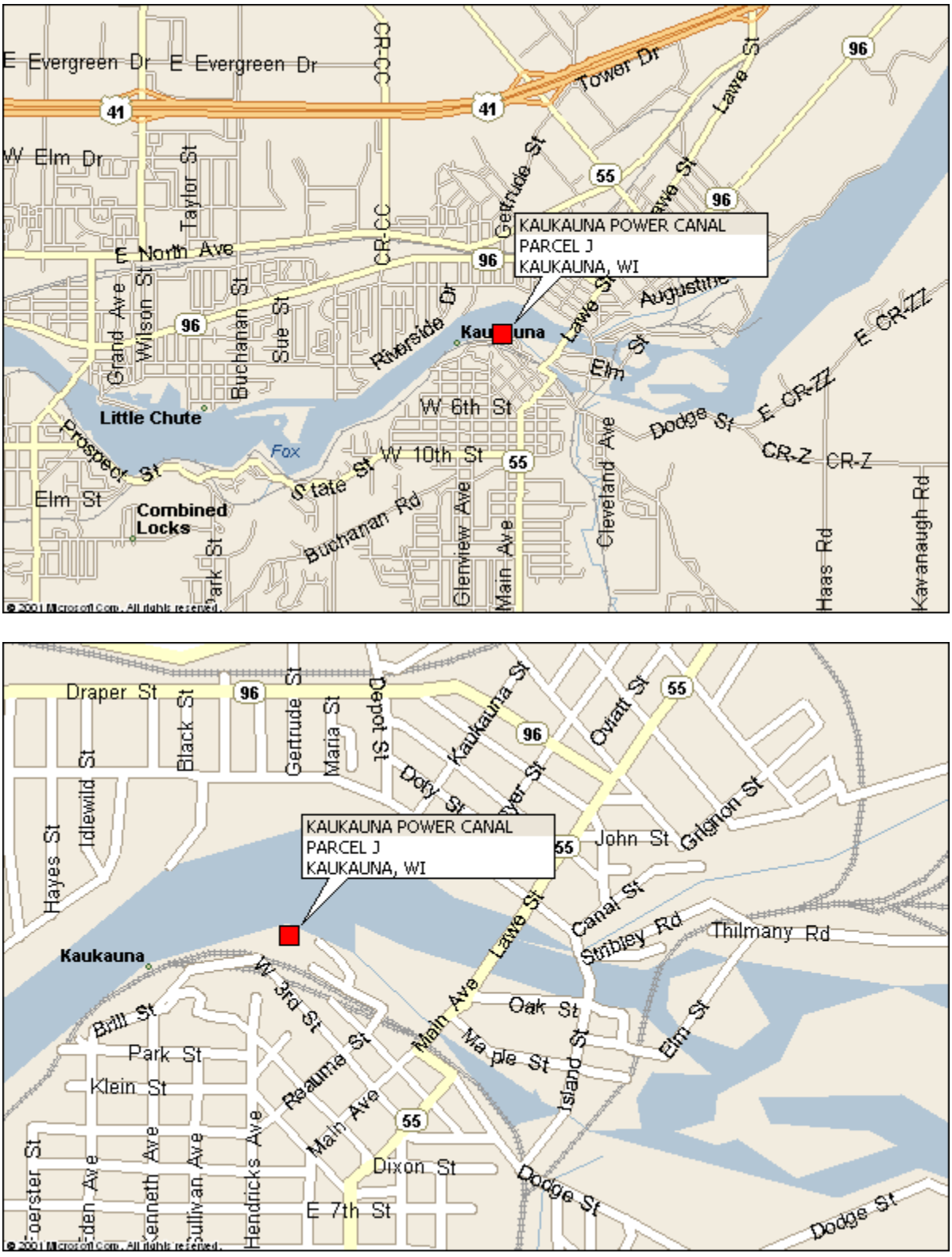
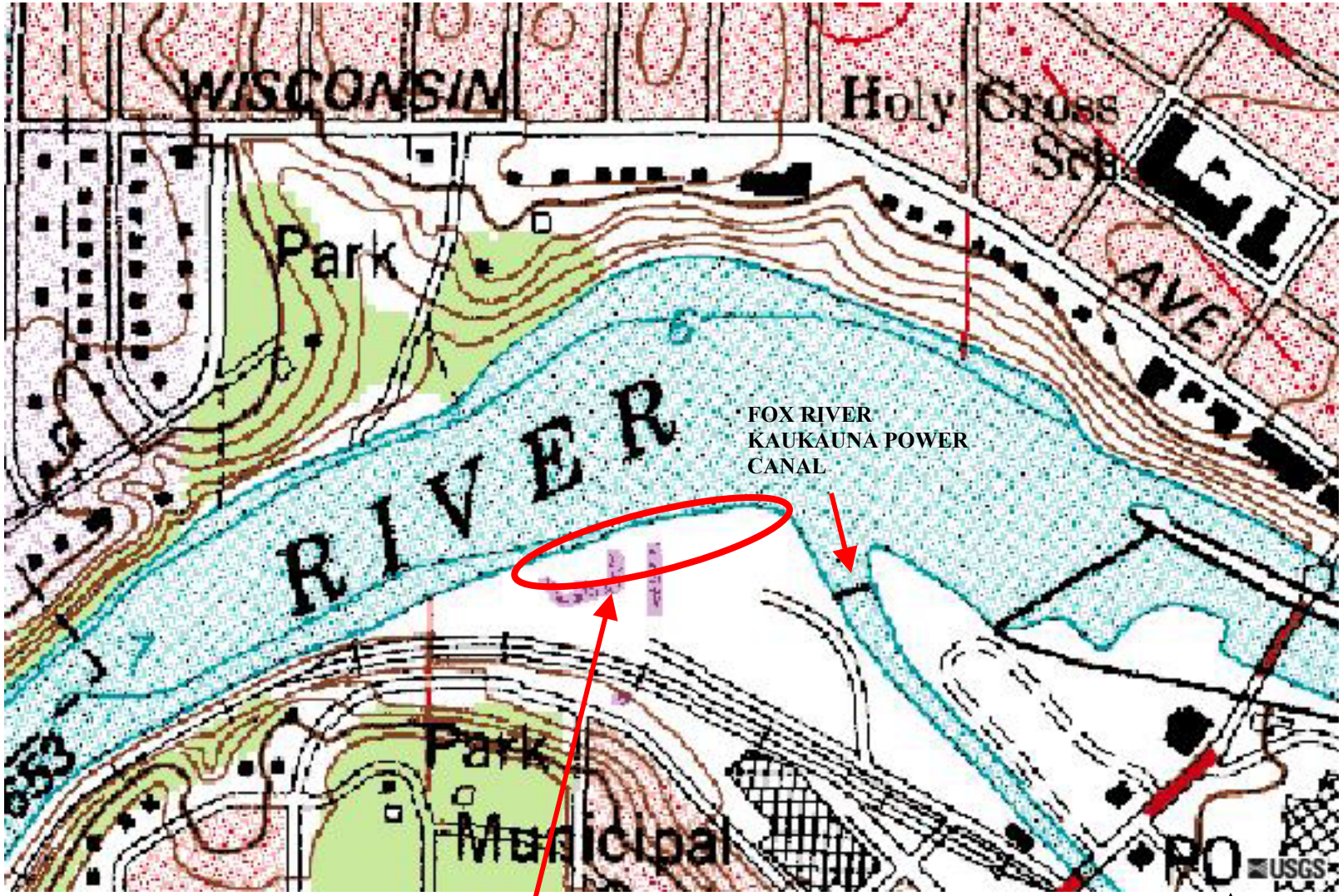


FIGURE 2: TOPOGRAPHIC MAP



FOX RIVER KAUKAUNA POWER CANAL PARCEL "J" SAMPLING LOCATION

N

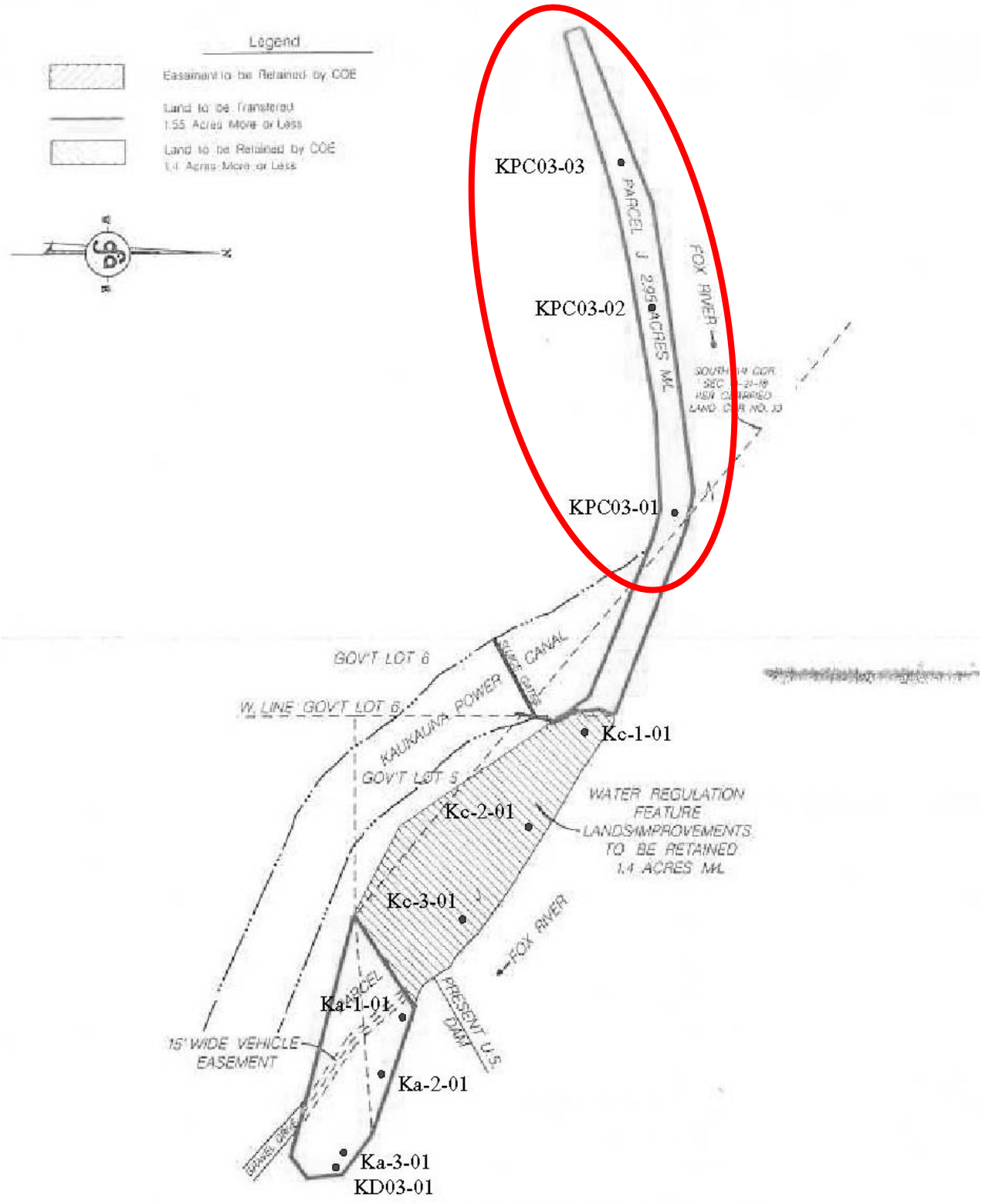
FIGURE 3: 1992 AERIAL PHOTOGRAPH



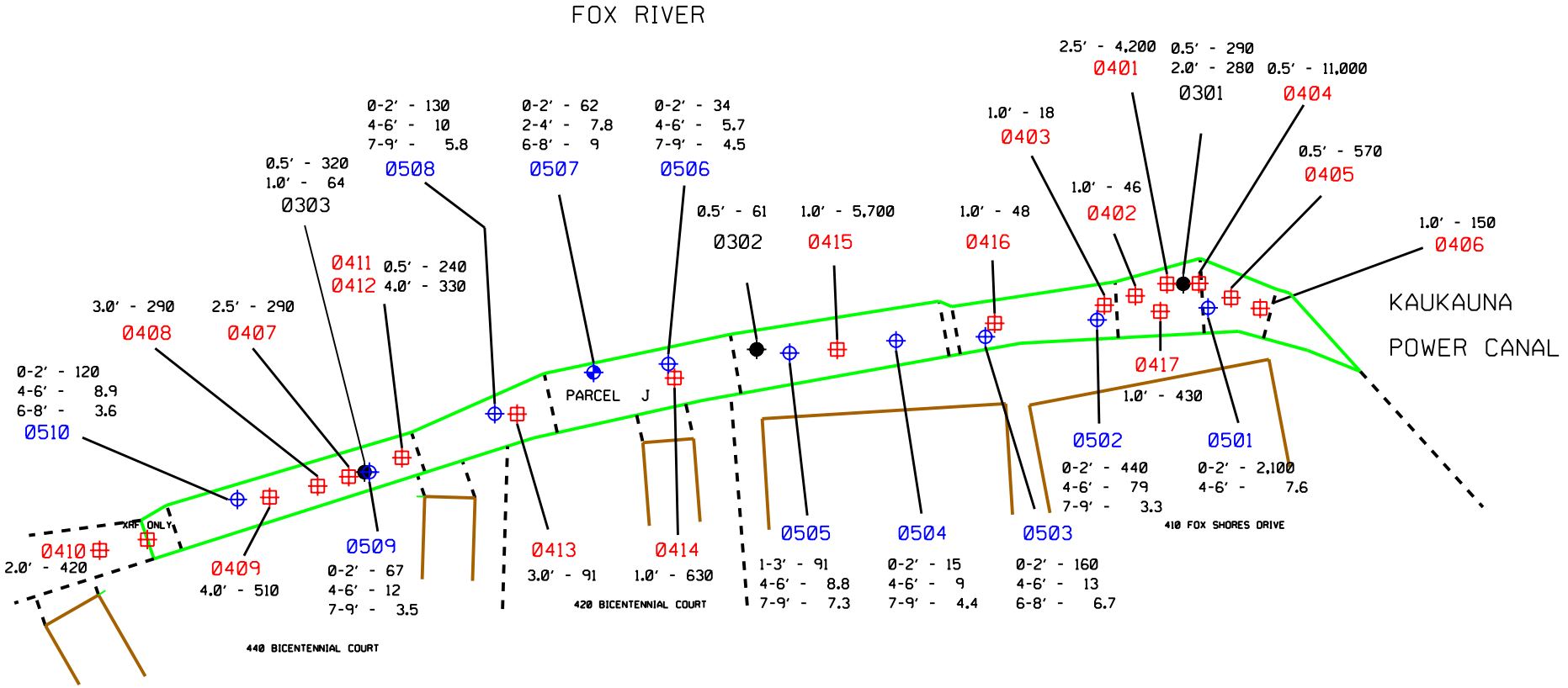
FOX RIVER KAUKAUNA POWER CANAL PARCEL "J" SAMPLING LOCATION

N

FIGURE 4: PARCEL J – 2003 SAMPLE LOCATIONS



KAUKAUNA POWER CANAL PARCEL J



LEGEND

- PROPERTY BOUNDRY
- BUILDING OUTLINE
- SOIL BORING/SOIL SAMPLE FROM 2003 KCP03/KPC03
- SOIL BORING/SOIL SAMPLE FROM 2004 KCP04
- SOIL BORING/SOIL SAMPLE FROM 2005 KCP0905
- SOIL BORING/SOIL AND GROUNDWATER SAMPLE FROM 2005 KCP0905
- 0409 — BORING IDENTIFICATION NUMBER
- 4.0' - 510 — DEPTH, feet - LEAD ANALYTICAL RESULTS, mg/kg

NOTE:

1. ALL BORING LOCATIONS ARE ESTIMATED.
2. INFORMATION FOR FIGURE FROM DRAWINGS PROVIDED BY ACOE AND BY OUTAGAMIE COUNTY.

N

SCALE 1" = 100'

0 40 80 120 160 200

REVISION	DATE	DESCRIPTION	BY	CHKD
1	03-APR-06	ADD TCLP AND SPLP DATA	MH	

DRAWN BY	MH
DESIGNED BY	MH
DATE	08-NOV-05
SCALE	1" = 100'
DRAWING NUM	5

ALTECH ENVIRONMENTAL SERVICES
SOUTHFIELD, MICHIGAN

KAUKAUNA POWER CANAL
PARCEL J
KAUKAUNA, WISCONSIN

SOIL BORING LOCATION MAP
SOIL LEAD LEVELS

FIGURE 5

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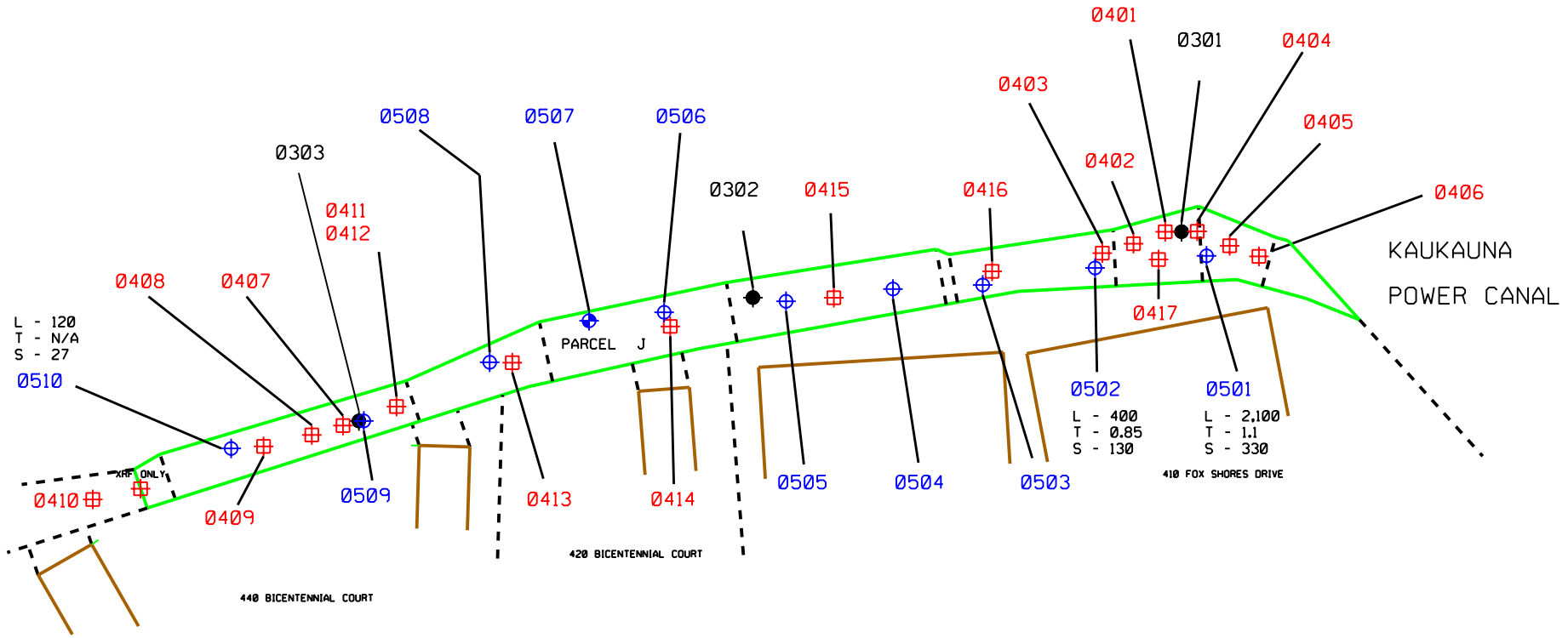


LEGEND

	PROPERTY BOUNDRY
	BUILDING OUTLINE
◆	SOIL BORING/SOIL SAMPLE FROM 2003 KCP03/KPC03
⊞	SOIL BORING/SOIL SAMPLE FROM 2004 KCP04
⊕	SOIL BORING/SOIL SAMPLE FROM 2005 KCP0905
◈	SOIL BORING/SOIL AND GROUNDWATER SAMPLE FROM 2005 KCP0905
0409	BORING IDENTIFICATION NUMBER
L - 2,100	LEAD ANALYTICAL RESULTS, mg/kg
T - 1.1	TCLP LEAD ANALYTICAL RESULTS, mg/L
S - 330	SPLP LEAD ANALYTICAL RESULTS, ug/L

NOTE:

1. ALL BORING LOCATIONS ARE ESTIMATED.
2. INFORMATION FOR FIGURE FROM DRAWINGS PROVIDED BY ACOE AND BY OUTAGAMIE COUNTY.

N

SCALE 1" = 100'

0 40 80 120 160 200

REVISION	DATE	DESCRIPTION	BY	CHKD
1	03-APR-06	ADD TCLP AND SPLP DATA	MH	

DRAWN BY: MH
DESIGNED BY: MH
DATE: 08-NOV-05
SCALE: 1" = 100'
DRAWING NUM: 6

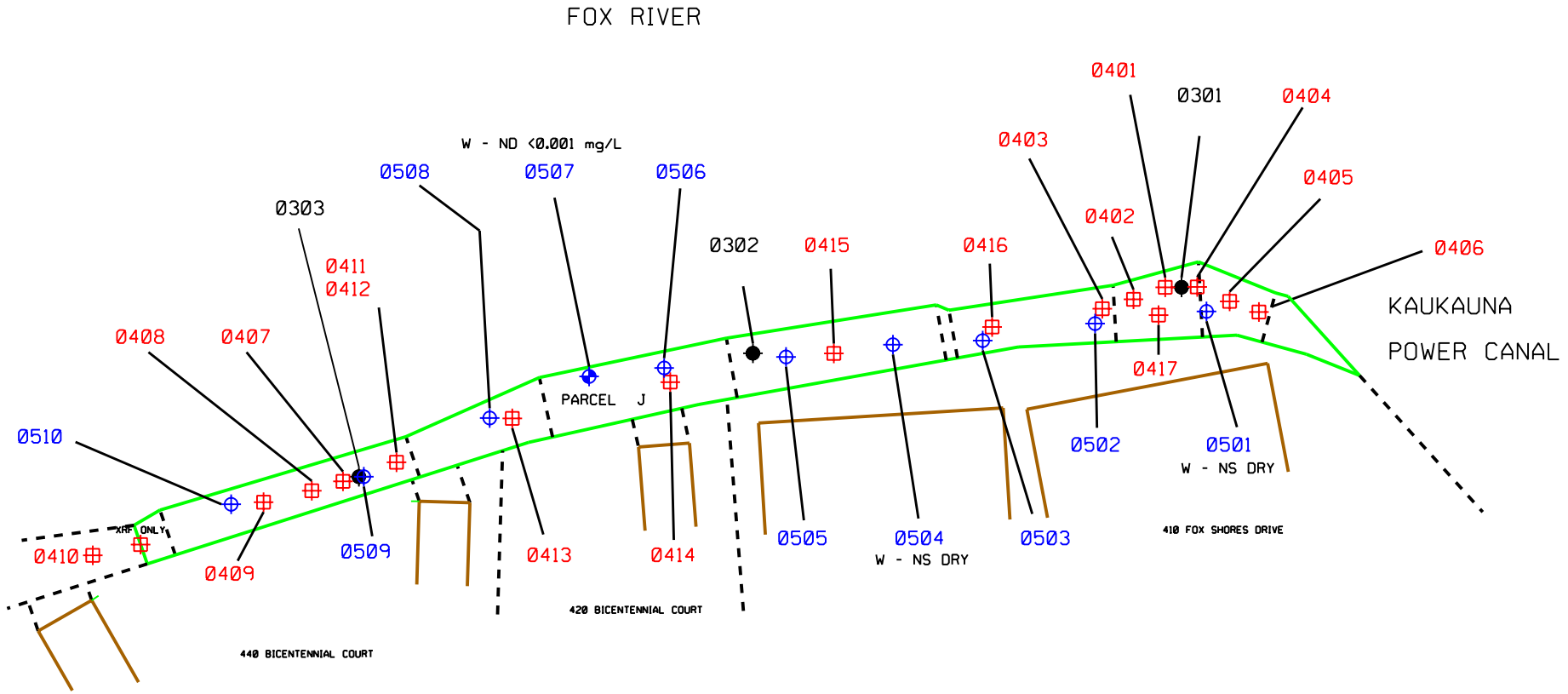
ALTECH ENVIRONMENTAL SERVICES
SOUTHFIELD, MICHIGAN

KAUKAUNA POWER CANAL
PARCEL J
KAUKAUNA, WISCONSIN

SOIL BORING LOCATION MAP
SOIL TCLP AND SPLP LEAD LEVELS

FIGURE 6

...\Parcel J\Parcel J.dgn 7/25/2006 4:56:32 PM



LEGEND

- PROPERTY BOUNDRY
- BUILDING OUTLINE
- SOIL BORING/SOIL SAMPLE FROM 2003 KCP03/KPC03
- SOIL BORING/SOIL SAMPLE FROM 2004 KCP04
- SOIL BORING/SOIL SAMPLE FROM 2005 KCP0905
- SOIL BORING/SOIL AND GROUNDWATER SAMPLE FROM 2005 KCP0905
- 0409 BORING IDENTIFICATION NUMBER
- W - ND/NS WATER SAMPLE - NON DETECT OR NOT SAMPLED

NOTE:

1. ALL BORING LOCATIONS ARE ESTIMATED.
2. INFORMATION FOR FIGURE FROM DRAWINGS PROVIDED BY ACOE AND BY OUTAGAMIE COUNTY.

N

SCALE 1" = 100'

0 40 80 120 160 200

REVISION	DATE	DESCRIPTION	BY	CHKD
1	03-APR-06	ADD TCLP AND SPLP DATA	MH	

DRAWN BY: MH
DESIGNED BY: MH
DATE: 08-NOV-05
SCALE: 1" = 100'
DRAWING NUM: 7

ALTECH ENVIRONMENTAL SERVICES
SOUTHFIELD, MICHIGAN

KAUKAUNA POWER CANAL
PARCEL J
KAUKAUNA, WISCONSIN

SOIL BORING LOCATION MAP
GROUNDWATER SAMPLE LOCATIONS

FIGURE 7

...\Parcel J\Parcel J.dgn 7/25/2006 4:59:01 PM

Appendix A

Site Photographs

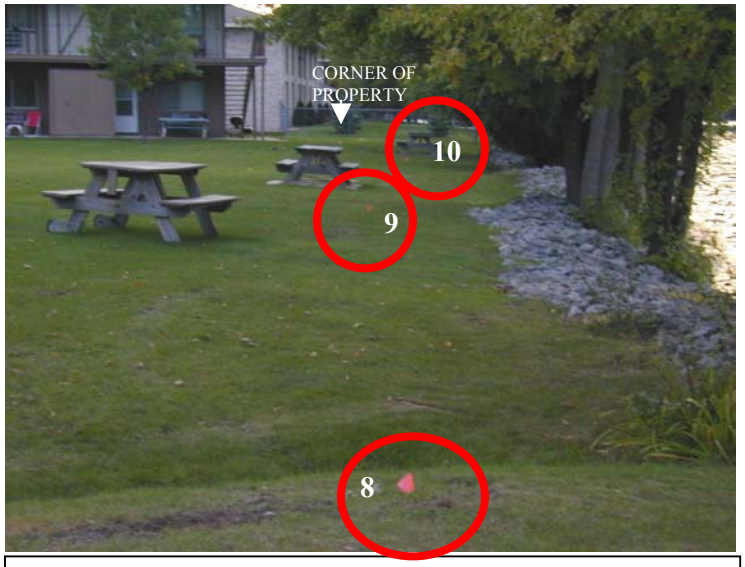


Photo 1. View of boring –08 looking southwest. Borings -09, and-10 located in background.



Photo 2. View of boring –08 looking southwest. Borings -09, -10 located in background.



Photo 3. View of borings –06 and -07 looking west-southwest.



Photo 4. View of boring -06 looking west-southwest. borings –07, through –10 are located in the background



Photo 5. View of borings –07, looking east-northeast. Borings –01 through –06 located in background



Photo 6. View of boring –05 looking east-northeast. Borings –01 through -04 located in background.

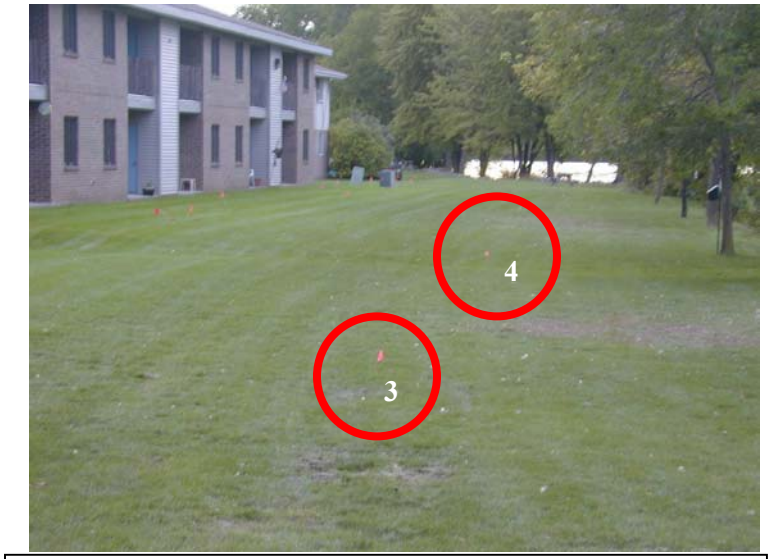


Photo 7. View of borings –03 and –04 looking west. Borings –06 and –07 located in background.



Photo 8. View of boring -01 looking east.

Appendix B

Soil Borings Logs

Hole No. KCP0501

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0501
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOV-ERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Sandy Loam, dark brown, dry, (TOPSOIL) loose.			0-2 0.0 2.0	
0.3		Silty Sand, dark brown, dry, (SM) friable.				
1.0		Gravelly Sand, yellow brown, dry, (SWG) friable.				
1.5		Gravelly Sand, grayish brown to light brown, dry, (SWG) friable.			4-6 4.0 6.0	
7.0		Sandy Clay, mottled brown black, moist, (CLS) soft, pliable, no odor.				
8.0		Sandy Gravel, dark brown to black, wet, (GWS) loose, no water collected.			8-10 8.0 10.0	
8.5		Sandy Clay, mottled brown gray, moist, (CLS) pliable.				
10.0						

Hole No. KCP0502

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0502
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0 UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05 COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOV-ERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Sandy Loam, dark brown, dry, (TOPSOIL).			0-2 0.0 2.0	
0.5		Gravelly Sand, dark to medium brown, dry, (SWG) loose.				
3.0		Sandy Clay, medium brown to yellow brown, dry to moist, (CLS) friable to soft and pliable.			4-6 4.0 6.0	
7.0		Sandy Silt, greenish gray to grayish brown, wet, (MLS) compacted, no water sample collected.			7-9 7.0 9.0	
8.0		Sand, gray to black, wet, (SW) compacted, no water sample collected.				
9.5		Sandy Clay, gray, moist, (CLS) soft, pliable.				
10.0						

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0503
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOV-ERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Sandy Clayey Loam, medium brown, damp, (TOPSOIL).			0-2 0.0 2.0	
0.5		Silty Clay, medium brown to reddish brown, dry to damp, (MH) soft, pliable, black staining from 0.5 to 1.5 feet and 5.0 to 6.0 feet.				
					4-6 4.0 6.0	
6.0		Sandy Clay, yellow brown, moist, (CLS) firm.			6-8 6.0 8.0	
7.5						
7.8		Sand, yellow brown, wet, (SP) no water collected.				
		Silty Clay, light to medium brown, dry, (MH) hard compacted, refusal at 8.5 feet.				
8.5						

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0504
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOVERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0						
0.3		Sandy Clayey Loam, reddish brown, dry, (TOPSOIL).			0-2 0.0 2.0	
		Gravelly Sand, medium to light brown, dry, (SWG) compacted, friable.				
2.5		Silty Clay, medium to dark to reddish brown, damp, (MH) pliable, firm.			3-5 3.0 5.0	
6.0		Silty Sand, yellow brown, dry, (SM) firm.				
6.8		Silty Clay, yellow to medium brown, moist, (MH) firm, pliable.			7-9 7.0 9.0	
7.5		Sandy Silt, light brown to grayish brown, damp, (MLS) firm.				
10.0						

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0505
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOVERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Sandy Loam, dark brown, dry, (TOPSOIL).				
0.5		Gravelly Sand, light brown, dry, (SWG) loose.			1-3 1.0 3.0	
2.0		Sandy Silt, mottled light to medium brown, dry, (MLS) firm, friable.				
5.0		Sandy Clay with Gravel, medium brown, moist, (CLS) firm, pliable, yellowish brown at 7 feet, dark grayish brown at 8.5 feet.			4-6 4.0 6.0	
					7-9 7.0 9.0	
10.0						

Hole No. KCP0506

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0506
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOV-ERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0 0.3		Clayey Loam, dark brown, dry, (TOPSOIL).			0-2 0.0 2.0	
2.5		Gravelly Sand, medium to yellow brown, dry, (SWG) compacted.				
8.0		Sandy Silt, medium to yellow brown, dry to moist to wet, (MLS) firm, wet at 8 feet, no water sample collected.			4-6 4.0 6.0 7-9 7.0 9.0	
10.0		Sandy Clay with Gravel, medium brown, moist, (CLS) firm, pliable.				

Hole No. KCP0507

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0507
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOV-ERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0						
0.3		Sandy Loam, dark brown, dry, (TOPSOIL).			0-2 0.0 2.0	
		Gravelly Sand, medium to yellow brown, dry, (SWG) compacted, friable.			2-4 2.0 4.0	
4.0						
		Sandy Clay, dark gray, dry to moist, (CLS) hard to firm, friable to pliable, compacted.			6-8 6.0 8.0	
8.0						
		Sandy Silt, yellowish gray, moist, (MLS) loose.				
10.0						

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0508
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOV-ERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Sandy Loam, dark brown, dry, (TOPSOIL).			0-2 0.0 2.0	
0.8		Sandy Silt, yellow to dark brown, dry, (MLS) firm, compacted.				
2.0		Clay, brown, dry, (CL) firm, hard, compacted.				
2.5		Sandy Silt, reddish to dark brown, dry, (MLS) firm, compacted.			4-6 4.0 6.0	
5.0		Sandy Clay, medium brown, moist, (CLS) soft, pliable.				
6.5		Sandy Silt, yellowish brown, moist, (MLS) firm, compacted.			7-9 7.0 9.0	
10.0						

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0509
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOVERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Sandy Loam, dark brown, dry, (TOPSOIL).			0-2 0.0 2.0	
0.5		Gravelly Sand, light brown, dry, (SWG) firm, compacted.				
2.5		Sandy Silt, dark brown, dry, (MLS) compacted.				
4.0		Sandy Clay, dark brown, moist, (CLS) pliable.			4-6 4.0 6.0	
5.0		Gravelly Clay, brown, moist, (CLG) pliable, soft.				
7.0		Sandy Silt, yellowish brown, wet, (MLS) compacted, no water collected.			7-9 7.0 9.0	
7.5		Sandy Clay with Gravel, medium brown, moist, (CLS) firm, pliable.				
10.0						

DRILLING LOG

DIVISION: DETROIT DISTRICT

INSTALLATION: KAUKAUNA, WISCONSIN

SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0510
5. NAME OF DRILLER: J. DAVIS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft): 10.0
8. DEPTH DRILLED INTO ROCK (ft): 0.0
9. TOTAL DEPTH OF HOLE (ft): 10.0
10. SIZE AND TYPE OF BIT: 2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
13. DEPTH GROUND WATER (ft):
14. ELEVATION GROUND WATER (ft):
15. SURFACE ELEVATION (ft):
16. DATE HOLE: STARTED 9/28/05; COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING: N/A %
18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOVERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0		Clayey Loam, dark brown, dry, (TOPSOIL).			0-2 0.0 2.0	
0.5		Sandy Silt, yellow to medium brown, dry, (MLS) firm, compacted.				
4.0		Clay, grayish brown, moist, (CH) soft, pliable.			4-6 4.0 6.0	
5.0		Sandy Clay, grayish brown, moist, (CLS) soft, pliable.				
7.0		Gravelly Sand, gray, wet, (SWG) no water sampled.			6-8 6.0 8.0	
7.5		Gravelly Sand, yellowish brown, moist, (SWG).				
8.0		Sandy Clay, gray, wet, (CLS) soft, pliable.				
10.0						

Appendix C

Trace Analytical Laboratories
Soil Lead Analytical Report

ANALYTICAL RESULTS

Deliver To: Ms. Mariah Hope
Altech Environmental Services
17350 W. 10 Mile Road
Suite 200
Southfield, MI 48075
(248)559-5500

TRACE ID: FJ328

CLIENT PROJECT ID: FOX RIVER, PROJECT #9201-038

REPORT DATE: 10/12/05

PROJECT MANAGER:

Jon Mink

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

Trace Analytical Laboratories, Inc.
2241 Black Creek Road
Muskegon, MI 49444-2673
info@trace-labs.com
www.trace-labs.com

REPORT VALIDATION

All reports were examined through Trace's validation process to ensure that all requirements for quality and completeness were satisfied. All reported analytical results were obtained in accordance with the methods referenced on the reports. Every practical effort was made to meet the reporting limit specifications for this work.

The following definitions and qualification keys are provided to aid in data interpretation.

QC DEFINITIONS:

LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
RPD	Relative Percent Difference
DUP	Matrix Duplicate

QUALIFIER KEYS: These descriptors will be associated with individual results for a specific sample and a specific analyte and will help qualify the data:

<,ND, or U	Indicates the compound was analyzed for but not detected
J	Indicates an estimated value
B	Indicates the analyte is found in the blank associated with the sample
E	Indicates the analyte exceeded the range of calibration
*	Indicates QC exceedance

TRACE IS VALIDATED BY THE U.S. ARMY CORPS OF ENGINEERS

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Certificate of Analysis

Workorder Sample Summary

Client	*Trace ID*	*Client Project ID*
Altech Environmental Services	FJ328	FOX RIVER, PROJECT #9201-038

Trace ID	*Sample ID*	*Matrix*	*Collected By*	*Collect Date/Time*	*Receive Date*
FJ328-01	KCP0501 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-02	KCP0501 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-04	KCP0502 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-05	KCP0502 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-06	KCP0502 7-9	Soil	Client	09/28/05 0:00	09/29/05
FJ328-07	KCP0503 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-08	KCP0503 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-09	KCP0503 6-8	Soil	Client	09/28/05 0:00	09/29/05
FJ328-10	KCP DUP 1	Soil	Client	09/28/05 0:00	09/29/05
FJ328-11	KCP0504 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-12	KCP0504 3-5	Soil	Client	09/28/05 0:00	09/29/05
FJ328-13	KCP0504 7-9	Soil	Client	09/28/05 0:00	09/29/05
FJ328-14	KCP0505 1-3	Soil	Client	09/28/05 0:00	09/29/05
FJ328-15	KCP0505 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-16	KCP0505 7-9	Soil	Client	09/28/05 0:00	09/29/05
FJ328-17	KCP0506 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-18	KCP0506 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-19	KCP0506 7-9	Soil	Client	09/28/05 0:00	09/29/05
FJ328-20	KCP DUP 2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-21	KCP0507 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-22	KCP0507 2-4	Soil	Client	09/28/05 0:00	09/29/05
FJ328-23	KCP0507 6-8	Soil	Client	09/28/05 0:00	09/29/05
FJ328-24	KCP0508 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-25	KCP0508 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-26	KCP0508 7-9	Soil	Client	09/28/05 0:00	09/29/05
FJ328-27	KCP0509 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-28	KCP0509 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-29	KCP0509 7-9	Soil	Client	09/28/05 0:00	09/29/05
FJ328-30	KCP0510 0-2	Soil	Client	09/28/05 0:00	09/29/05
FJ328-31	KCP0510 4-6	Soil	Client	09/28/05 0:00	09/29/05
FJ328-32	KCP0510 6-8	Soil	Client	09/28/05 0:00	09/29/05
FJ328-33	KCP DUP 3	Soil	Client	09/28/05 0:00	09/29/05
~~FJ328-34~~	~~FR090501 0.5-2~~	~~Soil~~	~~Client~~	~~09/27/05 0:00~~	~~09/29/05~~
~~FJ328-35~~	~~FR090501 4-6~~	~~Soil~~	~~Client~~	~~09/27/05 0:00~~	~~09/29/05~~
~~FJ328-36~~	~~FR090501 7-9~~	~~Soil~~	~~Client~~	~~09/27/05 0:00~~	~~09/29/05~~

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Trace Analytical Laboratories, Inc.
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Muskegon, MI 49444-2673
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www.trace-labs.com

Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-01	**KCP0501 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	1000	10/11/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**2100**	**2.1**		**mg/kg**

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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-02	**KCP0501 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**7.6**	**1.0**		**mg/kg**

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www.trace-labs.com

Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-04	**KCP0502 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**440**	**1.0**		**mg/kg**

phone 231.773.5998
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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-05	**KCP0502 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**79**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-06	**KCP0502 7-9**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	10	10/11/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**3.3**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-07	**KCP0503 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**160**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-08	**KCP0503 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**13**	**1.0**		**mg/kg**

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Trace ID	Sample ID	Collected	Matrix	%Moisture
FJ328-09	KCP0503 6-8	09/28/05 00:00	Soil	0

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	Result	RDL	MCL	Units
Lead	6.7	1.0		mg/kg

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-10	**KCP DUP 1**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	10	10/11/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**2.5**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-11	**KCP0504 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**15**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-12	KCP0504 3-5	09/28/05 00:00	Soil	0

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**9.0**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-13	**KCP0504 7-9**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	10	10/11/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**4.4**	**1.0**		**mg/kg**

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Trace ID	Sample ID	Collected	Matrix	%Moisture
FJ328-14	KCP0505 1-3	09/28/05 00:00	Soil	0

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	Result	RDL	MCL	Units
Lead	91	1.0		mg/kg

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-15	**KCP0505 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**8.8**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-16	KCP0505 7-9	09/28/05 00:00	Soil	0

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	7.3	1.0		mg/kg

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-17	**KCP0506 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**34**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-18	**KCP0506 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**5.7**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-19	**KCP0506 7-9**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**4.5**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-20	**KCP DUP 2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/05/2005	DIG / 2908 [32191]	SW846 3051	100	10/10/05	ms	META / 5715 [32389]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**37**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-21	**KCP0507 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**62**	**1.0**		**mg/kg**

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Trace ID	Sample ID	Collected	Matrix	%Moisture
FJ328-22	KCP0507 2-4	09/28/05 00:00	Soil	0

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	Result	RDL	MCL	Units
Lead	7.8	1.0		mg/kg

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-23	**KCP0507 6-8**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**9.0**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-24	**KCP0508 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**130**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-25	**KCP0508 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**10**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-26	**KCP0508 7-9**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**5.8**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-27	**KCP0509 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**67**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-28	**KCP0509 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**12**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-29	KCP0509 7-9	09/28/05 00:00	Soil	0

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	10	10/11/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**3.5**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-30	**KCP0510 0-2**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**120**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-31	**KCP0510 4-6**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**8.9**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-32	**KCP0510 6-8**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	10	10/11/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**3.6**	**1.0**		**mg/kg**

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Trace ID	*Sample ID*	*Collected*	*Matrix*	*%Moisture*
FJ328-33	**KCP DUP 3**	**09/28/05 00:00**	**Soil**	**0**

Inorganics - SW846 6020 Analysis, Soils

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/06/2005	DIG / 2910 [32227]	SW846 3051	100	10/10/05	ms	META / 5716 [32394]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**12**	**1.0**		**mg/kg**

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

Trace Analytical Laboratories, Inc.
2241 Black Creek Road
Muskegon, MI 49444-2673
info@trace-labs.com
www.trace-labs.com

Certificate of Analysis

QC Summary

Laboratory Control Sample

Trace ID: 63766 **Matrix:** Soil

Prep Batch: DIG / 2908 [32191]
Analytical Batch: META / 5715 [32389]

SW846 6020	Expected	Result	Recovery	Rec Limits
Lead	40 mg/kg	42	105	80 - 120

Matrix Spike

Trace ID: 63767 **Matrix:** Soil

Original Lab ID: FJ328-16
Prep Batch: DIG / 2908 [32191]
Analytical Batch: META / 5715 [32389]

SW846 6020	Original Result	Expected	Result	Recovery	Rec Limits
Lead	7.3	39 mg/kg	49	107	75 - 125

Matrix Spike Dup

Trace ID: 63768 **Matrix:** Soil

Original Lab ID: FJ328-16
Prep Batch: DIG / 2908 [32191]
Analytical Batch: META / 5715 [32389]

SW846 6020	Expected	Result	Recovery	Rec Limits	RPD	RPD Limits
Lead	39 mg/kg	49	106	75 - 125	0.94	0 - 20

Laboratory Control Sample

Trace ID: 63845 **Matrix:** Soil

Prep Batch: DIG / 2910 [32227]
Analytical Batch: META / 5716 [32394]

SW846 6020	Expected	Result	Recovery	Rec Limits
Lead	40 mg/kg	43	106	80 - 120

Matrix Spike

Trace ID: 63846 **Matrix:** Soil

Original Lab ID: FJ328-29
Prep Batch: DIG / 2910 [32227]
Analytical Batch: META / 5716 [32394]

SW846 6020	Original Result	Expected	Result	Recovery	Rec Limits
Lead	3.5	38 mg/kg	39	92	75 - 125

Matrix Spike Dup

Trace ID: 63847 **Matrix:** Soil

Original Lab ID: FJ328-29
Prep Batch: DIG / 2910 [32227]
Analytical Batch: META / 5716 [32394]

SW846 6020	Expected	Result	Recovery	Rec Limits	RPD	RPD Limits
Lead	39 mg/kg	40	93	75 - 125	1.1	0 - 20

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fax 231.773.6537

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Certificate of Analysis

QC Summary

Laboratory Control Sample

Trace ID: 63851 **Matrix:** Soil

Prep Batch: DIG / 2911 [32230]
Analytical Batch: META / 5717 [32395]

SW846 6020	Expected	Result	Recovery	Rec Limits
Lead	40 mg/kg	42	105	80 - 120

Matrix Spike

Trace ID: 63852 **Matrix:** Soil

Original Lab ID: FJ328-48
Prep Batch: DIG / 2911 [32230]
Analytical Batch: META / 5717 [32395]

SW846 6020	Original Result	Expected	Result	Recovery	Rec Limits
Lead	25	40 mg/kg	74	122	75 - 125

Matrix Spike Dup

Trace ID: 63853 **Matrix:** Soil

Original Lab ID: FJ328-48
Prep Batch: DIG / 2911 [32230]
Analytical Batch: META / 5717 [32395]

SW846 6020	Expected	Result	Recovery	Rec Limits	RPD	RPD Limits
Lead	40 mg/kg	73	120	75 - 125	1.7	0 - 20

Matrix Spike

Trace ID: 63426 **Matrix:** Soil

Original Lab ID: FJ328-60
Prep Batch: DIG / 2894 [32103]
Analytical Batch: META / 5719 [32397]

SW846 6020	Original Result	Expected	Result	Recovery	Rec Limits
Lead	8600	38 mg/kg	6400	-5730 *	75 - 125

Matrix Spike Dup

Trace ID: 63427 **Matrix:** Soil

Original Lab ID: FJ328-60
Prep Batch: DIG / 2894 [32103]
Analytical Batch: META / 5719 [32397]

SW846 6020	Expected	Result	Recovery	Rec Limits	RPD	RPD Limits
1 Lead	39 mg/kg	5200	-8610 *	75 - 125	-40 *	0 - 20

Result Notes

1 - The MS and MSD recoveries were out of control. Because the sample background concentration of this analyte is greater than four times the spike amount, no data require qualification.

Laboratory Control Sample

Trace ID: 64492 **Matrix:** Soil

Prep Batch: DIG / 2894 [32103]
Analytical Batch: META / 5719 [32397]

SW846 6020	Expected	Result	Recovery	Rec Limits
Lead	40 mg/kg	43	108	80 - 120

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Certificate of Analysis

QC Summary

Laboratory Control Sample

Trace ID: 64492 **Matrix:** Soil

Prep Batch: DIG / 2894 [32103]
Analytical Batch: META / 5719 [32397]

SW846 6020	*Expected*	*Result*	*Recovery*	*Rec Limits*

TRACE
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ANALYTICAL SERVICES AUTHORIZATION
CHAIN-OF-CUSTODY RECORD

TRACE ID NO. F1328

PLEASE COMPLETE STEPS 1 THRU 3. TRACE PERSONNEL WILL COMPLETE SECTIONS SHADED BLUE. Page 1 of 4

STEP 1 Report Results To:

Client Name: Altech Environmental Services
Contact Person: Mariah Hope
Mailing Address: 17350 W. 10 Mile Rd Suite 200
City, State, Zip Code: Southfield MI 48075
Phone: 2485595500 Fax: 2485595540
Email Address: MHope@altechenvironmental.com
Client Job #: 9201-038 P.O. #: Trace Quote #:
Sampled By: M Hope

For Use by TRACE Personnel Only

Logged By: Checked By: MH
Received on ice: Yes No
Cooler Temp (°C): ph Checked: Yes No
Volatiles Preserved: HCl MeOH En Core No Metals Pres: Yes No

Step 2 Sample Identification / Request for Analytical Services

Regulatory Requirements: MERA TMDL's ☐ RCRA ☐ NPDES ☐ USACE ☑ USACE Wisconsin ☐
Turnaround Requirements: Standard ☑ * 5 Day (RUSH) ☒ 7 day * 2-4 Day (RUSH) ☐ * 24 Hour (RUSH) ☐ * Requires prior approval
Matrix Key: DW = Drinking Water; S = Soil; SL = Sludge; W = Water; A = Air; O = Oil; X = Other

TRACE NO	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	VOLATILES PRESERVED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	Lead	REMARKS	Possible Health Hazard
1	9/28/05				KCP0501 0-2	S	1	X		
2					KCP0501 4-6					
3					KCP0501 8-10				Rec'd Jar Broken Called left Message	
4					KCP0502 0-2					
5					KCP0502 4-6					
6					KCP0502 7-9					
7					KCP0503 0-2					
8					KCP0503 4-6					
9					KCP0503 6-8					
10					KCP Dup 1					

STEP 3 Chain of Custody

Item #	RELEASED BY	RECEIVED BY	DATE	TIME	Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1) Mariah Hope	Fedex	9/28/05	18:00	1-10	2) Fed-Ex		9/29/05	12:50
	3)					4)			

In executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

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ANALYTICAL SERVICES AUTHORIZATION
CHAIN-OF-CUSTODY RECORD

TRACE ID NO. M338

PLEASE COMPLETE STEPS 1 THRU 3. TRACE PERSONNEL WILL COMPLETE SECTIONS SHADED BLUE.

STEP 1 Report Results To:

Client Name: Altech Environmental Services
Contact Person: Mariah Hope
Mailing Address: 17350 W 10 Mile Rd Suite 200
City, State, Zip Code: Southfield MI 48075
Phone: 2485595500 Fax: 2485595540
Email Address: mhope@altechenvironmental.com
Client Job #: 9201-038 P.O. #: Trace Quote #:
Sampled By: M Hope

For Use by TRACE Personnel Only

Logged By: Checked By: m
Received on ice: (Yes) No
Cooler Temp (°C): ph Checked: Yes No
Volatiles Preserved: HCl MeOH En Core No Metals Pres: Yes No

Step 2 Sample Identification / Request for Analytical Services

Regulatory Requirements: MERA TMDL's ☐ RCRA ☐ NPDES ☐ USACE ☑ Wisconsin ☐
Turnaround Requirements: Standard ☑ * 5 Day (RUSH) ☐ * 2-4 Day (RUSH) ☐ * 24 Hour (RUSH) ☐ * Requires prior approval
Matrix Key: DW = Drinking Water; S = Soil; SL = Sludge; W = Water; A = Air; O = Oil; X = Other

TRACE NO	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	VOLATILES PRESERVED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	Lead	REMARKS	Possible Health Hazard
11	9/28/05				KCP0504 0-2	S	1	X		
12					KCP0504 3-5					
13					KCP0504 7-9					
14					KCP0505 1-3					
15					KCP0505 4-6					
16					KCP0505 7-9					
16					KCP0505 7-9 MS/MSD					
17					KCP0506 0-2					
18					KCP0506 4-6					
19					KCP0506 7-9					

STEP 3 Chain of Custody

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1) Mariah Hope	Fedex	9/28/05	1810
	3)			

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
1-10	2) Fed-Ex		9/29/05	12:50
	4)			

In executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

TRACE
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ANALYTICAL SERVICES AUTHORIZATION
CHAIN-OF-CUSTODY RECORD

TRACE ID NO. F-0338

PLEASE COMPLETE STEPS 1 THRU 3. TRACE PERSONNEL WILL COMPLETE SECTIONS SHADED BLUE. Page 3 of 4

STEP 1 Report Results To:

Client Name: Altech Environmental Services
Contact Person: Marick Hope
Mailing Address: 17350 W 10 Mile Rd Suite 200
City, State, Zip Code: Southfield MI 48075
Phone: 248 5595500 Fax: 2485595546
Email Address: Mhope@altechenvironmental.com
Client Job #: 9201-038 P.O. #: Trace Quote #:
Sampled By: M Hope

For Use by TRACE Personnel Only

Logged By: Checked By: mj
Received on ice: (Yes) No
Cooler Temp (°C): ph Checked: Yes No
Volatiles Preserved: HCl MeOH En Core No Metals Pres: Yes No

Step 2 Sample Identification / Request for Analytical Services

Regulatory Requirements: MERA TMDL's ☐ RCRA ☐ NPDES ☐ USACE ■ Wisconsin ■
Turnaround Requirements: Standard ■ * 5 Day (RUSH) ☐ * 2-4 Day (RUSH) ☐ * 24 Hour (RUSH) ☐ * Requires prior approval
Matrix Key: DW = Drinking Water; S = Soil; SL = Sludge; W = Water; A = Air; O = Oil; X = Other

ANALYSIS REQUESTED

TRACE NO.	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	VOLATILES PRESERVED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	VOC	REMARKS	Possible Health Hazard
20	9/28/05				KCP Dup 2	S	1	X		
21					KCP0507 0-2					
22					KCP0507 2-4					
23					KCP0507 6-8					
24					KCP0508 0-2					
25					KCP0508 4-6					
26					KCP0508 7-9					
27					KCP0509 0-2					
28					KCP0509 4-6					
29					KCP0509 7-9					

STEP 3 Chain of Custody

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1) Mark Hope	Fedex	9/28/05	1800
	3)			

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
1-10	2) Fed-Ex		9/29/05	12:50
	4)			

In executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

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ANALYTICAL SERVICES AUTHORIZATION
CHAIN-OF-CUSTODY RECORD

TRACE ID NO. FC 328

PLEASE COMPLETE STEPS 1 THRU 3. TRACE PERSONNEL WILL COMPLETE SECTIONS SHADED BLUE. Page 4 of 4

STEP 1 Report Results To:

Client Name: Altech Environmental Services
Contact Person: M. Hope
Mailing Address: 17350 W 10 Mile Rd Suite 200
City, State, Zip Code: Southfield MI 48075
Phone: 2485595500 Fax: 2485595540
Email Address: MHope@altechenvironmental.com
Client Job #: 9201-038 P.O. #: Trace Quote #:
Sampled By: M Hope

For Use by TRACE Personnel Only

Logged By: Checked By: MG
Received on ice: Yes No
Cooler Temp (°C): ph Checked: Yes No
Volatiles Preserved: HCl MeOH En Core No Metals Pres: Yes No

Step 2 Sample Identification / Request for Analytical Services

Regulatory Requirements: MERA TMDL's ☐ RCRA ☐ NPDES ☐ USACE ☐ Wisconsin ☐

Turnaround Requirements: Standard ☐ * 5 Day (RUSH) ☐ * 2-4 Day (RUSH) ☐ * 24 Hour (RUSH) ☐ * Requires prior approval

Matrix Key: DW = Drinking Water; S = Soil; SL = Sludge; W = Water; A = Air; O = Oil; X = Other

ANALYSIS REQUESTED: Lead

TRACE NO.	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	VOLATILES PRESERVED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	REMARKS	Possible Health Hazard
29	9/28/05				KCP0509 MS MSD	S	1	X	
30					KCP0510 0-2				
31					KCP0510 4-6				
32					KCP0510 6-8				
33					KCP Dup 3	S	2		

STEP 3 Chain of Custody

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1) Martikka	Fedex	9/28/05	1800
	3)			

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
1-5	2) Fed-Ex		9/29/5	12:50
	4)			

In executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

SAMPLE LOG IN CHECKLIST

Date: 9-29-05 | Client Name: AITech | # of Coolers: 01 Cl Cl

HPN #: ——— | Project Name: 9201-08 Fox River | Cooler #s: ———

Project #: EQ328 | Logged in by: [signature] | Cooler #s: ———

Cooler Receipt

Cooler/samples delivered by: Trace courier ☐ | Hand delivered ☐ | Commercial courier ☒ | Name of delivery person: ———

Name of courier service: FED-EX

Did cooler come with a bill of lading? No ☒ | Yes ☐ | Way Bill or Tracking #: ———

COC Seals present and intact on cooler? No ☐ | Yes ☒ | Custody seals signed by: See BACK

Client COC number: ———

Type of packing in cooler: ———

Coolant and Temperature

Type of Coolant Used

	Yes	No
Slurry w/ crushed, cubed, or chip ice?	☐	☐
Multiple bags of ice around samples?	☒	☐
Ice Packs/ Blue Ice :	☐	☐
No Coolant Present:		☐

Cooler Temperature

Correction Factor -0.2 °C

Date: 9-29-05 Time: 12:50

Temperature Blank: ——— °C

Range of 3 samples: 5 °C

Melt Water: ——— °C

Ice still present upon receipt: ☒ Yes ☐ No

General

	Yes	No	NA
COC taped to inside of cooler lid?	☒	☐	☐
All bottles arrived unbroken with labels in good condition?	☒	☒	☐
Each sample is in a sealed plastic bag?	☒	☐	☐
Labels filled out completely?	☒	☐	☐
All bottle labels agree with Chain of Custody (COC)?	☒	☐	☐
Sufficient sample to run tests requested?	☒	☐	☐
pH checked and samples at correct pH?	☐	☐	☒
Correct preservative added to samples?	☐	☐	☒
DRO/GRO samples received and appropriate check in form completed?	☐	☐	☒
Air bubbles absent from VOAs?	☐	☐	☒
COC filled out properly and signed by client?	☒	☐	☐
COC signed in by TRACE sample custodian?	☒	☐	☐
Was project manager called and samples discussed?	☒	☐	☐

Contact: ——— Date: ———

Notes: Received ONE 4oz JAR BROKEN

KCP0501

CUSTODY SEAL
QEC
Quality Environmental Containers
800-255-3850 • 304-255-3850
DATE 9-28-05
SIGNATURE

CUSTODY SEAL
QEC
Quality Environmental Containers
800-255-3850 • 304-255-3850
DATE
SIGNATURE

SAMPLE LOG IN CHECKLIST

Date: 9-29-05 Client Name: Altech # of Coolers: 1

HPN #: — Project Name: Fox River Cooler #s ?

Project #: F0328 Logged in by: J Smith Cooler #s:

Cooler Receipt

Cooler/samples delivered by: Trace courier ☐ Hand delivered ☐ Commercial courier ☒ Name of delivery person: ____ Name of courier service: Fed-Ex

Did cooler come with a bill of lading? No ☒ Yes ☐ Way Bill or Tracking #: ____

COC Seals present and intact on cooler? No ☐ Yes ☒ Custody seals signed by: See Back

Client COC number: ____

Type of packing in cooler: ____

Coolant and Temperature

Type of Coolant Used

	Yes	No
Slurry w/ crushed, cubed, or chip ice?	☐	☐
Multiple bags of ice around samples?	☒	☐
Ice Packs/ Blue Ice :	☐	☐
No Coolant Present:		☐

Cooler Temperature

Correction Factor -0.2 °C

Date: 9-29-05 Time: 2:40

Temperature Blank: ____ °C

Range of 3 samples: 4 — 10 °C

Melt Water: ____ °C

Ice still present upon receipt: ☒ Yes ☐ No

General

	Yes	No	NA
COC taped to inside of cooler lid?	☐	☒	☐
All bottles arrived unbroken with labels in good condition?	☒	☐	☐
Each sample is in a sealed plastic bag?	☐	☒	☐
Labels filled out completely?	☒	☐	☐
All bottle labels agree with Chain of Custody (COC)?	☒	☐	☐
Sufficient sample to run tests requested?	☒	☐	☐
pH checked and samples at correct pH?	☐	☐	☒
Correct preservative added to samples?	☐	☐	☒
DRO/GRO samples received and appropriate check in form completed?	☐	☐	☒
Air bubbles absent from VOAs?	☐	☐	☒
COC filled out properly and signed by client?	☒	☐	☐
COC signed in by TRACE sample custodian?	☒	☐	☐
Was project manager called and samples discussed?	☐	☐	☒

Contact: ____ Date: ____

Notes:


CUSTODY SEAL
DATE 9-28-05
SIGNATURE
QEC
Quality Environmental Containers


CUSTODY SEAL
DATE 9-28-05
SIGNATURE
QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. F5328

RVWMET.XLS

Rev. 2
7/30/97

PART 1: ANALYST REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Appropriate SOPs have been followed					
Sample preparation information is correct and complete					
MS/MSDs are within established control limits					
Blanks are within established control limits					
Laboratory control samples are within established control limits					
Qualifiers have been added to benchsheet and explained correctly					
Copies of digestion logs and run logs are included with benchsheets if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Quantitative results are correct and complete					
All data is generated with a valid calibration curve					
RPDs have been calculated where appropriate					
Reporting limits have been adjusted where necessary					
Signed/Date					5/9/05

Notations/Comments:
60 ms/msd out concentration > 4 times NDRQ

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. F5328

Rev. 2
7/30/97

PART 2: METALS MANAGER REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Analysis in file matches COC					
Appropriate SOPs have been followed					
Significant figures are correct					
Reporting limits are correct					
Method numbers are correct					
Copy of run log and digestion logs are in file if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Calibration data are scientifically sound, appropriate and documented					
Quantitative results have been reviewed					
Necessary qualifiers have been added to benchsheet and explained correctly					
Analyst review has been checked					
Analysis is approved for release to reporting					
Signed/Date					10-12-05

Notations/Comments:

Appendix D

Trace Analytical Laboratories
TCLP Lead Analytical Report

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

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www.trace-labs.com

TRACE

the science of compliance

ANALYTICAL RESULTS

Deliver To: Ms. Mariah Hope
Altech Environmental Services
17350 W. 10 Mile Road
Suite 200
Southfield, MI 48075
(248)559-5500

TRACE ID: FK294

CLIENT PROJECT ID: 9201-038 TCLP RE-ACTIVATION

REPORT DATE: 11/03/05

PROJECT MANAGER: Jon Mink

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

Trace Analytical Laboratories, Inc.
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Muskegon, MI 49444-2673
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www.trace-labs.com

REPORT VALIDATION

All reports were examined through Trace's validation process to ensure that all requirements for quality and completeness were satisfied. All reported analytical results were obtained in accordance with the methods referenced on the reports. Every practical effort was made to meet the reporting limit specifications for this work.

The following definitions and qualification keys are provided to aid in data interpretation.

QC DEFINITIONS:

LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
RPD	Relative Percent Difference
DUP	Matrix Duplicate

QUALIFIER KEYS: These descriptors will be associated with individual results for a specific sample and a specific analyte and will help qualify the data:

<,ND, or U	Indicates the compound was analyzed for but not detected
J	Indicates an estimated value
B	Indicates the analyte is found in the blank associated with the sample
E	Indicates the analyte exceeded the range of calibration
*	Indicates QC exceedance

TRACE IS VALIDATED BY THE U.S. ARMY CORPS OF ENGINEERS

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fax 231.773.6537

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Muskegon, MI 49444-2673
info@trace-labs.com
www.trace-labs.com

Certificate of Analysis

Workorder Sample Summary

Client	*Trace ID*	*Client Project ID*
Altech Environmental Services	FK294	9201-038 TCLP RE-ACTIVATION

Trace ID	*Sample ID*	*Matrix*	*Collected By*	*Collect Date/Time*	*Receive Date*
FK294-01	FR090501 0.5-2	TCLP	Client	09/27/05 0:00	10/25/05
FK294-02	FR090502 0.5-2	TCLP	Client	09/27/05 0:00	10/25/05
FK294-03	FR090502 3-5	TCLP	Client	09/27/05 0:00	10/25/05
FK294-04	FR090503 0.5-2	TCLP	Client	09/27/05 0:00	10/25/05
FK294-05	FR090503 3-5	TCLP	Client	09/27/05 0:00	10/25/05
FK294-06	FR090506 0.5-2	TCLP	Client	09/27/05 0:00	10/25/05
FK294-07	FR090509 0.5-2	TCLP	Client	09/27/05 0:00	10/25/05
FK294-08	FR090510 0.5-2	TCLP	Client	09/27/05 0:00	10/25/05
FK294-09	KCP0501 0-2	TCLP	Client	09/28/05 0:00	10/25/05
FK294-10	KCP0502 0-2	TCLP	Client	09/28/05 0:00	10/25/05

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info@trace-labs.com
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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*
FK294-09	**KCP0501 0-2**	**09/28/05 00:00**	**TCLP**

Inorganics - SW846 6020 Analysis, TCLP

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/26/2005	DIG / 2980 [32783]	SW846 3015 TCLP	20	11/02/05	ms	META / 5867 [33006]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**1.1**	**0.0034**		**mg/L**

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

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info@trace-labs.com
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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*
FK294-10	**KCP0502 0-2**	**09/28/05 00:00**	**TCLP**

Inorganics - SW846 6020 Analysis, TCLP

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
10/26/2005	DIG / 2980 [32783]	SW846 3015 TCLP	20	11/02/05	ms	META / 5867 [33006]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**0.85**	**0.0034**		**mg/L**

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info@trace-labs.com
www.trace-labs.com

Certificate of Analysis

QC Summary

Laboratory Control Sample

Trace ID: 66101 **Matrix:** Water

Prep Batch: DIG / 2980 [32783]
Analytical Batch: META / 5841 [32868]

SW846 6020	Expected	Result	Recovery	Rec Limits
Lead	0.056 mg/L	0.063	113	80 - 120

Matrix Spike

Trace ID: 66102 **Matrix:** Water

Original Lab ID: FK308-02
Prep Batch: DIG / 2980 [32783]
Analytical Batch: META / 5841 [32868]

SW846 6020	Original Result	Expected	Result	Recovery	Rec Limits
Lead	0.0025	0.056 mg/L	0.06	103	75 - 125

Matrix Spike Dup

Trace ID: 66103 **Matrix:** Water

Original Lab ID: FK308-02
Prep Batch: DIG / 2980 [32783]
Analytical Batch: META / 5841 [32868]

SW846 6020	Expected	Result	Recovery	Rec Limits	RPD	RPD Limits
Lead	0.056 mg/L	0.062	107	75 - 125	3.8	0 - 20

Matrix Spike

Trace ID: 66104 **Matrix:** TCLP

Original Lab ID: FK294-01
Prep Batch: DIG / 2980 [32783]
Analytical Batch: META / 5867 [33006]

SW846 6020	Original Result	Expected	Result	Recovery	Rec Limits
Lead	1.6	0.056 mg/L	1.6	82	75 - 125

Matrix Spike Dup

Trace ID: 66105 **Matrix:** TCLP

Original Lab ID: FK294-01
Prep Batch: DIG / 2980 [32783]
Analytical Batch: META / 5867 [33006]

SW846 6020	Expected	Result	Recovery	Rec Limits	RPD	RPD Limits
1 Lead	0.056 mg/L	1.6	127 *	75 - 125	43 *	0 - 20

Result Notes

1 - The MSD recovery was out of control, resulting in an out of control RPD between the MS and MSD. Because the background concentration of this analyte is greater than four times the spike amount, no data require qualification.

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CHAIN-OF-CUSTODY RECORD AND WORK AUTHORIZATION

TRACE ID NO. F15294

Page 1 of 1

10/24/2005 15:46 2485595540 91 ALTECH ENVIRONMENTAL PAGE 03

Client Name: Altech Environmental Services

Contact Person: M Hope

Mailing Address: 17350 W 10 Mile Rd Suite 200

City, State, Zip Code: Southfield MI 48075

Phone: 248 559 5500 Fax: 248 559 5540

Email Address: mhope@altechenvironmental.com

Project Name: PO #: Trace Quote #:

Project #: 9201-038 Sampled by:

For Use by TRACE Personnel Only

Logged By: Checked By:

Received on ice: Yes No

Preservative Checked: Yes No N/A

Soil Volatiles Preserved: MeOH En Core Low Level Lab

Regulatory Requirements
- MERA TMDL's ☐
- RCRA ☐
- NPDES ☐
- USACE ☒
- Special ☐

Turnaround Requirements
- Standard (2 wk) ☐
- * 5 Day ☐
- * 2-4 Day (RUSH) ☐
- * 24 Hour (RUSH) ☐
- * Requires prior approval

Matrix Key
- S = Soil
- W = Water
- SE = Sediment
- OI = Oil
- SO = Solid Waste
- WI = Wipes
- LW = Liquid Waste
- A = Air
- D = Drinking Water
- SL = Sludge

ANALYSIS REQUESTED

TRACE NO.	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	TCLP Lead	REMARKS	Possible Health Hazard
09	9/28/05			KCP0501 0-2	S	1	X	Analyze to	
10	1			KCP0502 0-2	S	1	X	1.0 mg/L	

Item #	RELEASED BY	RECEIVED BY	DATE	TIME	Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1)		10-24-05	1530		3)			
	2)					4)			

Please Sign

Sample Identification / Request for Analytical Services

n executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. FK294

RVWMET.XLS

Rev. 2
7/30/97

PART 1: ANALYST REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Appropriate SOPs have been followed					
Sample preparation information is correct and complete					
MS/MSDs are within established control limits					
Blanks are within established control limits					
Laboratory control samples are within established control limits					
Qualifiers have been added to benchsheet and explained correctly					
Copies of digestion logs and run logs are included with benchsheets if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Quantitative results are correct and complete					
All data is generated with a valid calibration curve					
RPDs have been calculated where appropriate					
Reporting limits have been adjusted where necessary					

Notations/Comments:

Signed/Date _____ Signed/Date _____ Signed/Date _____ Signed/Date _____ Signed/Date SD for MS ~~12-3-05~~ 11-3-05 SD 11-3-05

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. FK294

Rev. 2
7/30/97

PART 2: METALS MANAGER REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Analysis in file matches COC					✓
Appropriate SOPs have been followed					✓
Significant figures are correct					✓
Reporting limits are correct					✓
Method numbers are correct					✓
Copy of run log and digestion logs are in file if needed					✓
Analyst initials are on benchsheet					✓
Analysis date is on benchsheet					✓
Calibration data are scientifically sound, appropriate and documented					✓
Quantitative results have been reviewed					✓
Necessary qualifiers have been added to benchsheet and explained correctly					✓
Analyst review has been checked					✓
Analysis is approved for release to reporting					✓
					✓
Signed/Date					11-3-05

Notations/Comments:

Appendix E

Trace Analytical Laboratories
SPLP Lead Analytical Report

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ANALYTICAL RESULTS

Deliver To: Ms. Mariah Hope
Altech Environmental Services
17350 W. 10 Mile Road
Suite 200
Southfield, MI 48075
(248)559-5500

TRACE ID: GC124

CLIENT PROJECT ID: 9201-038

REPORT DATE: 03/29/06

PROJECT MANAGER:

Jon Mink

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

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REPORT VALIDATION

All reports were examined through Trace's validation process to ensure that all requirements for quality and completeness were satisfied. All reported analytical results were obtained in accordance with the methods referenced on the reports. Every practical effort was made to meet the reporting limit specifications for this work.

The following definitions and qualification keys are provided to aid in data interpretation.

QC DEFINITIONS:

LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
RPD	Relative Percent Difference
DUP	Matrix Duplicate

QUALIFIER KEYS: These descriptors will be associated with individual results for a specific sample and a specific analyte and will help qualify the data:

<,ND, or U	Indicates the compound was analyzed for but not detected
J	Indicates an estimated value
B	Indicates the analyte is found in the blank associated with the sample
E	Indicates the analyte exceeded the range of calibration
*	Indicates QC exceedance

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Certificate of Analysis

Workorder Sample Summary

Client	*Trace ID*	*Client Project ID*
Altech Environmental Services	GC124	9201-038

Trace ID	*Sample ID*	*Matrix*	*Collected By*	*Collect Date/Time*	*Receive Date*
GC124-01	KCP0501 0-2	SPLP	Client	09/28/05 0:00	03/14/06
GC124-02	KCP0502 0-2	SPLP	Client	09/28/05 0:00	03/14/06
GC124-03	KCP0510 0-2	SPLP	Client	09/28/05 0:00	03/14/06
GC124-04	FR090502 3-5	SPLP	Client	09/27/05 0:00	03/14/06
GC124-05	FR090503 0.5-2	SPLP	Client	09/27/05 0:00	03/14/06
GC124-06	FR090503 3-5	SPLP	Client	09/27/05 0:00	03/14/06
GC124-07	FR090506 0.5-2	SPLP	Client	09/27/05 0:00	03/14/06
GC124-08	FR090509 0.5-3	SPLP	Client	09/27/05 0:00	03/14/06
GC124-09	FR090510 0.5-2	SPLP	Client	09/27/05 0:00	03/14/06

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Certificate of Analysis

Trace ID	Sample ID	Collected	Matrix
GC124-01	KCP0501 0-2	09/28/05 00:00	SPLP

INORGANICS - SW846 6020 Analysis, SPLP

(Results reported on a wet weight basis)

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
03/15/2006	DIG / 3352 [36206]	SW846 3015	5	03/15/06	ms	META / 6803 [36241]

Parameter	Result	RDL	MCL	Units
Lead	0.33	0.0030		mg/L

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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*
GC124-02	**KCP0502 0-2**	**09/28/05 00:00**	**SPLP**

INORGANICS - SW846 6020 Analysis, SPLP

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
03/15/2006	DIG / 3352 [36206]	SW846 3015	5	03/15/06	ms	META / 6803 [36241]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**0.13**	**0.0030**		**mg/L**

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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*
GC124-03	**KCP0510 0-2**	**09/28/05 00:00**	**SPLP**

INORGANICS - SW846 6020 Analysis, SPLP

(Results reported on a wet weight basis)

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
03/15/2006	DIG / 3352 [36206]	SW846 3015	5	03/15/06	ms	META / 6803 [36241]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	**0.027**	**0.0030**		**mg/L**

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Certificate of Analysis

Method Blank

Trace ID	*Sample ID*
78644	**MB for HBN 36206 [DIG/3352]**

SW846 6020

Prep Date	*Prep Batch*	*Prep Method*	*Dilution*	*Analyzed*	*By*	*Analytical Batch*
03/15/2006	DIG / 3352 [36206]	SW846 3015	5	03/15/06	ms	META / 6803 [36241]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	<0.0030	0.0030		mg/L

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Certificate of Analysis

QC Summary

Laboratory Control Sample

Trace ID: 78645 **Matrix:** Water

Prep Batch: DIG / 3352 [36206]
Analytical Batch: META / 6803 [36241]

SW846 6020	*Expected*	*Result*	*Recovery*	*Rec Limits*
Lead	0.056 mg/L	0.057	103	80 - 120

Matrix Spike

Trace ID: 78646 **Matrix:** SPLP

Original Lab ID: GC124-01
Prep Batch: DIG / 3352 [36206]
Analytical Batch: META / 6803 [36241]

SW846 6020	*Original Result*	*Expected*	*Result*	*Recovery*	*Rec Limits*
Lead	0.33	0.056 mg/L	0.38	83	75 - 125

Matrix Spike Dup

Trace ID: 78647 **Matrix:** SPLP

Original Lab ID: GC124-01
Prep Batch: DIG / 3352 [36206]
Analytical Batch: META / 6803 [36241]

SW846 6020	*Expected*	*Result*	*Recovery*	*Rec Limits*	*RPD*	*RPD Limits*
Lead	0.056 mg/L	0.39	95	75 - 125	13	0 - 20

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CHAIN-OF-CUSTODY RECORD AND WORK AUTHORIZATION

03/28/06
04/04/06

TRACE ID NO. GC124

Page 1 of 1

Report Results To:

Client Name: Nitech

Contact Person: Dayal Saran

Mailing Address:

City, State, Zip Code:

Phone: Fax:

Email Address:

Project Name: PO #: Trace Quote #:

Project #: 9201-038 Sampled by:

For Use by TRACE Personnel Only

Logged By: Checked By:

Received on ice: Yes No

Re-Activation of FJ320 A-D FK294

Preservative Checked: Yes No N/A

Soil Volatiles Preserved: MeOH En Core Low Level Lab

Sample Identification / Request for Analytical Services

ANALYSIS REQUESTED

Regulatory Requirements		Turnaround Requirements		Matrix Key	
MERA TMDL's	☐	Standard (2 wk)	☐	S = Soil	WI = Wipes
RCRA	☐	* 5 Day	☐	W = Water	LW = Liquid Waste
NPDES	☐	* 2-4 Day (RUSH)	☐	SE = Sediment	A = Air
USACE	☐	* 24 Hour (RUSH)	☐	OI = Oil	D = Drinking Water
Special	☐	* Requires prior approval		SO = Solid Waste	SL = Sludge

TRACE NO.	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	SRP-Lead	REMARKS	Possible Health Hazard
01	9/26/5			KCP0501 0-2	S	1	X		
02	9/26/5			KCP0502 0-2	S	1	X		
03	9/26/5			KCP0510 0-2	S	1	X		
04	9/27/5			FR090402 3-5	S	1	X		
05	9/27/5			FR090503 0.5-2	S	1	X		
06	9/27/5			FR090503 3-5	S	1	X		
07	9/27/5			FR090506 0.5-2	S	1	X		
08	9/27/5			FR090505 0.5-3	S	1	X		
09	9/27/5			FR090510 0.5-2	S	1	X		

Please Sign

Item #	RELEASED BY	RECEIVED BY	DATE	TIME	Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1) Cooler		3/14/06	11:17		3)			
	2)					4)			

In executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. GC124

RVWMET.XLS

Rev. 2
7/30/97

PART 1: ANALYST REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Appropriate SOPs have been followed					
Sample preparation information is correct and complete					
MS/MSDs are within established control limits					
Blanks are within established control limits					
Laboratory control samples are within established control limits					
Qualifiers have been added to benchsheet and explained correctly					
Copies of digestion logs and run logs are included with benchsheets if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Quantitative results are correct and complete					
All data is generated with a valid calibration curve					
RPDs have been calculated where appropriate					
Reporting limits have been adjusted where necessary					
Signed/Date					8D for MS

Notations/Comments:

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. GC124

Rev. 2
7/30/97

PART 2: METALS MANAGER REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Analysis in file matches COC					X
Appropriate SOPs have been followed					
Significant figures are correct					
Reporting limits are correct					
Method numbers are correct					
Copy of run log and digestion logs are in file if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Calibration data are scientifically sound, appropriate and documented					
Quantitative results have been reviewed					
Necessary qualifiers have been added to benchsheet and explained correctly					
Analyst review has been checked					
Analysis is approved for release to reporting					
Signed/Date					10/12/04

Notations/Comments:

Appendix F

Trace Analytical Laboratories
Groundwater Lead Analytical Report

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ANALYTICAL RESULTS

Deliver To: Ms. Mariah Hope
Altech Environmental Services
17350 W. 10 Mile Road
Suite 200
Southfield, MI 48075
(248)559-5500

TRACE ID: FJ339

CLIENT PROJECT ID: FOX RIVER/9201-038

REPORT DATE: 10/14/05

PROJECT MANAGER: Jon Mink

phone 231.773.5998
toll-free 800.733.5998
fax 231.773.6537

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2241 Black Creek Road
Muskegon, MI 49444-2673
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REPORT VALIDATION

All reports were examined through Trace's validation process to ensure that all requirements for quality and completeness were satisfied. All reported analytical results were obtained in accordance with the methods referenced on the reports. Every practical effort was made to meet the reporting limit specifications for this work.

The following definitions and qualification keys are provided to aid in data interpretation.

QC DEFINITIONS:

LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
RPD	Relative Percent Difference
DUP	Matrix Duplicate

QUALIFIER KEYS: These descriptors will be associated with individual results for a specific sample and a specific analyte and will help qualify the data:

<,ND, or U	Indicates the compound was analyzed for but not detected
J	Indicates an estimated value
B	Indicates the analyte is found in the blank associated with the sample
E	Indicates the analyte exceeded the range of calibration
*	Indicates QC exceedance

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Muskegon, MI 49444-2673
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Certificate of Analysis

Workorder Sample Summary

Client	*Trace ID*	*Client Project ID*
Altech Environmental Services	FJ339	FOX RIVER/9201-038

Trace ID	*Sample ID*	*Matrix*	*Collected By*	*Collect Date/Time*	*Receive Date*
FJ339-01	AL40905 02-09	Soil	Client	09/29/05 0:00	09/30/05
FJ339-02	AL40905 04-8	Soil	Client	09/29/05 0:00	09/30/05
FJ339-03	AL40905 05-3	Soil	Client	09/29/05 0:00	09/30/05
FJ339-04	AL40905 06-1	Soil	Client	09/29/05 0:00	09/30/05
FJ339-05	AL40905 DUP-1	Soil	Client	09/29/05 0:00	09/30/05
FJ339-06	AL40905 02W	Water	Client	09/29/05 0:00	09/30/05
FJ339-07	AL40905 04W	Water	Client	09/29/05 0:00	09/30/05
FJ339-08	AL40905 05W	Water	Client	09/29/05 0:00	09/30/05
FJ339-09	AL40905 DUP 1	Water	Client	09/29/05 0:00	09/30/05
FJ339-10	AL40905 FIELD BLANK	Water	Client	09/29/05 0:00	09/30/05
FJ339-11	KCP0507-W	Water	Client	09/29/05 0:00	09/30/05

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Certificate of Analysis

Trace ID	*Sample ID*	*Collected*	*Matrix*
FJ339-11	**KCP0507-W**	**09/29/05 00:00**	**Water**

Inorganics - SW846 6020 Analysis, Dissolved Metals

(Results reported on a wet weight basis)

Dilution	*Analyzed*	*By*	*Analytical Batch*
5	10/04/05	ms	META / 5649 [32159]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	<0.0010	0.0010		mg/L

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Certificate of Analysis

Instrument Blank

Trace ID	*Sample ID*
63626	**IB for HBN 32159 [META/5649]**

SW846 6020

Dilution	*Analyzed*	*By*	*Analytical Batch*
1	10/04/05	ms	META / 5649 [32159]

Parameter	*Result*	*RDL*	*MCL*	*Units*
Lead	<0.0010	0.0010		mg/L

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Certificate of Analysis

QC Summary

Instrument Control Sample

Trace ID: 63627 **Matrix:** Water **Analytical Batch:** META / 5649 [32159]

SW846 6020	*Expected*	*Result*	*Recovery*	*Rec Limits*
Lead	0.05 mg/L	0.051	101	80 - 120

ICP/ICPMS Matrix Spike

Original Lab ID: FJ339-11

Trace ID: 63628 **Matrix:** Water **Analytical Batch:** META / 5649 [32159]

SW846 6020	*Original Result*	*Expected*	*Result*	*Recovery*	*Rec Limits*
Lead	0	0.25 mg/L	0.26	102	75 - 125

ICP/ICPMS Matrix Spike Dup

Original Lab ID: FJ339-11

Trace ID: 63629 **Matrix:** Water **Analytical Batch:** META / 5649 [32159]

SW846 6020	*Expected*	*Result*	*Recovery*	*Rec Limits*	*RPD*	*RPD Limits*
Lead	0.25 mg/L	0.25	100	75 - 125	2	0 - 20

TRACE
Analytical Laboratories, Inc.
2241 Black Creek Road • Muskegon, MI 49444-2673
Phone 231-773-5998 • Fax 231-773-6537

ANALYTICAL SERVICES AUTHORIZATION
CHAIN-OF-CUSTODY RECORD

TRACE ID NO: FJ339

PLEASE COMPLETE STEPS 1 THRU 3. TRACE PERSONNEL WILL COMPLETE SECTIONS SHADED BLUE. Page 2 of 2

STEP 1 Report Results To:

Client Name: Altech Environmental Services
Contact Person: M Hoe
Mailing Address: 17350 W 12 Mile Rd Suite 200
City, State, Zip Code: Southfield MI 48075
Phone: 248 559 5500 Fax: 248 559 5540
Email Address: MHoe@altechenvironmental.com
Client Job #: 9201-038 P.O. #: Trace Quote #:
Sampled By: M Hoe

For Use by TRACE Personnel Only
Logged By: MJ Checked By: MB
Received on ice: (Yes) No
Cooler Temp (°C): 1° ph Checked: Yes No
Volatiles Preserved: HCl MeOH En Core No Metals Pres: Yes (No)

Step 2 Sample Identification / Request for Analytical Services

Regulatory Requirements: MERA TMDL's ☐ RCRA ☐ NPDES ☐ USACE ☐ Wisconsin ☐
Turnaround Requirements: Standard ☐ * 5 Day (RUSH) ☐ * 2-4 Day (RUSH) ☐ * 24 Hour (RUSH) ☐ * Requires prior approval
Matrix Key: DW = Drinking Water; S = Soil; SL = Sludge; W = Water; A = Air; O = Oil; X = Other

ANALYSIS REQUESTED

TRACE ID	DATE TAKEN	TIME TAKEN	METALS FIELD FILTERED	VOLATILES PRESERVED	CLIENT SAMPLE ID	MATRIX	NUMBER OF CONTAINERS	Lead Dissolved per Marsha Hoe 9/30/05	REMARKS	Possible Health Hazard
11	9-29-05	N			KCP0507-W	W	1	X	Not filtered Not preserved	
12					Trip Blank 9/30/05					

STEP 3 Chain of Custody

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	1) Marsha Hoe	FedEx	9/29/05	1900
	3)			

Item #	RELEASED BY	RECEIVED BY	DATE	TIME
	2) Fed	Mary Conn	9/30/05	10:15am
	4)			

In executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.

SAMPLE LOG IN CHECKLIST

Date: 9/30/05 Client Name: Altech # of Coolers: 1

HPN #: Project Name: 9201-038 Cooler #s:

Project #: Logged in by: my Cooler #s:

Cooler Receipt

Cooler/samples delivered by: Trace courier ☐ Hand delivered ☐ Commercial courier ☑ Name of delivery person: Fed Ex Name of courier service:

Did cooler come with a bill of lading? No ☐ Yes ☐ Way Bill or Tracking #:

COC Seals present and intact on cooler? No ☐ Yes ☒ Custody seals signed by: Marrah Hope

Client COC number: F-J 338

Type of packing in cooler: Ice

Coolant and Temperature

Type of Coolant Used

	Yes	No
Slurry w/ crushed, cubed, or chip ice?	☐	☐
Multiple bags of ice around samples?	☒	☐
Ice Packs/ Blue Ice :	☐	☐
No Coolant Present:		☐

Cooler Temperature Correction Factor ____ °C

Date: 9/30/05 Time: 10:5 am

Temperature Blank: 7.4 °C

Range of 3 samples: 1 °C

Melt Water: °C

Ice still present upon receipt: ☒ Yes ☐ No

General

	Yes	No	NA
COC taped to inside of cooler lid?	☑	☐	☐
All bottles arrived unbroken with labels in good condition?	☑	☐	☐
Each sample is in a sealed plastic bag?	☑	☐	☐
Labels filled out completely?	☑	☐	☐
All bottle labels agree with Chain of Custody (COC)?	☑	☐	☐
Sufficient sample to run tests requested?	☑	☐	☑
pH checked and samples at correct pH?	☐	☐	☑
Correct preservative added to samples?	☑	☐	☐
DRO/GRO samples received and appropriate check in form completed?	☐	☐	☑
Air bubbles absent from VOAs?	☑	☐	☐
COC filled out properly and signed by client?	☑	☐	☐
COC signed in by TRACE sample custodian?	☑	☐	☐
Was project manager called and samples discussed?	☐	☑	☐

Contact: Date:

Notes:

QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

Part # 156297-435 RIT 07/05

FedEx PRIORITY OVERNIGHT FRI
emp# 244769 29SEP05
TRK# 8504 4931 9450 FORM 0200
Deliver By: 30SEP05 AA
49444 -MI -US GRR XX MKGA



CUSTODY SEAL
DATE 9-29-05
SIGNATURE

QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

CUSTODY SEAL
DATE 9-29-05
SIGNATURE

CUSTODY SEAL
DATE 9-29-05
SIGNATURE

QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

CUSTODY SEAL
DATE 9-29-05
SIGNATURE

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. FJ339

RVWMET.XLS

Rev. 2
7/30/97

PART 1: ANALYST REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Appropriate SOPs have been followed					
Sample preparation information is correct and complete					
MS/MSDs are within established control limits					
Blanks are within established control limits					
Laboratory control samples are within established control limits					
Qualifiers have been added to benchsheet and explained correctly					
Copies of digestion logs and run logs are included with benchsheets if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Quantitative results are correct and complete					
All data is generated with a valid calibration curve					
RPDs have been calculated where appropriate					
Reporting limits have been adjusted where necessary					
Signed/Date					MS 10-5-01

Notations/Comments:

Trace Analytical Laboratories, Inc.
Metals File Review
Trace Job No. F5339

Rev. 2
7/30/97

PART 2: METALS MANAGER REVIEW

	As, Se	Hg	ICP Metals	Furnace Metals	ICP-MS
Analysis in file matches COC					
Appropriate SOPs have been followed					
Significant figures are correct					
Reporting limits are correct					
Method numbers are correct					
Copy of run log and digestion logs are in file if needed					
Analyst initials are on benchsheet					
Analysis date is on benchsheet					
Calibration data are scientifically sound, appropriate and documented					
Quantitative results have been reviewed					
Necessary qualifiers have been added to benchsheet and explained correctly					
Analyst review has been checked					
Analysis is approved for release to reporting					

Notations/Comments:

Signed/Date	Signed/Date	Signed/Date	Signed/Date	Signed/Date
				10-5-05

Volume I

Fox River Environmental Baseline Assessment and Phase I Environmental Assessment Report

Fox River Project Excess Property

Prepared for
U.S. Army Corps of Engineers
Detroit District

November 2000

BARR

4700 West 77th Street
Minneapolis, MN 55435
Phone: (952) 832-2600
Fax: (952) 832-2601

Fox River Environmental Baseline Assessment and Phase I Environmental Assessment Report Fox River Project Excess Property

Table of Contents

1.0 Introduction 1
1.1 Phase I Environmental Site Assessment 1
1.2 Environmental Baseline Survey 1
1.3 Classification of Environmental Condition of Property Area Types 2
2.0 Report Organization 4
3.0 Project Background Information 5
4.0 Data Resources 6
5.0 Property Summaries 7
5.1 De Pere Lock and Dam 7
5.2 Little Kaukauna Lock and Dam 10
5.3 Rapide Croche Lock and Dam 13
5.4 Stockbridge Harbor 15
5.5 Kaukauna Locks and Dam 16
5.6 Kaukauna Depot 8 22
5.7 Little Chute Locks and Dam 24
5.8 Cedars Lock and Dam 27
5.9 Appleton Locks and Dam 29
5.10 Brothertown Harbor 36
5.11 Menasha Lock 37

Volume I
List of Tables

Table 1	De Pere Lock Primary Resources Summary
Table 2	Little Kaukauna Lock and Dam Primary Resources Summary
Table 3	Rapide Croche Lock and Dam Primary Resources Summary
Table 4	Stockbridge Harbor Primary Resources Summary
Table 5	Kaukauna Locks and Dams Primary Resources Summary
Table 6	Kaukauna Depot 8 Primary Resources Summary
Table 7	Little Chute Locks and Dam Primary Resources Summary
Table 8	Cedars Lock and Dam Primary Resources Summary
Table 9	Appleton Locks and Dam Primary Resources Summary
Table 10	Brothertown Harbor Primary Resources Summary
Table 11	Menasha Lock Primary Resources Summary

List of Figures

Fox River Project Area Location Map

Figure 1	De Pere Lock
Figure 2	Little Kaukauna Lock and Dam
Figure 3	Rapide Croche Lock and Dam
Figure 4	Stockbridge Harbor
Figure 5	Kaukauna Locks and Dams
Figure 6	Kaukauna Depot 8
Figure 7	Little Chute Locks and Dam
Figure 8	Cedars Lock and Dam
Figure 9	Appleton Locks and Dam
Figure 10	Brothertown Harbor
Figure 11	Menasha Lock

List of Appendices

Appendix A	Phase I Environmental Site Assessment Checklists

Volume II
List of Appendices
(Included by Section Designation)

Appendix B Historical Documentation
- Topographic Maps
- Aerial Photographs
- Sanborn Fire Insurance Maps
- Historic Maps
- Company Records
- Reverse City Directories (not included because of copyright laws)
- Geological Survey Well Logs

Appendix C EDR Report

Appendix D Previous Investigation Data

Appendix E Photographic Log

Appendix F Signatures and Qualifications

1.0 Introduction

Barr Engineering has performed eleven environmental property assessments of excess Corps of Engineers property from the Fox River Project (Property) according to the *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (ASTM Standard E1527-97) and *Standard Practice for Conducting Environmental Baseline Surveys* (ASTM D 6008-96). The assessments were performed to provide data to support classification by the DoD component, in order to facilitate and support findings of suitability to transfer (FOSTs). Classifications are determined according to *Standard Classification of Environmental Condition of Property Area Types for Defense Base Closure and Realignment Facilities* (ASTM D 5746-98). Descriptions and summaries of the ASTM standard practices follow.

The purpose of conducting these assessments was specifically to determine the suitability of the Fox River Project Area excess properties for transfer. The excess properties were identified in the 1997 Environmental Impact Statement (EIS) Final Disposition Report.

1.1 Phase I Environmental Site Assessment

The purpose of the *Phase I Environmental Site Assessment Process* (ASTM Standard E1527-97) is to define consistent methods for conducting an environmental site assessment of a parcel of commercial real estate with respect to the range of contaminants within the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and for petroleum products.

The goal of the processes defined within the Phase I Environmental Site Assessment Process is to identify "recognized environmental conditions." The term recognized environmental condition means the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property.

The Phase I Environmental Site Assessment consists of four components: records review, site reconnaissance, interviews, and a report. This practice does not include any testing or sampling of materials (e.g., soil, water, air, building materials). The Phase I Environmental Assessment report includes the documentation from the records review, site reconnaissance, and interviews. The report must also identify and describe recognized environmental conditions in full and include an assessment of the impact of the recognized environmental conditions in connection with the property.

1.2 Environmental Baseline Survey

The purpose of the *Standard Practice for Conducting Environmental Baseline Surveys* (ASTM D6008-96) is to define good practice for conducting an environmental baseline survey (EBS) in order to determine certain elements of the environmental condition of federal real property. The EBS is conducted to fulfill certain requirements of CERCLA Section 120(h) as amended by the Community Environmental Response Facilitation Act (CERFA). This practice is intended to help a user gather and analyze data and

information which will be used to classify property into seven environmental condition of property area types. The actual classification is determined according to *Standard Classification of Environmental Condition of Property Area Types for Defense Base Closure and Realignment Facilities* (ASTM D 5746-98). The EBS is also used to support Findings of Suitability to Transfer (FOSTs) pursuant to the requirements of CERFA.

The EBS is based on existing environmental information related to storage, release, treatment, or disposal of hazardous substances or petroleum products on the property to determine or discover the obviousness of the presence or likely presence or a release or threatened release of any hazardous substance or petroleum product. At a minimum, the EBS consists of the following:

- Detailed search and review of available information and records in the possession of the DoD Components or records made available by the regulatory agencies or other involved federal agencies
- Review of all reasonably obtainable federal, state, and local government records for each adjacent facility where there has been a release or likely release
- Analysis of aerial photographs
- Interviews with current or former employees
- Visual inspections of the real property and buildings
- Identification of sources of contamination on the installation and on adjacent properties which could migrate to the parcel during federal government ownership
- Summary of ongoing response actions or actions that have been taken at or adjacent to the parcel
- Physical inspection of the property adjacent to the real property
- Determination of the environmental condition of the property area type
- Preparation of an Environmental Baseline Survey report and map

1.3 Classification of Environmental Condition of Property Area Types

Information gathered and evaluated for the Phase I Environmental Assessment and Environmental Baseline Assessment processes will be used to support classification of the parcels relative to their environmental conditions as Property Area Types. The purpose of the *Standard Classification of Environmental Condition of Property Area Types for Defense Base Closure and Realignment Facilities* (ASTM D5746-9) is to define seven standard environmental condition of property area types for DoD real property at a closing military installation with respect to the requirements of CERCLA 1980 Section 120(h) as amended by CERFA and Section 331 of the National Defense Authorization Act for Fiscal Year 1997. The resulting classification is intended to permit a DoD component to classify property in order to facilitate and support findings of suitability to transfer (FOSTs), findings of suitability to lease (FOSLs), and uncontaminated parcel determinations pursuant to the requirement of CERFA.

The standard environmental condition of property area types are as follows:

- Type 1 – An area of parcel of real property where no release, or disposal of hazardous substances or petroleum products or their derivatives has occurred (including no migration of these substances from adjacent properties.

- Type 2 – An area or parcel of real property where only the release or disposal of petroleum products or their derivatives has occurred.
- Type 3 – An area or parcel of real property where release, disposal, or migration, or some combination thereof, of hazardous substances has occurred, but at concentrations that do not require a removal or remedial action.
- Type 4 - An area or parcel of real property where release, disposal, or migration, or some combination thereof, of hazardous substances has occurred, and all remedial actions necessary to protect human health and the environment have been taken.
- Type 5 - An area or parcel of real property where release, disposal, or migration, or some combination thereof, of hazardous substances has occurred and removal or remedial actions, or both, are underway, but all required actions have not yet been taken.
- Type 6 - An area or parcel of real property where release, disposal, or migration, or some combination thereof, of hazardous substances has occurred, but required response actions have not yet been initiated.
- Type 7 – An area or parcel of real property that is unevaluated or requires additional evaluation. This type or property area includes parcels where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. This type does not fit any of the previous area types with certainty because evaluation efforts have not occurred, are ongoing, or are inconclusive.

2.0 Report Organization

This report is presented in two volumes. Volume I contains this report, historical documentation summary tables, Property figures, and Phase I Environmental Site Assessment checklists completed for each Property. The checklists are included as Appendix A.

Volume II contains the remaining appendices for the report. Resources reviewed and evaluated during the preparation of this report are included as Appendices B through E. Appendix F are the Barr Engineering and the Environmental Professional qualifications for conducting this study and the limitations for the report. The resources presented in Appendix B through Appendix E are identified by Property.

3.0 Project Background Information

The project area is located along the Fox River, which is a tributary of Green Bay located between the cities of Menasha and DePere, Wisconsin. The contract for the Phase I Environmental Assessments is with the Detroit District, U.S. Army Corps of Engineers (USACE).

The eleven properties total approximately 132 acres in size. The properties support dams, locks, and active and abandoned support buildings for the dams and locks. In 1872, the Fox River Project was acquired for commercial navigational needs for the Fox River. However, since 1959, commercial traffic has been virtually nonexistent. Today, the project provides for recreational navigation, as well as environmental enhancement, flood control, hydropower, and water supply.

The locations of the 11 Fox River Project properties are included on the Fox River Project Area Location Map and are listed below. The individual Property layout maps are included as Figures 1 through 11. The following are the Properties evaluated and their respective section numbers:

Section 1 De Pere
Section 2 Little Kaukauna Lock and Dam
Section 3 Rapide Croche Lock and Dam
Section 4 Stockbridge Harbor
Section 5 Kaukauna Locks and Dams
Section 6 Kaukauna Depot 8
Section 7 Little Chute Locks and Dam
Section 8 Cedars Lock and Dam
Section 9 Appleton Locks and Dam
Section 10 Brothertown Harbor
Section 11 Menasha Lock

4.0 Data Resources

The Phase I Environmental Site Assessments/Environmental Baseline Surveys included review and evaluation of publicly available resources, vendor supplied regulatory database searches, U.S. Corps of Engineers provided records, reports, and references, site inspections, and interviews. Specific information gleaned from each of these resources for each Property are summarized and discussed in the Phase I Environmental Site Assessment checklists (Appendix A).

The following publicly available resources, when available, were evaluated for each Property: aerial photographs, current topographic map, historical maps, Sanborn Fire Insurance maps, and reverse city directories. The following U.S. Corps of Engineers reports and references were also evaluated:

U.S. Army Corps of Engineers, Detroit District. 1985. *Waterway Operations Manual Fox River, Wisconsin*

Environmental Impact Statements and Environmental Assessment Worksheets.
U.S. Army Engineering District, Chicago. May 1977. *Final Environmental Impact Statement Relating to the Operation and Maintenance of the Fox River, Wisconsin Navigation Project.*

Environmental Science & Engineering, Inc., December 2, 1993. *Report of Asbestos Inspections at Lockmaster Dwellings: Fox River, Wisconsin – Contract No. DACW35-93-D-001.*

Detroit District COE Fox River and Winnebago Delivery Order #0033, August 25, 1989. *Fox River Locks/Dams Sediment Characteristics* (Sampled May 1-4, 1989).

5.0 Property Summaries

The following summarizes available site information and recognized environmental conditions identified at the Properties. In order to provide a succinct summary for each Property, site information discussed is not fully referenced below. Appropriate references are provided in the Property Phase I Environmental Site Assessment checklists included in Appendix A.

5.1 De Pere Lock and Dam

5.1.1 Property Information

The De Pere Lock and Dam Property is located at 100 James Street in De Pere, Wisconsin. The Property is 2.04 acres in size. The layout of the Property is shown on Figure 1.

5.1.2 Property History

The original service date for the existing De Pere lock was in 1936 with significant improvements completed in 1974. An older lock was identified at the Property as early as 1890. The current lockshelter (old lockmaster dwelling) has been at the current location since 1890. Two additional small buildings were observed on the 1890 Sanborn Map which are no longer on the Property. The uses of these buildings are not known. The existing Lockmaster Dwelling first appeared on the 1914 Sanborn Map. The existing Lockmaster Dwelling contained an aboveground storage tank (AST) in the basement for storage of fuel oil. The location of this former AST tank was not accessible during the site inspection, however, the USACE representative indicated that the tank was previously drained and removed. An underground fill line was trenched between the Lockmaster Dwelling and the southwestern corner of the lock so that the fueling truck could fill the tank from the eastern side of the lock. No specific information regarding this underground fill line is available. However, it is likely that this line does not meet Wisconsin tank appurtenance guidelines. The locations of current and known historical structures are shown on Figure 1.

Dunham and Smith Flour Mill and the Merchant Mill (at least 1890 to prior to 1990) and De Pere Water Power Company (at least 1890 to prior to 1895) previously occupied the southern portion of the Property. Ruins of American Writing Paper Co. are shown on the southern portion of the Property on the 1910 U.S. Gov. Historical Map. The locations of the former industrial activities are shown on Figure 1.

5.1.3 Property Area Regulatory History

The De Pere Lock and Dam Property was not identified as being on any of the regulatory lists searched by Environmental Data Resources (EDR) as stated in the March 14, 2000 EDR report.

One neighboring property is identified in the March 14, 2000 EDR report as a site with the potential to impact the Property. The Osen Milling Company site is located at 201 James Street (adjacent to and east of the Property). The location of the Osen Milling Company site is shown on Figure 1. The former Osen Milling Company building is now occupied by the James Street Inn. The site is identified as a closed high-priority Leaking Underground Storage Tank (LUST) site. The EDR report also identifies the site as a non-LUST cleanup site. The EDR report indicates chlorinated solvents have impacted the soil at this site

and that it is classified as high priority by the state. The city of DePere has been directed by the WIDNR to do a site investigation and as of June 2000, no work had been completed.

5.1.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Sixteen (16) samples were collected for analysis from the De Pere Locks and Dam Lockmaster Dwelling. Of the samples collected, five were identified as being asbestos-containing-material (ACM). Friable and non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. However, non-friable ACM can become friable during demolition activities. The locations of the ACM identified are as follows: roof shingle (non-friable), linoleum floor tile under kitchen sink (non-friable), linoleum floor tile in bathroom (non-friable), tape on ducts in basement (non-friable), and pipe insulation in basement stairwell (friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two (2) samples were collected from the De Pere Lock area. One sample was for physical parameters (density, organic carbon, grain size, and % solids) and one sample was selected for contaminant analyses. The contaminant sample contained PCB 1242 (17 mg/kg), arsenic (1.9 mg/kg), cadmium (2.8 mg/kg), chromium (110 mg/kg), copper (73 mg/kg), total cyanide (0.15 mg/kg), nickel (16 mg/kg), lead (160 mg/kg), mercury (4.0 mg/kg), oil and grease (4,400 mg/kg), and phenols (0.8 mg/kg). De Pere was identified as a site with mercury as a concern in the report for the May 1989 shoal sediment study. The survey suggested a limited possibility of hazardous or toxic category material at De Pere Lock and Dam.

5.1.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. There is no information available which may indicate that dredge material was disposed of at this Property.

5.1.6 Property Inspection Summary

The De Pere Lock and Dam Property was inspected on April 14, 2000. A gravel driveway services the Property. Access to the Property is restricted by a locked chain-link fence. There are currently four buildings on the Property: Lockmaster dwelling, Lockmaster garage, oil house, and a lockshelter. The locations of these buildings are shown on Figure 1. The interiors of all buildings were inspected except the Lockmaster dwelling. USACE personnel indicated that the interior of this building was similar to other dwellings inspected and no hazardous chemicals or petroleum products are currently used or stored in the dwelling. Paint and petroleum products were previously stored in the oil house and fuel oil was previously stored in an AST in the basement of the Lockmaster's dwelling. Currently no hazardous substances or petroleum products are used or stored at the Property. All floors and drains inspected were in good conditions and staining or spills were not observed.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.1.7 Conclusions and Recommendations

- The Property was not serviced by municipal water and, therefore, it is likely that a well was used to service the lockmasters dwelling. There is no record of removing/sealing a well at the Property. An unsealed well could act as a conduit to drinking water supplies if there was a release at the Property. The Property well should be located and properly abandoned if it has not been abandoned. The potential presence of unsealed wells should be disclosed at the time of Property transfer.

- Non-friable and friable asbestos containing materials were identified at the property. ACMs, if still present, should be removed prior to demolition of any structures. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- The 1989 COE sediment study concluded that elevated mercury is present in sediment within the lock area at a concentration of 4.0 mg/kg. This sediment has not been dredged and placed on the Property and, therefore, has a limited potential to impact the Property. No work regarding the sediment is recommended. The sediment data for the material within the canal should be disclosed at the time of Property transfer.

- The fill pipe for the AST basement of the lockmasters dwelling was installed underground between the lockmasters dwelling and the southwest corner of the lock (approximately 150 feet). The construction of this fill line does not meet WIDNR tank appurtenance construction requirements. It is possible that leaks may have developed along the fill line and it is also possible that surface spills occurred around the fill pipe during filling operations. The soil along the fill line should be sampled and analyzed.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving removal of paint will need to comply with OSHA guidelines. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

- One septic system is present at the property. Details regarding the construction of this system is not known. There are no recommendations proposed in regard to the septic system other than that the presence of the septic system should be disclosed at the time of Property transfer.

- Three neighboring sites have been identified as having the potential to have an impact on the Property. Two of these sites, the CA Lawton Site and the Earthheart Cafe and Deli Site, have been closed by the WIDNR and have a limited potential to impact the Property. No recommendations

regarding these sites are proposed. The Milling Site (Osen Milling Company) has been identified as a high-priority site by the State. Chlorinated solvents have impacted soil at the Site. This site is immediately east and adjacent to the Property. The city of DePere has been directed to perform an investigation at the Site and has not done so as of June 2000. Samples should be collected and analyzed to verify that offsite migration to the Property is not occurring.

- Industrial operations have historically operated on the southern portion of the Property. The Dunham and Smith Flour Mill, Merchant Mill, DePere Water Power Company, and the American Writing Paper Company historically operated on the Property. No records of investigations or remedial activities are available from the Wisconsin DNR for these industrial activities. Due to the industrial use of the properties (likely petroleum and/or solvent use), there is a potential that these operations may have impacted the Property. The site inspection for the Property showed no visual evidence of contamination. Sampling is recommended to determine if industrial activities impacted the soil.

5.1.8 Classification Determination

This Property is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. These specific areas of concern are related to the underground fuel oil fill line, the proximity of and suspected releases from the Osen Milling site, and the historical industrial activities that were conducted on the Property.

5.2 Little Kaukauna Lock and Dam

5.2.1 Property Information

The Property is located on Mill Road (Rural Route 3) in the Village of Lawrence, Wisconsin. The Property is 3.3 acres in size. The layout of the Property is shown on Figure 2.

5.2.2 Property History

The original service date for the current Little Kaukauna Lock and Dam is 1937. An older lock structure was present at the Property as early as 1910 downstream of the current location. The lockmaster dwelling appears to be at the current location by 1910. Two additional buildings, which are no longer on the Property, were located on the 1910 U.S. Government Historical Map. The uses of these buildings are not known. All of the current buildings, including the lockmaster dwelling, garage, lockshelter, oil house, and sanitary facility, are shown at their current locations by the 1980s. The garage was formerly located west of its present location. The foundation of the former garage was observed during the site visit. A lockshelter was formerly located on the northwest corner of the lock. The current lockshelter is located northeast of the lock. Current and known historical structure locations are shown on Figure 2.

A hydroelectric facility and mill operated on the north bank of the canal from at least 1910 to the 1970s. All of the buildings associated with the mill (except the mill/dam) were removed by 1982. Construction activities have been ongoing on the land adjacent to the mill from 1960 through 1992. The locations of the hydroelectric facility and mill are shown on Figure 2.

5.2.3 Property Area Regulatory History

The Little Kaukauna Lock and Dam Property was not identified as being on any of the regulatory lists searched by EDR as reported in the March 14, 2000 EDR report. Furthermore, no adjacent sites were identified as being of concern.

5.2.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 Lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Sixteen (16) samples were collected for analysis from the Little Kaukauna Lock and Dam Lockmaster dwelling and garage. Of the samples collected, seven were identified as being ACM. Friable and non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. Non-friable ACM can become friable during demolition activities. The locations of the ACM identified are as follows: roof shingle (non-friable), second floor ceiling plaster (friable), first floor ceiling plaster (friable), kitchen floor linoleum (non-friable), linoleum floor tile in bathroom (non-friable), tape on ducts in basement (non-friable), and second floor wall plaster (friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from the Little Kaukauna Lock area for density, organic carbon, grain size, and percent solids and one sample was selected for contaminant analyses. The contaminant sample contained PCB 1242 (2.4 mg/kg), arsenic (2.8 mg/kg), cadmium (1.1 mg/kg), chromium (50 mg/kg), copper (47 mg/kg), lead (78 mg/kg), mercury (0.72 mg/kg), nickel (19 mg/kg), oil and grease (1,300 mg/kg), and phenols (0.38 mg/kg).

5.2.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. The May 1977 Final Environmental Impact Statement for the Fox River listed primary sites for the disposal of dredged materials.

Dredging Location	Disposal Site	Ownership of Disposal Site	Dimension of Site	Approximate Year of Disposal
Channel above Little Kaukauna Lock.	Left side of channel above Little Kaukauna lock on existing dredge bank.	United States	50'x300'	1968

The location and use of this disposal site was verified by U.S. Army Corps of Engineers personnel.

5.2.6 Property Inspection Summary

The Little Kaukauna Lock and Dam Property was inspected on April 14, 2000. The Property is completely surrounded by the Fox River. The only way to access the Property is to cross the can on Wagon Bridge. Access to the Property is restricted by a locked chain-link fence. There are currently five buildings on the Property: Lockmaster dwelling, Lockmaster garage, oil house, sanitary facility, and a lockshelter. The locations of these buildings are shown on Figure 2. The interiors of all buildings were inspected except the Lockmaster dwelling. USACE personnel indicated that the interior of this building was similar to other dwellings inspected and no hazardous chemicals or petroleum products are currently used or stored in the dwelling. One quart of oil and four small gasoline containers were observed in the oil house. Fuel oil was previously stored in an AST in the basement of the Lockmaster's dwelling. No additional hazardous substances or petroleum products are used or stored at the Property. All floors and drains inspected were in good conditions and staining or spills were not observed.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.2.7 Conclusions and Recommendations

- Municipal water is not available to the Property. The Property has supported a Lockmaster dwelling since at least 1910. It is likely that a well or wells have serviced the Property since that time. The well observed at the Property appears to have been installed in the late 1970s or 1980s. No records of well sealing for any older wells are available for the Property. An unsealed well could act as a conduit if a release occurred at the Property. Unused wells should be located and properly abandoned. The potential presence of unsealed wells should be disclosed at the time of Property transfer.

- Sixteen (16) samples of building materials were collected for analysis from the Little Kaukauna Lock and Dam Lockmaster dwelling and garage. Of the samples collected, seven were identified as being asbestos-containing-material (ACM). ACMs, if still present, should be removed prior to demolition of any structures. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- The 1989 sediment investigation conducted by the U.S. Corp of Engineers found relatively low concentrations of mercury and PCBs in the sediment immediately upstream from the lock. The 1977 EIS report (REF. 6) indicated that dredged sediments were disposed at the Property in approximately 1968. The 1989 analytical data was for samples of sediment retrieved from the base of the channel. No recommendations are proposed for sediment near the Property in the channel except that the sediment data should be disclosed at the time of Property transfer.

  Because heavy metals and PCBs were present in the sediment in 1989, it is possible that heavy metals and/or PCBs may be present in the sediment dredged in approximately 1968 and placed on the Property. No analytical data is available for the sediment placed on the Property. Analytical

samples should be collected and analyzed to provide information on the quality of material previously deposited on-site.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving the removal of paint should comply with OSHA guidelines. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

Industrial properties (hydroelectric plant and a paper tissue mill) have historically operated north of the Property. No records of investigations or remedial activities are available from the Wisconsin DNR for this property. Due to the industrial use of the properties (likely petroleum and/or solvent use) and the proximity to the Property, there is a potential that these operations may have impacted the Property. The site inspection for this Property showed no visual evidence of contamination. Sampling is recommended to determine if these activities impacted the soil.

5.2.8 Classification Determination

Little Kaukauna is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. These specific areas of concern are related to the sediment dredge spoils that were disposed at the Property and the industrial activities that occurred adjacent to the Property.

5.3 Rapide Croche Lock and Dam

5.3.1 Property Information

The Property is located on Lock Road in Wrightstown, Wisconsin. The Property covers approximately 9.7 acres. The layout of the Property is shown on Figure 3.

5.3.2 Property History

The original service date for the current Rapide Croche Lock and Dam was 1934. Historically, there was a lock in the far eastern portion of the Property. This old lock had a lockmaster dwelling and garage supporting it. The current Lockmaster dwelling and lockshelter have been at the current locations since at least 1954. The sanitary facility, oil house and garage were added to the Property by 1981. Property use since at least 1934 has remained the same. Current and known historical structure locations are shown on Figure 3.

5.3.3 Property Area Regulatory History

The Rapide Croche Lock and Dam Property was not identified as being on any of the regulatory lists searched by EDR as reported in the March 14, 2000 EDR report. Furthermore, no adjacent sites were identified as being of concern.

5.3.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 Lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Thirteen (13) samples were collected for analysis from the Rapide Croche Lock and Dam Lockmaster dwelling and garage. Of the samples collected, four were identified as being. Non-friable ACMs were found. Non-friable ACM is intact and not likely to easily become airborne in its current condition. Non-friable ACM can become friable and airborne during demolition activities. The locations of the ACM identified are as follows: roof shingle (non-friable), exterior siding house (non-friable), linoleum floor tile in first floor bathroom (non-friable), and tape on ducts in basement (non-friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, three samples were collected from the Rapide Croche Lock and Dam area for density, organic carbon, grain size, and percent solids and two samples were selected for contaminant analyses. The contaminant samples contained PCBs (2.6 and 9.5 mg/kg), arsenic (2.6 and 3.4 mg/kg), cadmium (4.3 and 2.1 mg/kg), chromium (120 and 83 mg/kg), copper (110 and 59 mg/kg), total cyanide (0.11 and 0.06 mg/kg), lead (180 and 79 mg/kg), mercury (6.2 and 0.88 mg/kg), nickel (20 and 25 mg/kg), oil and grease (7,500 and 3,400 mg/kg), and phenols (0.45 and 0.64 mg/kg). The Level I survey report identifies Rapide Croche Lock and Dam as an area with mercury concerns.

5.3.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. There is no information available which may indicate that dredge material was disposed of at this Property.

5.3.6 Property Inspection Summary

The Rapide Croche Lock and Dam Property was inspected on April 13, 2000. A gravel driveway services the Property. Access to the Property is restricted by a locked chain-link fence. There are currently five buildings on the Property: Lockmaster dwelling, Lockmaster garage, oil house, sanitary facility, and a lockshelter. The locations of these buildings are shown on Figure 3. The interiors of all buildings were inspected except the Lockmaster dwelling. USACE personnel indicated that the interior of this building was similar to other dwellings inspected and no hazardous chemicals or petroleum products are currently used or stored in the dwelling. Paint and petroleum products were previously stored in the oil house and fuel oil was previously stored in an AST in the basement of the Lockmaster's dwelling. Currently no hazardous substances or petroleum products are used or stored at the Property. All floors and drains inspected were in good conditions and staining or spills were not observed.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific

observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.3.7 Conclusions and Recommendations

- An unsealed/unused well remains at the Property. The well could act as a conduit to drinking water supplies if there was a release at the Property. If this well is no longer going to be used, it should be properly abandoned. The presence of an unsealed well should be disclosed at the time of Property transfer.

- Non-friable asbestos containing materials were identified at the Property in the Lockmasters Dwelling and garage. ACMs, if still present, should be removed prior to demolition of any structures. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- Because of the age of the Property buildings, it is likely that lead-based paint has been used on Property structures. Any renovations involving removal of paint should comply with OSHA guidance. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

- Two septic systems are present at the Property. Details regarding the construction of these systems are not known. No recommendations are proposed in regard to the septic systems except that the presence of these septic system should be disclosed at the time of Property transfer.

5.3.8 Classification Determination

The Rapide Croche Lock and Dam Property is identified as a Type 1 property type. This classification is proposed because the Phase I Environmental Site Assessment and EBS activities did not identify areas with releases or suspected releases of hazardous substances or petroleum products or their derivatives.

5.4 Stockbridge Harbor

5.4.1 Property Information

The Stockbridge Harbor Property is located on West Street in Stockbridge, Wisconsin. The Property consists of 1.27 acres. The layout of the Property is shown on Figure 4.

5.4.2 Property History

Stockbridge Harbor is visible on historical maps as early as 1911. The harbor remained essentially unchanged through approximately 1997, at which time Calumet County redeveloped the Property and east of the Property into a larger harbor and park area.

5.4.3 Property Area Regulatory History

The Stockbridge Harbor Property was not identified as being on any of the regulatory lists searched by EDR as reported in the March 14, 2000 EDR report. Furthermore, no adjacent sites were identified as being of concern.

5.4.4 Previous Environmental Investigations

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from Stockbridge Harbor for density, organic carbon, grain size, and percent solids and one sample was selected for contaminant analyses. The contaminant sample did not contain PCBs. The sample did contain arsenic (1.1 mg/kg), cadmium (0.03 mg/kg), chromium (3.7 mg/kg), copper (1.3 mg/kg), lead (5.1 mg/kg), nickel (3.2 mg/kg), oil and grease (600 mg/kg), and phenols (0.15 mg/kg). The concentrations of metals and other parameters are consistent with background concentrations.

5.4.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. USACE records show that dredging was completed in the harbor in 1962 (1,060 c.y.) and in 1970 (5,010 c.y.). All of the material dredged from the harbor was placed directly into Calumet County vehicles and shipped away for disposal.

5.4.6 Property Inspection Summary

The Stockbridge Harbor Property was inspected on April 14, 2000. A gravel driveway services the Property. Access to the Property is not restricted. There are no buildings on the Property. Currently no hazardous substances or petroleum products are used or stored at the Property.

The exterior areas of the Property are covered primarily with grass and a gravel driveway. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.4.7 Conclusions and Recommendations

No recognized environmental conditions were identified for the Stockbridge Harbor Property. Therefore, no conclusions or recommendations are presented.

5.4.8 Classification Determination

The Stockbridge Harbor Property is identified as a Type 1 property type. This classification is proposed because the Phase I Environmental Site Assessment and EBS activities did not identify areas with releases or suspected releases of hazardous substances or petroleum products or their derivatives.

5.5 Kaukauna Locks and Dam

5.5.1 Property Information

The Kaukauna Locks and Dam Property is comprised of seven parcels. These parcels are referred to relative to the following features: Lock 1, Lock 2, Lock 3, Lock 4, Lock 5, Property Southwest of the

Dam, and Property Northeast of the Dam. These Property features are located on Canal and Augustine Streets in Kaukauna, Wisconsin. The Property parcels cover 50.4 acres. The layout of the Property is shown on Figure 5.

5.5.2 Property History

Locks 1, 2, 3, 4, and 5 were built in 1883, 1903, 1879, 1879, and 1898, respectively. The portion of the Lock 3 Property now supporting the Project Office and the Generator Building was acquired by the U.S. Government in 1947 by condemnation procedures. Current and known historical structure locations are shown on Figure 5.

Property Southwest of Dam

The Property southwest of the dam was depicted as part of the Kaukauna Water Power Company canal system in the 1885 Sanborn Map. The 1910 U.S. Government Map shows a small building with a well (purpose unknown), railroad spur, and a water closet. In 1952, 1956, and 1964, the Property was wooded, contained a small pond, and no structures. Surface disturbances were observed at the Property on the 1964 aerial photograph which may have been filling activities. The area of disturbance was larger in the 1971 aerial photograph. The 1974 historic map and 1992 topographic map show an unimproved roadway on the Property. This roadway is not apparent in the 1981 aerial photograph. In the 1992 aerial photograph, a square-shaped disturbance and driveway on the southeast portion of this Property are apparent. The locations of the disturbed areas are shown on Figure 5.

Property Northeast of Dam

From 1885 to 1951, the Property northeast of the dam contained small buildings/sheds related to the commercial establishments on Wisconsin Street. A "needle house" and "Guard Lock Skeleton Gates" were shown on the 1910 U.S. Government Map. From 1952 to 1964, this Property was open and vacant. In 1971, the Property was disturbed to construct an access road onto the Property.

Lock 1

The 1885, 1890, 1894, 1900, and 1906 Sanborn Maps show small outbuildings related to the adjoining lumber, paper, and hub-and-spoke manufacturing facilities on Lock 1 Property. The maps also show flumes related to these facilities crossing the Property and draining into the U.S. Canal. The 1910 U.S. Government Map shows a coal shed, warehouse, Lockmaster's dwelling, and barn immediately north of Lock 1. Small buildings associated with neighboring properties to the north of Lock 1, including a machine shop, are also shown on the Property. Buildings associated with the Union Bar and Paper Co. and Thilmany Paper Mill are also shown on the Property south of Lock 1. The neighboring property buildings on the northern portion of the Lock 1 Property remained on the Property until at least 1925. These buildings, including the machine shop, were removed from the Property by 1945. The 1952 and subsequent aerial photographs, and the 1956 Sanborn Map show an access road for Thilmany Paper on the southern shore of the Lock 1 Property. The areas of the Property used by adjacent commercial and industrial facilities are shown on Figure 5. In the 1981 aerial photograph, the large oil house, Lockmaster's dwelling, and garage are observed. The 1992 aerial photograph also shows a circular structure and a small area of surface disturbance/debris along the canal bank. The purpose of the circular structure is not known. During the site visit, the Lockmaster's dwelling, garage, large oil house, small oil house, and a lockshelter were observed at the Property.

Lock 2

The first map showing the area around Lock 2 is the 1910 U.S. Government Map. This map shows a Lockmaster's dwelling and a barn at the Property. The next documentation for this Property is the 1952 aerial photograph. This photograph shows the former Lockmaster's dwelling. A railroad track is also shown on the eastern portion of this Property. The railroad forms the boundary between the Lock 2 and Lock 3 Properties. The Property remained unchanged until at least 1957. In 1964, the former Lockmaster's dwelling was no longer at the Property. The lockshelter was first shown on the 1974 historic map. The oil house was first identified on the 1986 U.S. Government Map. The lockshelter and oil house were the only structures identified during the site inspection. The Lock 2 area is also known as the Kaukauna Depot 8. The Property was used for loading and unloading materials from barges. Details regarding the Kaukauna Depot 8 are included with this report in Section 5.6. Current and known historical structure locations are shown on Figure 5.

Lock 3

The first map showing the area around Lock 3 is the 1910 U.S. Government Map. This map shows the timber shed, dry dock, and garage with lean-to at their current locations. In addition, a shed, old pump house, shop, and outhouse were shown at the Property. A stone dock is also shown on the south side of the canal midway between Lock 3 and Lock 4. The 1952, 1957, and 1964 aerial photographs show similar structures as described on the 1910 map. Earth disturbances are evident on the 1964 aerial photograph at the present location of the project office. The project office is first shown on the 1974 historic map. The generator house, project office, timber shed, garage with lean-to, lockshelter, oil house, and dry dock are all apparent in the 1981 and 1992 aerial photographs. Current and known historical structure locations are shown on Figure 5.

Lock 4

The first map showing the area around Lock 4 is the 1910 U.S. Government Map. No buildings are shown on the Property on this map. The next documentation available for the Lock 4 Property is the 1957 aerial photograph. This photograph and the 1964,1971, and 1981 aerial photographs show the Lock 4 area as heavily wooded and no structures can be distinguished. The 1986 U.S. Government Map shows the lockshelter at the Property. The lockshelter and an oil house were observed during the site inspection.

Lock 5

The first map showing the area around Lock 5 is the 1910 U.S. Government Map. The Lockmaster's dwelling, a shed, water closet, barn, and two additional unidentified buildings are shown at the Property. The next documentation available for the Lock 5 Property is the 1957 aerial photograph. The Lockmaster's dwelling can be seen on this photograph and the 1964, 1971, and 1981 aerial photographs. The Lockmaster's dwelling and garage are shown on the 1986 U.S. Government Map. The Lockmaster's dwelling, garage, lockshelter, and oil house were observed during the site inspection. Current and known historical structure locations are shown on Figure 5.

5.5.3 Property Area Regulatory History

The Property (301 Canal Street) was identified as an Underground Storage Tank (UST) site and a RCRIS-small quantity generator (SQG) in the March 20, 2000 EDR report. The EDR report indicates one 500-

gallon leaded gasoline UST was closed/removed at the Property; no leaks from this former UST were reported at this Property address. No other USTs were indicated for the Property in the EDR report. No violations were found with respect to the RCRIS-SQG listing.

One adjacent site was identified as having the potential to impact the Property. Thilmany Pulp and Paper Co. is located south of and adjacent to the Property. Thilmany leases portions of the Property for use as their access road. The EDR report identifies this site as having two high-priority LUST releases with impacts to soil and groundwater. These LUST sites are not closed. Thilmany Pulp and Paper is also the site of a 42-acre landfill, an active waste disposal site, solvent releases, and numerous small petroleum releases. Details of these releases are documented in the EDR report (Appendix C-5). The location of the Thilmany Pulp and Paper property is shown on Figure 5. The exact locations of the releases associated with the Thilmany Pulp and Paper are not known.

5.5.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 Lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Thirteen (13) samples were collected for analysis from the Kaukauna Locks and Dam Lockmaster Dwelling and garage. Of the samples collected, five were identified as being ACM. Friable and non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. Non-friable can become friable during demolition activities. The locations of the ACM identified are as follows: exterior siding on house (non-friable), linoleum floor tile in bathroom (non-friable), ceiling plaster in second floor (friable), ceiling plaster in first floor (friable), and floor linoleum on basement landing (non-friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from the Kaukauna Locks and Dam area for density, organic carbon, grain size, and percent solids and two samples were selected for contaminant analyses. The contaminant samples contained PCB 1242 (1.4 and 9.4 mg/kg), arsenic (3.1 and 3.8 mg/kg), cadmium (2.2 and 3.6 mg/kg), chromium (58 and 140 mg/kg), copper (60 and 100 mg/kg), total cyanide (0.06 and 0.47 mg/kg), lead (160 and 230 mg/kg), mercury (0.67 and 3.7 mg/kg), nickel (18 and 21 mg/kg), oil and grease (4,200 and 5,600 mg/kg), and phenols (0.48 and 0.84 mg/kg).

5.5.5 Waste Management

The city of Kaukauna refuse handlers pick up all general refuse for the Fox River project. Recyclables are taken to the county recycling center. The Project Office previously contained a parts washer. SafetyKleen serviced and then removed the parts washer. SafetyKleen also disposes of fluorescent bulbs for the Fox River project.

The May 1977 Final Environmental Impact Statement for the Fox River listed primary sites for the disposal of dredged materials. One disposal site was listed for the Kaukauna Locks and Dam:

Dredging Location	Disposal Site	Ownership of Disposal Site	Dimension of Site	Approximate Year of Disposal
Channel below Kaukauna 5th lock	Left side of channel below Kaukauna 5th lock on existing dredge banks.	United States and State of Wisconsin	75'x1000'	1965

The location and use of this disposal site was verified by USACE personnel.

5.5.6 Property Inspection Summary

The Kaukauna Locks and Dam Property was inspected on April 12, 2000. Access to each portion of the Property is restricted by a locked chain-link fence. There are currently 23 buildings on the Property:

Lock 1 – Lockmaster dwelling, Lockmaster garage, large oil house, oil house, and lockshelter
Lock 2 – lockshelter and oil house
Lock 3 – lockshelter, abandoned building #1, abandoned building #2, generator building, compressed gas storage building, oil house, timber shed, garage with lean-to, project office, and sanitary facility
Lock 4 – oil house and lockshelter
Lock 5 – oil house, Lockmaster dwelling, garage, and lockshelter

The locations of these buildings are shown on Figure 5. The interiors of all buildings were inspected except the Lockmaster dwelling, garage, and lockshelter at Lock 1; lockshelter at Lock 2; abandoned building #2 and sanitary facility at Lock 3; and garage at Lock 5. USACE personnel indicated that the interior of these buildings were similar to other buildings inspected and no hazardous chemicals or petroleum products are currently used or stored in the buildings. Small vehicle maintenance is done at the project office at Lock 3. Compressed gas cylinders are stored at Lock 3. Paints, solvents, and petroleum products are stored in the project office for use on all of the Fox River project Properties. All floors and drains inspected were in good conditions and staining or spills were either not observed or very minimal.

The exterior areas of the Property parcels were primarily grass with concrete sidewalks near the locks and gravel driveways. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.5.7 Conclusions and Recommendations

- Abandoned Lockmaster's dwellings are present at Lock 1 and at Lock 5. There was a Lockmaster's dwelling at Lock 2 and a building with a well on the Property southwest of the dam. Though the locks are most likely now serviced by municipal water, it is likely that a well or wells previously serviced the Property. No records of well sealing are available for the Property. An unsealed well could act as a conduit if a release occurred at the Property. Unused wells should be located and properly abandoned. The potential presence of unsealed wells should be disclosed at the time of Property transfer.

- Thirteen (13) samples of building materials were collected for analysis from the Kaukauna Locks and Dam Lockmaster dwelling and garages. Of the samples collected, five were identified as being asbestos-containing-material (ACM). ACMs, if still present, should be removed prior to the demolition of any structures. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- Industrial/commercial activities previously occurred at the Property southwest of the dam (Kaukauna Water Power Company, railroad spur), northeast of the dam (small buildings and sheds related to the commercial buildings on Wisconsin Avenue), Lock 1 (small outbuildings related to the adjoining lumber, paper, and hub-and-spoke manufacturing facility, machine shop, Union Bar and Paper Co., Thilmany Paper Mill), and industrial flumes cross the Property at Lock 1. No records of investigations or remedial activities are available from the Wisconsin DNR for these historical activities. Due to the industrial use of the properties (likely petroleum and/or solvent use) and the proximity to the Property, there is a potential that these operations may have impacted the Property. The site inspection for the Property showed no visual evidence of contamination. Sampling is recommended to determine if the industrial activities impacted the soil.

- Possible filling activities occurred at the Property southwest of the dam between 1964 and 1971. It is not known what was filled. Samples should be collected and analyzed to determine the character of the filled material.

- Thilmany Pulp and Paper Co. (south of Cth Z/N of Cth Q) is located immediately south of Locks 1, 2, 3, and 4. This site is identified as a high-priority site for contamination to groundwater and soil due to releases from USTs and spills. This LUST site is not closed and impacts from this site to the Property are possible. The Thilmany Pulp and Paper Co. is also identified as a WDS site where solid or hazardous wastes have been or may have been deposited and as an ERP site (solvents, fuel oil, and turpentine). Impacts to the Property are also possible from non-petroleum releases at this site. Samples should be collected and analyzed to determine if offsite migration is impacting the Property.

- The 1989 sediment investigation conducted by the U.S. Corp of Engineers found heavy metals and concentrations of PCBs in the sediment within the Kaukauna locks. The 1977 EIS report (REF. 18) indicated that sediments were dredged from the canal and placed on the left side of the channel below Lock 5 in approximately 1965. The 1989 analytical data was for samples of sediment retrieved from the base of the channel. No recommendations are proposed for the channel material.

  Because heavy metals and PCBs were present in the sediment in 1989, it is possible that heavy metals and/or PCBs may be present in the sediment dredged in approximately 1965 and placed on the Property. No analytical data is available for the sediment placed on the Property. Analytical samples should be collected and analyzed to determine the quality of this material.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving removal of paint shall comply with OSHA guidance. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

5.5.8 Classification Determination

This Property is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. These specific areas of concern are related to the sediment dredge spoils that were disposed at the Property, the possible fill area on the parcel Southwest of the Dam, and the industrial activities that occurred adjacent to and on the Property. A specific area of concern is related to the industrial activities that occurred adjacent to the Property at Thilmany Pulp and Paper.

5.6 Kaukauna Depot 8

5.6.1 Property Information

The Property is located on Augustine Street in Kaukauna, Wisconsin. The Property is approximately 2 acres in size. The layout of the Property is shown on Figure 6.

5.6.2 Property History

Lock 2 was built in 1903. The first map showing the area around the Kaukauna Depot 8 (Lock 2) is the 1910 U.S. Government Map. This map shows a Lockmaster's dwelling and a barn at the Property. The next documentation for this Property is the 1952 aerial photograph. This photograph shows the former Lockmaster's dwelling. A railroad track is also shown on the eastern portion of this Property. The railroad forms the boundary between the Lock 2 and Lock 3 Properties. The Property remained unchanged until at least 1957. In 1964, the former Lockmaster's dwelling was no longer at the Property. The lockshelter was first shown on the 1974 historic map. The oil house was first identified on the 1986 U.S. Government Map. The lockshelter and oil house were the only structures identified during the site inspection. The Lock 2 area is known as the Kaukauna Depot 8. The Property was used for loading and unloading materials from barges. Current and known historical structure locations are shown on Figure 6.

5.6.3 Property Area Regulatory History

The Kaukauna Depot 8 (Lock 2) was not identified as being on any of the regulatory lists searched by EDR as reported on the March 20, 2000 EDR report for the Property.

One adjacent site was identified as having the potential to impact the Property. Thilmany Pulp and Paper Co. is located south of and adjacent to the Property. Thilmany leases portions of the Property for use as their access road. The EDR report identifies this site as having two high-priority LUST releases with impacts to soil and groundwater. These LUST sites are not closed. Thilmany Pulp and Paper is also the site of a 42-acre landfill, an active waste disposal site, solvent releases, and numerous small petroleum releases. Details of these releases are documented in the EDR report (Appendix C-5). The location of Thilmany Pulp and Paper is shown on Figure 6. The exact locations of the releases associated with the Thilmany Pulp and Paper property are not known.

5.6.4 Previous Environmental Investigations

No previous investigations for the Kaukauna Depot 8.

5.6.5 Waste Management

No waste is currently generated at the Kaukauna Depot 8. There is no information available which may indicate that dredge material was disposal of at this Property.

5.6.6 Property Inspection Summary

The Kaukauna Depot 8 Property was inspected on April 12, 2000. A gravel driveway services the Property. Access to the Property is restricted by a locked chain-link fence. There are currently two buildings on the Property: lockshelter and oil house. The locations of these buildings are shown on Figure 6. The interiors of all oil house was inspected, but the interior of the lockshelter could not be accessed. USACE personnel indicated that the interior of this building was similar to other lockshelters inspected and no hazardous chemicals or petroleum products are currently used or stored in the dwelling. Paint and petroleum products were previously stored in the oil house. Currently no hazardous substances or petroleum products are used or stored at the Property. The floor of the oil house was in good condition and staining or spills were not observed.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.6.7 Conclusions and Recommendations for Kaukauna Depot 8

- There was a Lockmaster's dwelling at Lock 2. It is likely that this dwelling had a well. No records of well sealing are available for the Property. An unsealed well could act as a conduit if a release occurred at the Property. The unused well should be sealed and properly abandoned. The possible presence of an unsealed well should be disclosed at the time of Property transfer.

- Thilmany Pulp and Paper Co. (south of Cth Z/N of Cth Q) is located immediately south of the Kaukauna Depot 8 (Lock 2). This site is identified as a high priority site for contamination to groundwater and soil due to releases from USTs and spills. This LUST site is not closed and impacts from this site to the Property are possible. The Thilmany Pulp and Paper Co. is also identified as a WDS site where solid or hazardous wastes have been or may have been deposited and as an ERP site (solvents, fuel oil, and turpentine). Impacts to the Property are also possible from non-petroleum releases at this site. Samples should be collected and analyzed to determine if the Property has been impacted by this offsite source.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving removal of paint shall comply with OSHA guidance. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

5.6.8 Classification Determination

Kaukauna Depot 8 is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. These specific areas of concern are related to the industrial activities that occurred adjacent to the Property at Thilmany Pulp and Paper.

5.7 Little Chute Locks and Dam

5.7.1 Property Information

The Little Chute Locks and Dam Property is located between 214 Mill Street and the end of Sanitorium Road in Little Chute, Wisconsin. The Property covers 42.48 acres total. The layout of the Property is shown on Figure 7.

5.7.2 Property History

The original service date for the Little Chute Locks and Dam was 1852. Improvements were completed in 1874, 1932, and 1974. The guard lock, second lock, the spillway north of second lock, dam, combined locks, guard lock and combined locks Lockmasters' dwellings, two small buildings at the combined locks and an unidentified building south of second lock (lockshelter) were observed on the 1910 U.S. Government Map. Zeeland Mill and one support building are located just south of the property just off the north edge of the dam. Approximately one-half of the unidentified support building is on U.S. Government Property. Current and known historical structure locations are shown on Figure 7.

The 1925 Sanborn Map indicates that the Guard Lock is out of service. Other than change to the Property, site structures stayed fairly constant between 1910 and the present. Small support buildings were constructed and taken down during this time period, but the larger buildings remained at the current locations.

The 1910 to 1971 Primary Resources indicate that the current park softball field area was a lagoon area. The Village of Little Chute filled this area in during 1971. A village public works employee indicated that the city used clean clay backfill material from a road/subdivision construction project in Little Chute to fill this lagoon area. The location of this filled area is shown on Figure 7.

5.7.3 Property Area Regulatory History

The Little Chute Locks and Dam Property was not identified as being on any of the regulatory lists searched by EDR as reported in the March 20, 2000 EDR report for this Property.

One adjacent site was identified as a property with the potential to impact the Property. 200 Sanitarium Road is identified as a high-priority UST and LUST site with impacts to soil and groundwater. This site has not been closed.

5.7.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The

asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Forty-one (41) samples were collected for analysis from the Little Chute Locks and Dam (and Combined Locks) Lockmaster Dwellings and garages. Of the samples collected, 12 were identified as being ACM. Friable and non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. Non-friable ACM can become friable during demolition activities. The locations of the ACM identified are as follows for the Combined Locks Lockmaster Dwelling: linoleum floor tile in kitchen (non-friable), wall stucco (friable), linoleum floor tile in bathroom (non-friable), and bedroom closet floor linoleum (non-friable). The locations of the ACM identified are as follows for the Little Chute Lockmaster Dwelling: pipe run insulation 4"-6" (friable), pipe fittings on TPA (friable), pipe run insulation 6" (friable), pipe fittings on TPB (friable), brown floor linoleum (non-friable), olive-green dining room floor linoleum (non-friable), basement landing linoleum (non-friable, and second floor ceiling plaster (friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from the Little Chute Lock area for density, organic carbon, grain size, and percent solids and two samples were selected for contaminant analyses. The contaminant samples contained PCB 1242 (2.0 and 30 mg/kg), arsenic (3.2 and 3.6 mg/kg), cadmium (4.5 and 1.4 mg/kg), chromium (110 and 30 mg/kg), copper (100 and 110 mg/kg), lead (70 and 190 mg/kg), mercury (0.75 and 3.2 mg/kg), nickel (11 and 22 mg/kg), oil and grease (1,800 and 6,400 mg/kg), and phenols (0.56 and 0.80 mg/kg). The reported PCB concentrations for Little Chute do not exceed TSCA criteria for "toxic" (50 mg/kg). However, the 30 mg/kg reported concentration of PCBs indicates that, statistically, the possibility of higher concentrations exists.

5.7.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. The May 1977 Final Environmental Impact Statement for the Fox River listed primary sites for the disposal of dredged materials. One disposal site was listed for Little Chute:

Dredging Location	Disposal Site	Ownership of Disposal Site	Dimension of Site	Approximate Year of Disposal
Channel below Little Chute Combined Locks	Left side of channel below Little Chute Combined Locks	United States and State of Wisconsin	50' x 400'	1968

The location and use of this disposal site was verified by USACE personnel.

5.7.6 Property Inspection Summary

The Little Chute Locks and Dam Property was inspected on April 14, 2000. Gravel driveways service the Property. Access to the Property buildings is restricted by locked chain-link fencing. There are currently 11 USACE buildings on the Property:

Guard Lock – Lockmaster dwelling, Lockmaster garage, bridge tenders house, sanitary facility oil house, and lockshelter.
Combined Locks – Lockmaster dwelling, Lockmaster garage, sanitary facility, oil house, and lockshelter

The locations of these buildings are shown on Figure 7. The interiors of the Lockmaster dwellings, garages, oil houses, sanitary facilities, and the lockshelters were not inspected. Vandalism has been a problem at this location and these buildings were boarded up. USACE personnel indicated that the interiors of these building were similar to other buildings inspected and no hazardous chemicals or petroleum products are currently used or stored in these buildings. Paint and petroleum products were previously stored in the oil houses and fuel oil was previously stored in ASTs in the basements of the Lockmaster dwellings. Currently no hazardous substances or petroleum products are used or stored at the Property. All floors and drains inspected were in good conditions and staining or spills were not observed.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.7.7 Conclusions and Recommendations

- Municipal water was not available to the Property until the 1930s or 1940s. The Property has supported lockmaster dwellings since at least 1910. It is likely that a well or wells previously serviced the Property. No records of well sealing are available for the Property. An unsealed well could act as a conduit if a release occurred at the Property. Unused wells should be located and properly abandoned. The potential presence of unsealed wells should be disclosed at the time of Property transfer.

- Forty-one (41) samples of building materials were collected for analysis from the Little Chute locks and dam Lockmaster dwellings and garages. Of the samples collected, 12 were identified as being asbestos-containing-material (ACM). ACMs, if still present, should be removed prior to demolition. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- 200 Sanitorium Road is located approximately 1/8 mile upgradient of the Property. This site is classified as high priority by the state and soil and groundwater has been impacted at this site. Based on the reports of soil and groundwater impact and the distance from the Property, this site has the potential to impact the Property. Samples should be collected and analyzed to verify that offsite migration to the Property is not impacting the Property.

- The 1989 sediment investigation conducted by the U.S. Corp of Engineers found heavy metals and concentrations of PCBs in the sediment immediately upstream and downstream from the locks. A concentration of 30 mg/kg PCB 1242 was reported in one of the samples collected from the Little Chute Locks area. The 1989 analytical data was for samples of sediment retrieved from the base of

the channel. An area previously underwater downstream from the Guard Lock is now dry and accessible. This area was one of the areas sampled and analyzed in 1989. Analytical samples should be collected and analyzed to determine the quality of material exposed.

- Because heavy metals and PCBs were present in the sediment in 1989, it is possible that heavy metals and/or PCBs may be present in the sediment dredged in approximately 1968 and placed on the Property. No analytical data is available for the sediment placed on the Property. Sediments were dredged in approximately 1968 from the canal and placed on the southern bank of the U.S. Canal. Analytical samples should be collected and analyzed to determine the quality of these sediments.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving the removal of paint should comply with OSHA Standards. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

- Industrial/commercial properties have historically operated on and immediately adjacent to the Property (Zeeland Mill, Little Chute Flour Mill, Little Chute village maintenance garage, and the Little Chute sewage treatment plant). No records of investigations or remedial activities are available from the Wisconsin DNR for these properties. Due to the industrial use of the properties (likely petroleum and/or solvent use) and the proximity to the Property, there is a potential that these operations may have impacted the Property. The site inspection for the Property showed no visual evidence of contamination. Sampling is recommended to determine if these industrial activities impacted the soil.

5.7.8 Classification Determination

Little Chute is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. These specific areas of concern are related to the sediment dredge spoils that were disposed at the Property, the sediment area downstream of the Guard Lock, the adjacent LUST site, and the industrial activities that occurred adjacent to and on the Property.

5.8 Cedars Lock and Dam

5.8.1 Property Information

The Cedars Lock and Dam Property is located at 1169 West Main Street in Little Chute, Wisconsin. The Property covers 3.21 acres. The layout of the Property is shown on Figure 8.

5.8.2 Property History

The Cedars lock has been at the current location since at least 1852. A "U.S. Lock House" and three small buildings are observed on the 1910 historical map. None of these buildings remain on the Property. The current Lockmaster dwelling was constructed in 1911. The lockshelter was constructed in the 1930s. The lockmaster garage and oil house first appear on the 1981 aerial photograph. Current and known historical structure locations are shown on Figure 8.

5.8.3 Property Area Regulatory History

The Cedars Locks and Dam Property was not identified as being on any of the regulatory lists searched by EDR as reported in the March 14, 2000 EDR report. No adjacent properties were identified as having the potential to impact the Property.

5.8.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Eleven (11) samples were collected for analysis from the Cedars Locks and Dam Lockmaster Dwelling and garage. Of the samples collected, two were identified as being ACM. Non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. However, non-friable ACM can become friable during demolition activities. The locations of the ACM identified are as follows: laundry and basement landing floor linoleum (non-friable) and roof shingle (non-friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from Cedars lock for density, organic carbon, grain size, and percent solids and one sample was selected for contaminant analyses. The sample contained PCB 1242 (7.4 mg/kg), arsenic (3.3 mg/kg), cadmium (2.8 mg/kg), chromium (52 mg/kg), copper (53 mg/kg), lead (97 mg/kg), mercury (0.76 mg/kg), nickel (17 mg/kg), oil and grease (4,300 mg/kg), and phenols (0.38 mg/kg).

5.8.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. There is no information available which may indicate that dredge material was disposal of at this Property.

5.8.6 Property Inspection Summary

The Cedars Lock and Dam Property was inspected on April 13, 2000. A gravel driveway services the Property. Access to the Property is restricted by a locked chain-link fence. There are currently four buildings on the Property: Lockmaster dwelling, Lockmaster garage, oil house, and a lockshelter. The locations of these buildings are shown on Figure 8. The interiors of all buildings were inspected except the lockshelter. USACE personnel indicated that the interior of this building was similar to other lockshelters inspected and no hazardous chemicals or petroleum products are currently used or stored in the building. Paint and petroleum products were previously stored in the oil house and fuel oil was previously stored in an AST in the basement of the Lockmaster's dwelling. Currently no hazardous substances or petroleum products are used or stored at the Property. All floors and drains inspected were in good conditions and staining or spills were not observed.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.8.7 Conclusions and Recommendations

- An unsealed/unused well remains at the Property. The well could act as a conduit to drinking water supplies if there was a release at the Property. If the Property well is not going to be used, it should be properly abandoned. The presence of an unsealed well should be disclosed at the time of Property transfer.

- Non-friable asbestos-containing materials were identified at the Property. ACMs, if still present, should be removed prior to demolition of any structures. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- Because of the age of the Property buildings, it is likely that lead-based paint has been used on Property structures. Any renovations involving removal of paint will need to comply with OSHA guidelines. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

- One septic system is currently on the Property. Details regarding the construction of the system are not known. No recommendations regarding the septic system are proposed except that the presence of a septic system should be disclosed at the time of Property transfer.

5.8.8 Classification Determination

The Cedars Lock and Dam Property is identified as a Type 1 property type. This classification is proposed because the Phase I Environmental Site Assessment and EBS activities did not identify areas with releases or suspected releases of hazardous substances or petroleum products or their derivatives.

5.9 Appleton Locks and Dam

5.9.1 Property Information

The Appleton Locks and Dam Property consists of six parcels. These Property parcels are referred to as Lock 1, Lock 2, Lock 3, Lock 4, former U.S. Government Offices and Storage Area, and West of the Dam. The Property consists of 16.8 acres. The layout of the Property is shown on Figure 9.

5.9.2 Property History

The primary resources reviewed for this assessment show that Locks 1, 2, 3, and 4 have occupied their current locations since at least 1883. The Mississippi & Green Bay Canal Co. Warehouse and platform are shown on the 1883 map at the future location of the U.S. Government office and warehouse.

Lock 1

On the 1910 map of the site, five buildings are shown at Lock 1: U.S. Warehouse, U.S. Timber Shed, bath, U.S. Lock Tender's House and an unidentified small building on the northwest corner of Lock 1. On the 1938 and 1957 aerial photographs, three or four buildings, including the Lockmaster dwelling, were observed near Lock 1 on government property. The area south of Lock 1 was heavily treed by 1964, and site buildings could not be discerned in the 1964, 1971, or 1981 aerial photographs; however, it is likely that the Lockmaster dwelling remained unchanged during this time period. The 1984 historic map showed the Lockmaster dwelling in the current location and one additional smaller building. The 1986 Corp of Engineers map shows current locations of Lockmaster dwelling, two garages, and oil house. A fifth unidentified building is also shown at the southwest corner of Lock 1. In the 1992 aerial photograph, the Lockmaster dwelling, one garage, and two smaller buildings can be observed near Lock 1. During the site visit, six buildings were present at Lock 1: Lockmaster dwelling, two garages, sanitary facility, lockshelter, and oil house. Current and known historical structure locations are shown on Figure 9.

U.S. Government Offices and Storage Area

The 1938, 1957, 1964, and 1971 aerial photographs showed the former U.S. Government office and storage building immediately west of Oneida Street and north of the U.S. Canal. The 1883 and 1886 Sanborn Maps identify these buildings as the Mississippi & Green Bay Canal Company Warehouse and platform and Edison Electric Light Company offices. The 1891, 1895, and 1901 Sanborn Maps identify these buildings as the Canal Co. Warehouse and platform and Edison Electric Light Company. The 1910 map shows a "turning basin" (widening of the river), U.S. Public Dock, and U.S. Public warehouse north of U.S. Canal and between current Oneida Skyline and Oneida Street. The 1911, 1924, and 1950 Sanborn Maps identified the buildings as U.S. Government storage and offices. These buildings were not seen in the 1981 aerial photograph. USACE personnel indicated that the buildings were removed in 1976 or 1977. During the site inspection, this parcel was observed to have landscaping and park benches. The locations of the former industrial/commercial uses of the Property are shown on Figure 9.

Lock 2

No buildings were shown at Lock 2 on the aerial photographs, historical maps, or historic maps used as primary resources through 1910. A "Lock Tenders Dwelling" and three additional small buildings are shown on the north side of the U.S. Canal approximately 300 feet east of Lock 2 on the 1910 U.S. Government map. This map is the only resource showing buildings at this location. No additional buildings are shown until the 1986 U.S. Government map. During the site visit, three buildings were present at Lock 2: lockshelter, oil house, and a flume house operated by Wisconsin Electric. Current and known historical structure locations are shown on Figure 9.

Lock 3

The Lockmaster dwelling at Lock 3 was first identified at the current location west of Lawe Street on the 1886 Sanborn Map. Two additional small buildings were added to the Lock 3 property by 1891. By 1895 only the lock, Lockmaster dwelling and one small building remained on the Property and, in 1924, only the Lockmaster dwelling was present on the parcel west of Lawe Street. Historical references show that the Lock 3 parcel remained unchanged until 1964, at which time construction began on the current garage. Two small buildings (lockshelter and oil house) were first observed at Lock 3 in the 1992 aerial

photograph. During the time of the site inspection, six buildings were observed at Lock 3: lockshelter, oil house, bridge control building, sanitary facility, garage, and Lockmaster dwelling. Current and known historical structure locations are shown on Figure 9.

The portion of the Lock 3 parcel immediately south of the lock was previously occupied by a toy and furniture manufacturing facility. The first documentation of this factory was on the 1883 Sanborn Map. The factory operated under the following names between 1883 and 1970: Appleton Toy Factory, Union Toy and Furniture, Appleton Toy and Furniture, and Appleton Juvenile Furniture. The historical Sanborn Maps indicate that numerous woodworking buildings and painting buildings formerly occupied the Property. The 1970 Sanborn Map shows the factory buildings and indicates that the factory is vacant. By 1971 buildings were being removed from the Property and, by 1981, no buildings remained. [redacted] indicated that the former factory was filled in with gravel and the foundations remain in place. The adjacent paper mill now leases this portion of the Property for parking. The area formerly occupied by the toy/furniture factory is shown on Figure 9.

Lock 4

A Lockmaster dwelling and two small buildings were shown adjacent to Lock 4 on the 1895 Sanborn Map. The 1901 Sanborn Map showed one dwelling and one small building. Only one dwelling was shown at Lock 4 on the 1910 U.S. Government map and the 1924 and 1950 Sanborn maps. No lock service buildings were observed in the 1964 or 1981 aerial photographs or 1971 Sanborn Map. During the time of the Property inspection, three buildings were observed: oil house, sanitary facility, and lockshelter.

The powerhouse for the Manufacturing Investment Co. paper and pulp mills (currently MI Drilling Fluids) was shown on Lock 4 property on the 1891 and 1895 Sanborn Maps. The owner of this powerhouse was identified as Interlake Pulp and Paper Mill on the 1901 and 1911 Sanborn Maps and as Consolidated Water Power and Paper Co. in 1924, 1950, and 1970. The 1955 historical map first shows large ASTs partially on the Property southeast of Lock 4. The contents of the ASTs are not identified on the 1955 historical map. The tanks remained at the site until prior to 1992. The 1970 Sanborn Map indicated that the largest AST was used as a "settling basin." The 1992 aerial photograph showed fewer industrial buildings immediately east of Lock 4 at the current MI Drilling Fluids location. The area used by the former paper/pulp mills is shown on Figure 9.

West of the Dam

The 1891 Sanborn Map showed the Champion Pulp Co. machine room and head race and a railroad switch on the property west of the dam. The 1895 Sanborn Map identified the machine room as vacant. The 1910 U.S. Government map showed an "Old Sawmill" on the property west of the dam. By 1911, the parcel west of the dam contained a grinding water wheel owned by Interlake Paper Co. and the railroad switch. In the 1938 and subsequent aerial photographs, the parcel west of the dam appears vacant. The area of the Property used by the former industrial facilities is shown on Figure 9.

5.9.3 Property Area Regulatory History

The Appleton Locks and Dam Property was not identified on any of the regulatory lists searched by EDR as reported in the March 16, 2000 EDR report; however, the Lockmaster's dwelling at Lock 1 was a former release site. The site was not found on the regulatory lists searched.

Riverside Paper Corp. (800 S. Lawe Street) is located immediately north of the U.S. Canal between Locks 2 and 3. This site is identified as a high-priority site for contamination to groundwater and soil due to releases from USTs and spills. The location of this site is shown on Figure 9.

5.9.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 Lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Thirty-eight (38) samples were collected for analysis from the Appleton Locks and Dam Lockmaster dwelling and garages. Of the samples collected, eight were identified as being ACM. Friable and non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. Non-friable ACM can become friable during demolition activities. The locations of the ACM identified are as follows for the Lower Appleton Lockmaster Dwelling: exterior siding on house (non-friable), kitchen floor linoleum (non-friable), and linoleum under sink in upstairs bathroom (non-friable). The locations of the ACM identified are as follows for the Upper Appleton Lockmaster Dwelling: exterior siding on house (non-friable), floor linoleum in laundry room, kitchen, and pantry (non-friable), floor linoleum in bathroom (non-friable), aircell insulation in basement (friable), and pipe fittings on TPA (friable).

On December 5, 1990, the Wisconsin DNR notified the USACE that a potential release at the 1st Lock Dwelling site should be investigated and remediated. The identified release was related to an underground fuel oil storage tank at the Lockmaster dwelling. These investigations and remediation were accomplished. On March 28, 1997, the Northeast Region Closeout Committee (Wisconsin DNR) determined that the site had been remediated in compliance with the requirements of chs. NR 700 to 724, Wis. Adm. Code and determined that the site was "closed" and that no further action was necessary at that time. The April 22, 1997, letter indicated that the site monitoring wells needed to be abandoned. The January 20, 1998, letter from Coleman Engineering Co. indicated that site monitoring wells were abandoned and that site closure was complete.

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from the Appleton Locks Lock area for density, organic carbon, grain size, and percent solids and one sample was selected for contaminant analyses. The contaminant sample contained PCB 1242 (4.4 mg/kg), arsenic (2.1 mg/kg), cadmium (1.1 mg/kg), chromium (31 mg/kg), copper (41 mg/kg), lead (91 mg/kg), mercury (0.54 mg/kg), nickel (11 mg/kg), oil and grease (2,800 mg/kg), and phenols (0.11 mg/kg).

5.9.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. The May 1977 Final Environmental Impact Statement for the Fox River listed primary sites for the disposal of dredged materials. Two disposal sites were listed for the Appleton Navigation Canal:

Dredging Location	Disposal Site	Ownership of Disposal Site	Dimension of Site	Approximate Year of Disposal
Between 1st and 2nd Locks	Right side of canal on existing bank above Lock 2	United States	30' x 200'	1967
Below 4th Lock	Left side of Channel below Lock 4 on existing dredge banks	United States	50'x400'	1968

The location and use of these disposal sites were verified by USACE personnel. USACE personnel also stated that, historically, the paper/pulp mills north of the U.S. Canal between Locks 2 and 3 disposed "clinkers" on the Property. The clinkers were waste products from the mill processes. The USACE representative also stated that the paper companies that previously operated on the southern portion of the Lock 4 parcel would discharge "chemicals" from the ASTs on the south portion of the parcel through pipes along the riverbank.

5.9.6 Property Inspection Summary

The Appleton Locks and Dam Property was inspected on April 13, 2000. Access to the Property buildings is restricted by a locked chain-link fencing. There are currently 18 buildings on the Property:

Lock 1 – Lockmaster dwelling, Lockmaster garage #1, Lockmaster garage #2, oil house, sanitary facility, lockshelter
Lock 2 – lockshelter, oil house, flume house operated by Wisconsin Electric and Power
Lock 3 – lockshelter, oil house, Lockmaster dwelling, Lockmaster garage, bridge control building, sanitary facility
Lock 4 – oil house, sanitary facility, lockshelter

The locations of these buildings are shown on Figure 9. The interiors of all buildings were inspected except the Lockmaster dwelling at Lock 1; oil house and lockshelter at Lock 2; and lockshelter, Lockmaster dwelling, garage, and sanitary facility at Lock 3. USACE personnel indicated that the interior of these buildings were similar to others inspected and no hazardous chemicals or petroleum products are currently used or stored in the buildings. Currently no hazardous substances or petroleum products are used or stored at the Property. All floors and drains inspected were in good conditions and staining or spills were not observed or were minimal.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific

observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.9.7 Conclusions and Recommendations

- Abandoned Lockmaster's dwellings are present at Lock 1 and at Lock 3. There were historically Lockmaster's dwellings at Lock 4 and north of the U.S. Canal midway between Lock 2 and Lock 3. There were also offices at the Former U.S. Government offices and warehouse parcel northeast of Lock 1. Though the locks are most likely now serviced by municipal water, it is likely that a well or wells previously serviced the Property. No records of well sealing are available for the Property. An unsealed well could act as a conduit if a release occurred at the Property. Unused wells should be located and property abandoned. The potential presence of unsealed wells should be disclosed at the time of Property transfer.

- Thirty-eight (38) building material samples were collected for analysis from the Appleton Locks and Dam Lockmaster dwelling and garages. Of the samples collected, eight were identified as being asbestos-containing-material (ACM). ACMs, if still present, should be removed prior to any demolition activities. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- Industrial/commercial activities previously occurred on U.S. Government property at the U.S. Government office and storage area (Edison Electric Light Company offices and platform), north of the U.S. Canal between Lock 2 and Lock 3 (paper/pulp mill activities and "clinker" disposal), immediately south of Lock 3 (toy and children's furniture factory, including painting activities), immediately south of Lock 4 (large ASTs on the Property, power house, and reported chemical discharge), and on the parcel west of the dam (Champion Pulp Co. machine room/ headrace, "Old Sawmill," Interlake Paper Co. grinding water wheel). There are no records of investigations or remedial activities related to the commercial/industrial activities available from the Wisconsin DNR. The historical activities have the potential to have impacted the Property. The site inspection for this Property showed no visual evidence of contamination. Sampling is recommended to determine if industrial activities impacted the soil.

- Riverside Paper Corp. (800 S. Lawe Street) is located immediately north of the U.S. Canal between Locks 2 and 3. This site is identified as a high-priority site for contamination to groundwater and soil due to releases from USTs and spills. The site is not closed by the state of Wisconsin and impacts from this site to the Property are possible. "Clinkers" produced in this paper plant have been historically disposed of on the Property. Samples should be collected and analyzed to determine if contaminants from this site have migrated onto the Property.

- Consolidated Paper formerly operated at the current location of MI Drilling immediately adjacent to Lock 4. This site historically contained numerous large ASTs containing petroleum products and other chemicals. This site was also the source of "chemical spills" on the Property described in the third bullet. Samples should be collected and analyzed to determine if contaminants from this site have migrated onto the Property.

- The 1989 sediment investigation conducted by the U.S. Corp of Engineers found heavy metals and concentrations of PCBs in the sediment in the channel between the Appleton Locks. No recommendations are proposed for sediment near the Property in the channel except that the presence of impacted sediment should be disclosed at the time of Property transfer.

- The 1977 EIS report indicated that sediments were dredged from the channel and placed on the right side of the canal on the existing bank above Lock 2 and on the left side of the channel below Lock 4 on existing dredge in approximately 1967 and 1968. The 1989 analytical data was for samples of sediment retrieved from the base of the channel. Because heavy metals and PCBs were present in the sediment in 1989, it is possible that heavy metals and/or PCBs may be present in the sediment dredged in approximately 1967 and 1968 and placed on the Property. No analytical data is available for the sediment placed on the Property. Analytical samples should be collected and analyzed to determine the quality of this sediment.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving removal of paint will need to comply with OSHA guidelines. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

- The status/history of sanitary sewer service to the Property is unclear. Abandoned Lockmaster's dwellings are present at Lock 1 and at Lock 3. There were historically Lockmaster's dwellings at Lock 4 and north of the U.S. Canal midway between Lock 2 and Lock 3. There were also offices at the Former U.S. Government offices and warehouse parcel northeast of Lock 1. Though the locks are most likely now serviced by sanitary service, it is likely that multiple septic systems previously serviced the Property. No records of septic system abandonments are available for the Property. No recommendations regarding the historical septic systems are proposed except that the presence of potential septic systems should be disclosed at the time of Property transfer.

- The portion of the U.S. Canal at the historical location of the U.S. Government offices and warehouses was previously a "turning basin." It is possible that waste material or debris was used to fill this area. Samples should be collected and analyzed to determine the character of the filled material.

- The head race that was previously located on the parcel west of the dam was filled in with unknown materials. It is possible that waste material or debris was used to fill this area. If granular soil was used to fill the head race, this channel may act as a conduit for any releases that may have occurred at the Property. Samples should be collected and analyzed to determine the character of the material placed on the Property.

5.9.8 Classification Determination

Appleton is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. These specific areas of concern are related to the sediment dredge spoils that were

disposed at the Property, industrial activities that occurred adjacent to the Property, clinker disposal on the Property, industrial activities that occurred on the Property (toy factory), reported chemical discharges on the parcel south of Lock 4, and the fill material that was used to fill the turning basin and the former head race.

5.10 Brothertown Harbor

5.10.1 Property Information

The Brothertown Harbor Property is located on Harbor Road in Brothertown, Wisconsin. The parcel is comprised of 0.2 acres. The layout of the Property is shown on Figure 10.

5.10.2 Property History

The Brothertown Harbor is visible on historical maps as early as 1910. Between 1962 and 1971, the dike was extended farther out into the Harbor.

5.10.3 Property Area Regulatory History

The Property was not identified on any of the regulatory lists searched by EDR and reported in the March 14, 2000 EDR report. Nor were adjacent sites of concern identified.

5.10.4 Previous Environmental Investigations

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, two samples were collected from Brothertown Harbor for density, organic carbon, grain size, and percent solids and one sample was selected for contaminant analyses. The contaminant sample did not contain PCBs. The sample did contain arsenic (0.88 mg/kg), cadmium (0.47 mg/kg), chromium (6.8 mg/kg), copper (6.0 mg/kg), lead (6.9 mg/kg), nickel (5.1 mg/kg), oil and grease (1,500 mg/kg), and phenols (0.12 mg/kg). The concentrations of metals and other parameters are consistent with background concentrations.

5.10.5 Waste Management

No waste is generated at the Property. There is no evidence of sediment/dredge disposal at the Property. Company records show that dredging was completed in the Harbor in 1962 (4,320 c.y.), 1966 (3,435 c.y.) and 1970 (2,550 c.y.). All material dredged was placed directly in trucks and shipped away by the county for disposal.

5.10.6 Property Inspection Summary

The Brothertown Harbor Property was inspected on April 14, 2000. A gravel driveway services the Property. Access to the Property is not restricted. There are no buildings on the Property. Currently no hazardous substances or petroleum products are used or stored at the Property.

The exterior areas of the Property are covered primarily with grass and a gravel driveway. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific

observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.10.7 Conclusions and Recommendations

No recognized environmental conditions were identified for the Brothertown Harbor Property. Therefore, no conclusions or recommendations are presented.

5.10.8 Classification Determination

The Brothertown Harbor Property is identified as a Type 1 property type. This classification is proposed because the Phase I Environmental Site Assessment and EBS activities did not identify areas with releases or suspected releases of hazardous substances or petroleum products or their derivatives.

5.11 Menasha Lock

5.11.1 Property Information

The Menasha Lock is located at 82 Broad Street in Menasha, Wisconsin. The Property is comprised of 0.7 acres. The layout of the Property is shown on Figure 11.

5.11.2 Property History

The original service date for the Menasha lock was 1852 with improvements completed in 1876, 1937, 1949, 1951, 1958, 1962, 1967, 1971, 1974, 1979, and 2000. The lockmaster dwelling has been at the current location since at least 1910. Two additional buildings were located on the 1910 U.S. Government Map, these are no longer on the Property. The uses of these buildings are not known. The lockmaster garage, sanitary facility, oil house, and lockshelter have all been at their current locations since at least 1981. Property use has remained consistent since at least 1852. Current and known historical structure locations are shown on Figure 11.

5.11.3 Property Area Regulatory History

The Property was not identified on any of the regulatory lists searched by EDR and reported in the March 14, 2000 EDR report. No adjacent properties were identified that have the potential to impact the Property.

5.11.4 Previous Environmental Investigations

Environmental Science & Engineering, Inc. conducted asbestos inspections of 10 lockmaster dwellings and associated outbuildings under contract to the U.S. Army Corps of Engineers in November 1993. The asbestos inspections included sampling and analysis of all suspect asbestos-containing material from the dwellings and associated outbuildings located along the Fox River in Wisconsin. Seven (7) samples were collected for analysis from the Menasha Lock Lockmaster dwelling and garage. Of the samples collected, two were identified as being ACM. Non-friable ACMs were found. Friable ACM is material which may easily become airborne if touched or disturbed. Non-friable ACM is intact. However, non-friable ACM can become friable during demolition activities. The locations of the ACM identified are as follows: exterior siding on house (non-friable) and floor linoleum in first floor bathroom (non-friable).

A Level I survey intended to produce overall gross characterization of the shoal sediments within the Fox River and Lake Winnebago system was conducted in May 1989. Of the locations sampled for the Fox River project, three samples were collected from the Menasha Lock area for density, organic carbon, grain size, and percent solids and three samples were selected for contaminant analyses. The contaminant samples contained PCB 1242 (1.4-4.3 mg/kg), PCB 1254 (2.5 mg/kg), arsenic (0.86-4.6 mg/kg), cadmium (0.43-1.8 mg/kg), chromium (11-48 mg/kg), copper (11-69 mg/kg), total cyanide (0.08-0.29 mg/kg), lead (33-190 mg/kg), mercury (0.08-0.88 mg/kg), nickel (8.1-18 mg/kg), oil and grease (1,700-5,000 mg/kg), and phenols (0.14-0.27 mg/kg).

5.11.5 Waste Management

Any waste generated at the Property is taken to the Kaukauna Lock #3 (Project Office) for management. Waste is not generated at this Property on a regular basis. If any waste is generated, it is the result of intermittent maintenance activities at the Property or litter picked up from the Property. The May 1977 Final Environmental Impact Statement for the Fox River listed primary sites for the disposal of dredged materials. One disposal site was listed for the Menasha Channel:

Dredging Location	Disposal Site	Ownership of Disposal Site	Dimension of Site	Approximate Year of Disposal
Menasha Channel (below lock)	Left side of channel on existing dredge banks	State of Wisconsin	60'x1200'	1967

The location and use of this disposal site was confirmed by USACE personnel.

5.11.6 Property Inspection Summary

The Menasha Lock Property was inspected on April 13, 2000. Access to the Property is restricted by a locked chain-link fence. There are currently five buildings on the Property: Lockmaster dwelling, Lockmaster garage, oil house, sanitary facility, and a lockshelter. The locations of these buildings are shown on Figure 11. The interiors of all buildings were inspected except the oil house. USACE personnel indicated that the interior of this building was similar to other oil houses inspected except that it was still in use and, therefore, likely contained paint and petroleum products. Fuel oil was previously stored in an AST in the basement of the Lockmaster's dwelling. All floors and drains inspected were in good conditions and staining or spills were not observed or were minimal.

The exterior areas of the Property were primarily grass with concrete sidewalks near the lock. No visible evidence of filling, dumping, injections, excavations, vegetative stress, burned areas, pits, ponds, liquid discharges, abandoned or discarded chemical containers, or transformers were observed. Specific observations from the Property inspection are summarized on the Property checklist included in Appendix A.

5.11.7 Conclusions and Recommendations

- Municipal water was not available to the Property until the 1940s or 1950s. The Property has supported a lockmaster dwelling since at least 1910. It is likely that a well or wells previously serviced the Property. No records of well sealing are available for the Property. An unsealed well could act as a conduit if a release occurred at the Property. Unused wells should be located and

properly abandoned. The potential presence of unsealed wells should be disclosed at the time of Property transfer.

- Seven (7) samples were collected for analysis of asbestos from the Menasha Lock Lockmaster dwelling and garage. Of the samples collected, two were identified as being asbestos-containing-material (ACM). ACMs, if still present, should be removed prior to demolition activities. The presence of and locations of the ACM should be disclosed at the time of Property transfer.

- The 1989 sediment investigation conducted by the U.S. Corp of Engineers found heavy metals and concentrations of PCBs in the sediment immediately upstream and downstream from the lock. No recommendations are proposed for the sediment in the channel adjacent to the Property except that the presence of impacted sediment should be disclosed at the time of Property transfer.

- The 1977 EIS report indicated that sediments were dredged from the channel and placed on the western shore of the Property in approximately 1967. The 1989 analytical data was for samples of sediment retrieved from the base of the channel. Because heavy metals and PCBs were present in the sediment in 1989, it is possible that heavy metals and/or PCBs may be present in the sediment dredged in approximately 1967 and placed on the Property. No analytical data is available for the sediment placed on the Property. Analytical samples should be collected and analyzed to determine the quality of this material placed on the Property.

- Because of the age of the property buildings, it is likely that lead-based paint has been used on property structures. Any renovations involving removal of paint will need to comply with OSHA guidelines. The likely presence of lead-based paint on the Property buildings should be disclosed at the time of Property transfer.

- Sanitary sewer service was not available to the Property until the 1940s or 1950s. The lockmasters dwelling was present at the Property prior to this time. It is likely that a septic system was present at the Property in the past. No information regarding closure of the system is available. No recommendations are proposed for the potential historical septic system except that the possible presence of a septic system be disclosed at the time of Property transfer.

- The Property is located in an area of archeological interest (Native American site). Prior to any earth moving activities, archeologists much be contacted. This requirement should be disclosed at the time of Property transfer.

5.11.8 Classification Determination

Menasha is identified as a Type 7 property type because the Property contains areas where the presence of sources or releases of hazardous substances or petroleum products or their derivatives is suspected, but not well characterized. The specific area of concern is the area of sediment dredge spoils that were disposed at the Property.

TABLES

Table 1 – DePere Lock and Dam

Primary Resources Summary

Source	Date	
Sanborn Map	1884	**Property** Property not shown on this map.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between James and Charles Streets (north to south). Parcel northeast of intersection of James and Front identified as Novelty Manufacturing and Foundry. Cooper Shop and Cigar Factory shown on Front Street midway between James and George Street. Winegard and Persons Co. De Pere Elevator identified southeast of the intersection of Front and Charles Streets.
Sanborn Map	1890	**Property** Lock shown at current location. Dam shown in current location. Old Lockmaster house shown at current location of lockshelter building. Two additional small buildings shown southeast of lockshelter; those buildings no longer present. Dunham and Smith Flour Mill and Merchant Mill and De Pere Water Power Company shown on south end of Property under current George Street bridge. Not all of Property shown.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between James and Charles Streets (north to south) and area west of Front Street between George and John Streets. Parcel northeast of intersection of James and Front identified as C.A. Lawton Machine Shop and Foundry. Cooper Shop and Cigar Factory shown on Front Street midway between James and George Street. Winegard and Persons Co. De Pere Elevator identified southeast of the intersection of Front and Charles Streets on 1884 map is not shown. Area between lock and James Street identified as J.P. Dousman Flour Mill/Merchant Mill (office, flour mill, elevator, boat house). Land north of the lock identified as National Furnace (charcoal blast furnace, charcoal shed, coal shed, ore shed and several small offices/warehouses).

Table 1 – DePere Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map	1895	**Property** Not all of Property shown. Lock, dam, and one unlabeled building near the lock shown. Dunham and Smith Four Mill still observed south and west of lock on Property. De Pere Water Power Co. no longer observed on Property.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between John and Lewis Streets (north to south) and area west of Front Street between George and John Streets. Parcel north of intersection of Front and William Streets identified as a grain elevator. Parcel northeast of intersection of James and Front identified as C.A. Lawton Machine Shop and Foundry. Cooper Shop and Cigar Factory shown on Front Street midway between James and George Street. Area between lock and James Street identified as J.P. Dousman Flour Mill/Merchant Mill (office, flour mill, wheel house, elevator, boat house). Area between lock and William St. identified as De Pere Lumber and Fuel Co. (office, laboratory store, mill). Land north of the dam identified as property of A.G. Wells (charcoal blast furnace) but identified as vacant.
Sanborn Map	1900	**Property** Not all of Property shown. Lock and one building shown. Dam shown. Dunham and Smith Flour Mill no longer on Property.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between John and Lewis Streets (north to south) and area west of Front Street between George and John Streets. Parcel north of intersection of Front and William Streets identified as a grain elevator and feed mill. Parcel northeast of intersection of James and Front identified as C.A. Lawton Machine Shop and Foundry. Cigar Factory shown on Front Street midway between James and George Street. Area between lock and James Street identified as J.P. Dousman Flour Mill/Merchant Mill (office, flour mill, wheel house, elevator). De Pere Light and Power Company with flume shown immediately east of lock. Area between lock and William St. identified as De Pere Lumber and Fuel Co. (office, laboratory store, mill). Land north of the dam identified as property of A.G. Wells (charcoal blast furnace) but identified as vacant.
U.S. Government Historic Map	1910	**Property** One building shown at current location of garage. Purpose of the building is not identified. Chicago & Northwestern Railroad bridge shown crossing on north end of lock. Ruins of American Writing Paper Co. are shown on the southern portion of the Property.
		Surrounding Plant of the American Writing Paper Company shown west of Fox River. Property north of Property identified as A.G. Wells and Co. (old blast furnace, two warehouses, and coal shed). Buildings for the Electric Light Co. and flour mills are shown east of the Property.

Table 1 – DePere Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map	1914	**Property** Not all of Property shown. Lock, current lockshelter (old Lockmaster dwelling) and current Lockmaster house shown. Shown.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between John and Lewis Streets (north to south) and area west of Front Street between George and John Streets. Parcel north of intersection of Front and William Streets identified as a grain elevator and feed mill. C.A. Lawton Machine Shop expanded to include west half and northeast quarter of the block between Front, William, Broadway, and James Streets. Area between lock and James Street identified as J.P. Dousman Flour Mill/Merchant Mill (office, flour mill, wheel house, elevator). De Pere Light and Power Company with flume shown immediately east of lock. Area between lock and William St. identified as Central Lumber Co. Land north of the lock identified as the A.G. Wells Coal Yard.
Sanborn Map	1925	**Property** Property not shown on this map.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between Cass (formerly John) and Lewis Streets (north to south). Parcel north of intersection of Front and William Streets identified as a grain elevator and feed mill. C.A. Lawton Machine Shop includes west half and northeast quarter of the block between Front, William, Broadway, and James Streets.
Reverse Directory	1925	**Property** Property not included in directory.
		Surrounding Surrounding area not included in directory.
Reverse Directory	1933	**Property** Not specifically identified in directory.
		Surrounding Wisconsin Public Service Corp., Osen Milling Company, and Edward Zuehls (residence) identified on James Street between Fox River and Front Street. Nicolet Paper Corp. identified on Main Ave. (George Street) immediately west of Fox River. Buth Oil Co. identified on North Front Street north of Cass Street. Bridge House identified on George Street next to Fox River. De Pere Home Oil Co.
Aerial Photograph	1938	**Property** Lock, dam, lockshelter, and Lockmaster dwelling observed.
		Surrounding Cluster of buildings between lock and Front Street. Piles of lumber observed north of lock. Piles of black material (likely coal) observed north of Property.

Table 1 – DePere Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1939	**Property** Property not included in directory.
		Surrounding Surrounding area not included in directory. Continental Oil Company (bulk station) identified at 305 North Front Street. Bridge House identified on George Street next to Fox River.
Sanborn Map	1946	**Property** Property not included on map.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between Cass (formerly John) and Lewis Streets (north to south). Parcel north of intersection of Front and William Streets identified as a grain elevator and feed mill. C.A. Lawton Machine Shop includes west half and northeast quarter of the block between Front, William, Broadway, and James Streets. Artificial Ice Plant identified northeast of intersection of Front and George Streets.
Reverse Directory	1946	**Property** U.S. Government locks identified on James Street between the Fox River and Front Street.
		Surrounding Continental Oil Company (bulk station) identified at 305 North Front Street. Wisconsin Public Service Corp (power plant), Osen Milling Co., and Edward Zuehls identified on James Street between Fox River and Front Street. Bridge House identified on George Street next to Fox River.
Reverse Directory	1951	**Property** U.S. Government locks identified on James Street between the Fox River and Front Street.
		Surrounding Wisconsin Public Service Corp (power plant), Osen Milling Co., and Edward Zuehls identified on James Street between Fox River and Front Street. Bridge House identified on George Street next to Fox River.
Sanborn Map	1953	**Property** Property not shown on maps.
		Surrounding Area shown is east of Fox River between Front and Michigan Streets (west to east) and between Cass (formerly John) and Lewis Streets (north to south). Parcel north of intersection of Front and William Streets identified as a grain elevator and feed mill. C.A. Lawton Machine Shop includes west half and northeast quarter of the block between Front, William, Broadway, and James Streets. Machine Shop shown on Front Street between James and George Streets.

Table 1 – DePere Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Historic Map	1954	**Property** Lock, dam, and Lockmaster dwelling near lock identified. Small scale map.
		Surrounding Buildings shown between lock and Front Street. Nicolet Paper Company southwest of Property. Small scale map.
Reverse Directory	1959	**Property** U.S. Government locks identified at 100 James (Harold Ruechel (Lockmaster?))
		Surrounding Mineau P.J. Mach Co. identified at 126 North Front Street. Bridge House identified on George Street east of Fox River. Osen Milling Company and Beemster Electric Co. (power plant) identified on James between the Fox River and Front Street. City Water Department and VanStrated Trucking identified just south of George Street on Front Street.
Aerial Photograph	1960	**Property** Lock, one building near lock, Lockmaster dwelling, small shed west of lock, and dam observed.
		Surrounding Cluster of buildings between lock and Front Street. Piles of lumber observed north of lock. Piles of black material (likely coal) observed north of Property. Overland surface discharge making a delta north of coal piles. Paper company evident immediately west of river.
Reverse Directory	1966	**Property** U.S. Government locks identified at 100 James (Harold Ruechel (Lockmaster?))
		Surrounding City Water Department and VanStrated Trucking identified just south of George Street on Front Street. Bridge House identified on George Street east of Fox River. Osen Milling Company and Beemster Electric Co. (power plant) identified on James between the Fox River and Front Street.
Aerial Photograph	1967	**Property** Lock, one building near lock, Lockmaster dwelling, small shed west of lock, and dam observed.
		Surrounding Cluster of buildings between lock and Front Street. Piles of black material (likely coal) observed north of Property. Delta from overland surface discharge still evident but not discharging any more. Tracks over surface of delta. Coal piles evident. Paper company evident immediately west of river.
Historic Map	1971	**Property** Lock, Dam, and Lockmaster dwelling near lock identified. Small scale map.
		Surrounding Buildings shown between lock and Front Street and north of Property. Nicolet Paper company southwest of Property. Small scale map.

Table 1 – DePere Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1971	**Property** U.S. Government locks identified at 100 James (Harold Ruechel (Lockmaster?))
		Surrounding Dennis Distributor ambulance sales, Maes Bus Service, and Valley Packaging Supply Co. identified 126 Front St. N. Van Straten Trucking south of George St. on Front St. Bridge House identified between Fox River and Front St. on George Street. Osen Milling Company and Beemster Electric Co. (power plant) identified on James between the Fox River and Front Street.
Aerial Photograph	1974	**Property** Lock, one building near lock, Lockmaster dwelling, small shed, and dam observed.
		Surrounding Cluster of buildings between lock and Front Street. Delta from overland surface discharge still evident but not discharging any more. Tracks and trees over surface of delta. Paper company evident immediately west of river. No more coal piles north of Property.
Reverse Directory	1976	**Property** U.S. Government locks identified at 100 James (Burt Linden (Lockmaster?))
		Surrounding Maes Bus Service and Valley Packaging Supply Co. identified 126 Front St. N. De Pere City Water Department south of George St. on Front St. Bridge House identified between Fox River and Front St. on George Street. Osen Milling Company and Beemster Electric Co. (power plant) identified on James between the Fox River and Front Street.
Reverse Directory	1981	**Property** U.S. Government locks identified at 100 James (Burt Linden (Lockmaster?))
		Surrounding Maes Bus Service identified 126 Front St. North. De Pere City Water Department south of George St. on Front Street. Osen Milling Company and Beemster Electric Co. (power plant) identified on James between the Fox River and Front Street.
Aerial Photograph	1982	**Property** Poor quality photograph. Lock and dam evident. No buildings can be seen.
		Surrounding Cluster of small buildings between lock and James Street. Earthmoving activities evident in area north of lock (delta and former coal area). Paper company evident on west side of river.

Table 1 – DePere Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Historic Map	1982	**Property** Lock, dam, small building near lock and Lockmaster dwelling on island identified. Small scale map.
		Surrounding Buildings shown between lock and Front Street and north of Property. Nicolet Paper Company southwest of Property. Small scale map. New roads north of Property (delta area) current park area.
Reverse Directory	1986	**Property** Fox River Management Commission identified at 100 James Street.
		Surrounding De Pere City Water Department south of George St. on Front Street. Osen Milling Company and Beemster Electric Co. (power plant) identified on James between the Fox River and Front Street.
Reverse Directory	1991	**Property** Fox River Management Commission identified at 100 James Street.
		Surrounding De Pere City Water Department south of George St. on Front Street.
Aerial Photograph	1992	**Property** Lock and dam observed. Lockmaster house observed. Small shed no longer observed. Lockshelter, garage, and oil house observed.
		Surrounding All but one building (Beemster and James St. Inn) formerly located between lock and James Street gone. Area north of lock appears to be landscaped into trails, parking, etc. Paper mill on west side of river evident.
Historic Map	1992	**Property** Lock, dam, and Lockmaster dwelling evident. Small scale map.
		Surrounding Small scale map. Neighboring properties not discernible.

Table 2 – Little Kaukauna

Primary Resources Summary

Source	Date	
U.S. Government Historical Map	1910	**Property** The lock is located downstream from its current location. There are two small support buildings located just north of the lock and one building that resembles the current lockmaster dwelling in size and location. The dam is in its current location. The location of a former dam upstream from the current location is drawn on the map.
		Surrounding Access to the Property is over Wagon Bridge. A hydroelectic facility and mill operate on the north bank of the canal. The area between the current Property and the current shore line to the north is identified as "old tail race" and "tail race". The area also contains parcel lines which may indicate that this area was previously dry land. Buildings associated with the structure include a wood room, wet machine room, platform, and grinder room. The Village of Lawrence is located north of the canal. The map area does not extend south of Fox River.
Aerial Photograph	1938	**Property** The lock and dam are now both shown in their current locations. The old lock downgradient is still visible on the map. The Fox River is clouded with sediment near and downstream of the former lock. Construction activities may be occurring on the Property. The map is blurred and difficult to distinguish.
		Surrounding The hydroelectric facility, mill and support buildings located north of the Property are still distinguishable on the map. Land between current Property and current north shore of the river is filled with water. The land north of the mill is primarily residential housing followed by agricultural land. Land to the south of the dam and Fox River is woodland, then agricultural.
Historical Map	1954	**Property** Small-scale map. Property features appear consistent with present day maps. Lock and dam are labeled on map. One building is shown at the current location of the lockmaster's dwelling. No additional buildings are shown.
		Surrounding Small-scale map, neighboring properties not discernible. The mill/dam and two associated buildings are shown north of the mill/dam. The area shown on the map is northeast of the Property. The very western tip of the Property embankments is not shown.

Table 2 – Little Kaukauna (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1960	**Property** Lock and dam, lockmaster dwelling, and lockshelter are visible in their current locations. One additional possible building is shown on the north end of the north embankment. The purpose of this building is not known. Land features of the two embankments are also now current. Three concrete square piers are located downgradient of the south embankment for temporary boat docking.
		Surrounding The hydroelectric facility, mill and support buildings located north of the Property are still distinguishable on the map. A dwelling is located north of the mill support buildings. Just north of the mill, the land is scarred and construction activities are on going. Large piles of wood are observed on the property immediately north of the mill. Additional buildings have been added in the residential area north the mill. Land to the south of the dam and Fox River is woodland, then agricultural.
Aerial Photograph	1967	**Property** Lock and dam, lockmaster dwelling, and lockshelter are visible in their current locations. Land features of the two embankments are current. Unidentified small building on the north end of the north embankment no longer present. All other site features as observed in the 1960 aerial photograph.
		Surrounding The hydroelectric facility, mill and support buildings and dwelling located north of the Property are still distinguishable on the map. Additional buildings have been added in the residential area north the mill. Land to the south of the dam and Fox River is woodland then agricultural.
Historical Map	1971	**Property** Small-scale map. Property features appear consistent with present day maps. Lock and dam are labeled on map. The lockmaster dwelling is visible.
		Surrounding Small-scale map, neighboring properties not discernible. The dwelling north of the Property is visible. The area shown on the map is northeast of the Property. The very western tip of the Property embankments is not shown.
Aerial Photograph	1974	**Property** Lock and dam, lockmaster dwelling, and lockshelter are visible in their current locations. A garage is located west of the current garage, and one other additional building has been added on the Property (likely the sanitary facility). Land features of the two embankments are current.
		Surrounding The hydroelectric facility, mill and support buildings, and dwelling located north of the Property are still distinguishable on the map. Some scarring and tree removal has occurred immediately east of the dwelling, indicating possible construction. Residential area followed by agricultural land has remained as it was in 1967. Land to the south of the dam and Fox River is woodland, then agricultural.

Table 2 – Little Kaukauna (cont.)

Primary Resources Summary

Source	Date	
Historical Map	1982	**Property** Small-scale map. Property features appear consistent with present day maps. Lock and dam are labeled on the map. The lockmaster dwelling and garage are shown.
		Surrounding Small-scale map, neighboring properties not discernible. The dwelling and three other buildings are visible north of the Property. A substation is labeled on the map less than ½ mile north of the lock. The area shown on the map is northeast of the Property. The very western tip of the Property embankments is not shown.
Aerial Photograph	1982	**Property** Lock and dam, lockmaster dwelling, lockshelter, both the former and current garages, and the sanitary facility are visible in their current locations. Land features of the two embankments are current.
		Surrounding The photograph is blurred. It appears that the mill buildings have been removed. The old dwelling is still in place and newer residence shown approximately 250 feet east of the former dwelling. Residential area followed by agricultural land north of the dwelling. Land to the south of the dam and Fox River is woodland then agricultural. One building has been constructed approximately 500 feet from the south river bank.
U.S. Government Historical Map	1986	**Property** Lock and dam, lockmaster dwelling, lockshelter, one garage, and the sanitary facility are visible in their current locations. Land features of the two embankments are current. Aerial transmission line shown crossing the Fox River over the Property. A "timber boom" is shown off the west end of the north embankment.
		Surrounding Mill buildings are not shown. Two buildings are shown northeast of the Property at the location of the "new" residence.
Historical Map	1992	**Property** Small-scale map. Property features appear consistent with present day maps. Lock and dam are labeled on the map. The lockmaster dwelling is visible.
		Surrounding Small-scale map, neighboring properties not discernible. One building (new residence) is shown northeast of the Property. A substation is labeled on the map less than ½ mile north of the lock. The area shown on the map is northeast of the Property. The very western tip of the Property embankments is not shown.
Aerial Photograph	1992	**Property** Lock and dam, lockmaster dwelling, lockshelter, current garage, sanitary facility, and oil house are visible in their current locations. Land features of the two embankments are current.
		Surrounding Mill buildings and dwelling removed. A new dwelling is located northwest of the Property. Foundations of old buildings are visible. Residential area followed by agricultural land north of the Property. Land to the south of the dam and Fox River is woodland, then agricultural. One building is located approximately 500 feet from the south river bank.

Table 3—Rapide Croche

Primary Resources Summary

Source	Date	
U.S. Government Historical Map (company records)	1910	**Property** Dam is shown in current location. Lock is shown approximately 1,000 feet east of current location. Unidentified small building shown at old lock. Former Lockmaster dwelling shown at location of "old foundation" shown on Appendix A-3, Figure 2.
		Surrounding Buildings shown at location of farmstead currently north of Property. (Six structures total). Clay pits shown immediately northeast of old lock and on U.S. Government property west of lock Property. The property with clay pits is not part of the Property.
Aerial Photograph	1952	**Property** The lock and dam are both identifiable on the map at current locations. The lockshelter and Lockmaster dwelling exist on the Property at current locations. The foundation of the old Lockmaster dwelling observed.
		Surrounding Riverbanks and the finger of land between and lock and dam are lined with trees and other vegetation. Land north and south of the Fox River is agricultural. Garage structure observed immediately east of Property at current farmstead. Residential properties south of Fox River.
Historical Map	1954	**Property** Small-scale map, the lock and dam are labeled on the map.
		Surrounding Small-scale map, neighboring properties not discernible. Farmstead east of Property has one building. Residences shown south of Fox River. Land use is agricultural or undeveloped. The Chicago and North Western Railroad is ¾ mile north of the site and runs parallel along Fox River.
Aerial Photograph	1957	**Property** Lock, dam, Lockmaster dwelling observed as in 1952. The scarring west of the Lockmaster dwelling is a garden. (REF. 10).
		Surrounding Land use is similar to 1952, agricultural or woodland with one building.
Aerial Photograph	1971	**Property** Lock, dam, lockshelter, Lockmaster dwelling, and sanitary facility are observed. Foundation from the old Lockmaster dwelling is hidden in tree cover.
		Surrounding New small residential development immediately north of Property. A small road has been constructed off of Highway 96 with 3 new residential buildings and Ron's Auto Body Shop. New residential buildings on Highway 96 and on farmstead east of Property.

Table 3—Rapide Croche (cont.)

Primary Resources Summary

Source	Date	
Historical Map	1974	**Property** Lock and dam are labeled on the map. One building (Lockmaster's dwelling) shown on Property.
		Surrounding Power plant labeled south of the dam. A park (Wayside Park) is located south of the Property on the south side of Fox River just east of the dam. The Chicago and North Western Railroad runs along Highway 96 approximately ¾ of a mile north of the Property. St. Paul Cemetery is labeled about ½ mile northeast of the Property. A sandpit is labeled I mile northwest of the Property. Land use is agricultural with mixed residential or undeveloped.
Aerial Photograph	1981	**Property** Lock, dam, lockshelter, Lockmaster dwelling, garage, oil house, and sanitary facility are all observed. The photograph has been damaged near the Property area, so the western portion of Property can not be discerned.
		Surrounding Land use in the surrounding area generally as described for 1971. One house has been added to the development to the north.
U.S. Government Map (company records)	1986	**Property** Lock, lockshelter, Lockmaster dwelling, garages, sanitary facility and dam shown at current locations.
		Surrounding South end of dam identified as Kaukauna Hydroelectric and Water Department Plan. Wayside Park shown south of Fox River.
Historical Map	1992	**Property** Lock and dam are labeled on the map. One building and gaging station identified on Property.
		Surrounding Land use is similar to the 1974 historical map. Additional residential buildings constructed north of site and south of river.
Aerial Photograph	1992	**Property** Lock, dam, lockshelter, Lockmaster dwelling, garage, oil house, and sanitary facility are all observed. An old foundation (old gazebo) is visible north of the Lockmaster dwelling. In previous photographs this area was hidden in tree cover.
		Surrounding Land use is similar to the 1981 photograph.

Table 4—Stockbridge Harbor

Primary Resources Summary

Source	Date	
Historical Map	1911	**Property** Small-scale map. Stockbridge Harbor is visible and labeled on the map.
		Surrounding The area shown is east of Lake Winnebago between the Lake and Long Road (west to east) and Carney and Kloten Roads (north to south). Small-scale map, neighboring properties not discernible. Residential property buildings are located along the main roads. Buildings are shown southeast of Property and north of Property.
Aerial Photograph	1938	**Property** Harbor is surrounded by vegetation. The northern two-thirds of the harbor is clouded with sediment.
		Surrounding Area shown is west of Lake Winnebago between the Lake and Lake Shore Drive (west to east) and surrounding Lake Street (north to south). Land mainly agricultural with residential housing along Lake Street. There are 3 or 4 buildings just east of the harbor, a farm house and associated agricultural buildings. There is also a house at the intersection of Lake and West Streets just north of the Property.
Aerial Photograph	1953	**Property** Docks are located around the periphery of the harbor. Access road accesses Property from the north.
		Surrounding Land uses similar to 1938. Area shown is west of Lake Winnebago between the Lake and Lake Shore Drive (west to east) and Lake Street to Sunset Beach Road (north to south). Housing exists south of the harbor on the lakefront. Baseball diamond north of the harbor. Farmstead to southeast of harbor.
Historical Map	1955	**Property** Small-scale map, Stockbridge Harbor is visible and labeled on the map.
		Surrounding The area shown is east of Lake Winnebago between the Lake and Long Road (west to east) and the Stockbridge Indian Reservation boundary and Kloten Road (north to south). Small-scale map, neighboring properties not discernible. Additional residential development, especially along the lakeshore. Land use similar to the 1911 historical map with buildings north and southeast of harbor.
Aerial Photograph	1962	**Property** Shore of harbor wooded. Docks on west side of harbor.
		Surrounding Land use has not changed since 1953. Area shown is west of Lake Winnebago between the Lake and Lake Shore Drive (west to east) and Lake Street to Sunset Beach Road (north to south). Baseball diamond has been removed. Farmsteads remain north and southeast of Property.

Table 4—Stockbridge Harbor (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1971	**Property** As described for 1962.
		Surrounding Farmsteads remain north of Property. Farmstead buildings to southeast have been removed.
Historical Map	1974	**Property** Property appears similar to present day features.
		Surrounding Land use is similar to 1971. Just beyond the intersection of Lake Street and Lake Shore Drive a sewer treatment pond is labeled on the map (approx. 1 mile east of Property).
Aerial Photograph	1981	**Property** Property appears similar to present day features. The boat landing located on the northwestern edge of the Property is now visible.
		Surrounding Land use has not changed since the 1971 aerial photograph, except the data-collecting and well house is also visible on the photograph. Trailer storage just north of the Property. Former farmstead southeast of Property is growing over.
U.S. Government Map (company records)	1986	**Property** Launching platforms shown on western and northeastern portions of Property. Wharf shown on northwestern portion of Property; no buildings shown.
		Surrounding Three buildings shown immediately east of Property; uses are not defined.
Aerial Photograph	1992	**Property** Property appears similar to present day features.
		Surrounding Land use is similar to the 1981 aerial photograph. Additional residential development north of Lake Street. Additional trailer storage and also ice houses storage is visible north of the Property but south of Lake Street. The agricultural buildings east of the Harbor have been removed.
Historical Map	1992	**Property** Property appears similar to present day features.
		Surrounding Land use similar to the historical map from 1971. A quarry is labeled on the northwest corner of the block surrounded by Moore Road and Lakeshore Drive, about 1½ miles north of the Property.

Table 5 – Kaukauna Locks and Dam

Primary Resources Summary

Source	Date	
Sanborn Maps	1885	**Property** *Property southwest of dam:* Property is depicted as part of the Kaukauna Water Power Company canal system. No buildings are apparent. *Property northeast of dam:* The maps show the entire Property, which consists of the land immediately north of the Fox River between approximately Desnoyer Ave. and Island Street (west to east). No development is depicted, with the possible exception of some small outbuildings associated with the nearby businesses. The maps indicate the Property *consists* of a bluff that slopes down to the government canal. The Island Street bridge crosses the eastern edge of the Property. *Lock 1:* The maps show the southern shore of the Property, including the western portion of Lock 1 itself. The northern portion of the Property is not depicted. Although it is difficult to discern the Property's exact southern boundary line, the southern land portion appears to support minimal structures. These small structures are associated with the adjoining lumber, paper, and hub and spoke manufacturing facilities to the south. Approximately five flumes are depicted along the Property, trending from the southern adjacent properties, north across the Lock 1 Property, to the canal. *Lock 2, 3, 4, and 5:* These properties are not shown on the available Sanborn maps.
		Surrounding *Property southwest of dam:* Maps do not show the area west of Property. Although difficult to decipher, the buildings immediately south appear to be associated with the railroad line further south. The industrial/commercial type buildings to the southeast of the Property are likely associated with the Kaukauna Water Power Company. The Fox River borders the Property to the north. The dam is shown. *Property northeast of dam:* The land area immediately north of this Property supports mainly small commercial businesses interspersed with a few light industrial businesses along Wisconsin Avenue (30 – 71Wisconsin Avenue [south side] and 2 – 22, 901 – 911 Wisconsin Avenue [north side]). Businesses include hotel, tailor, barber, shoemaker, drug store, meat/dairy store, and *black* smith. The presence of wells is indicated for many adjoining businesses. Land area west of the Property is not shown. The Fox River borders the Property to the south. The dam is shown.
		Lock 1: The area north of this Property is *not* shown on the Sanborn map. Manufacturing facilities are present immediately south of the Property. Listed from west to east, these manufacturing facilities include Franklin Mill; Kaukauna Pulp Co. (machine room, pulp and grinding room, washing and heating); American Pulp Co. (machine room, possible tank); Kaukauna Lumber & Manufacturing Co. (glazing room); and Reuter Hub & Spoke Co. (finishing room). Flumes trend from the paper company properties north to the U.S. Canal; tail races trend from most all the aforementioned manufacturing facilities south to the Fox River. Portions of the adjoining property buildings are situated on the Property. The uses of the portions of the buildings that overlap onto the Property are not legible on the Sanborn Map. The maps also depict the portion of the southern shore of the Fox River directly across from these manufacturing facilities. This area also appears to be occupied by similar facilities, including the Tolman, Conroe, and Co. Lumber Yard, the Union Pulp Co., G.F. Kelso's Pulp Mill, and the Fox River Pulp and Paper Co.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Maps (cont.)	1885	*Lock 2, 3, 4, and 5:* The area surrounding these properties was not shown on the available Sanborn maps.
Sanborn Maps	1890	**Property** *Property southwest of dam:* Not shown on available Sanborn maps. *Property northeast of dam:* Land-use appears similar to that in 1885. *Lock 1:* The maps do not show the eastern half of the Lock 1 Property. The land on the north shore of the canal supports portions of small commercial/light industrial and residential buildings situated on adjacent properties along Canal Street to the north, and/or outbuildings associated with adjacent buildings. The land-use on the south shore of the canal generally appears the same as in 1885. However, the southwestern portion of the Property supports a driveway. *Lock 2, 3, 4, and 5:* These properties are not shown on the available Sanborn maps.
		Surrounding *Property southwest of dam:* The surrounding area is not shown on available Sanborn maps. *Property northeast of dam:* Surrounding land-use appears similar to that in 1885.
		Lock 1: The area immediately north of the Property supports somewhat sparse mixed commercial, light industrial, and residential development along Canal Street (addresses A – U Canal Street), including a blacksmith and wagon shop, beer bottler, icehouses, and coal sheds. Portions of the adjacent property buildings overlap onto Lock 1 Property. The area south of Lock 1 Property supports similar industrial-type land-use. However, building composition appears to have changed (i.e., buildings were added and/or removed). Manufacturing facilities listed west to east include: Russell Bro's Flour Mill/"Victoria Mills" Water Power; Kaukauna Paper Co. Paper and Pulp Mill; Thilmany Pulp and Paper Mill; and Kaukauna Lumber and Mfg. Co's/City Electric Works/Planing Mill and Sash, Door, and Blind Factory. Only one tail race is depicted on the Sanborn map; other tail race areas on the southern portion of this Property appear to have been filled, as the land area between the canal and the Fox River has increased in size. Railroad tracks are apparent north of the Fox River, along the riverbank. *Locks 2, 3, 4, and 5:* The area surrounding these properties is not shown on the available Sanborn maps.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map	1894	**Property** *Property southwest of dam:* Not shown on available Sanborn maps. *Property northeast of dam:* Land-use appears similar to that in 1890. *Lock 1:* The maps do not show the eastern half of the Lock 1 Property. Land-use on the depicted southern and northern portions of the Lock 1 Property is similar to that of 1890. *Lock 2, 3, 4, and 5:* These properties are not shown on the available Sanborn maps.
		Surrounding *Property southwest of dam:* A roundhouse (coal sheds, black smith, machine shop, repair shop, carpenter shop) and rail yard is depicted south of the Property. *Property northeast of dam:* Land-use surrounding the Property is similar to that in 1890. *Lock 1:* The maps do not show the eastern half of the Lock 1 Property. Depicted land-use surrounding the northern portion of the Property is similar to that in 1890. The land-use surrounding the southern portion of the Property is also similar to that in 1890. However, some occupants have changed and building composition may have changed (i.e., buildings were added and/or removed). Manufacturing facilities listed west to east include: Russell Bro's Flour Mill/"Victoria Mills" Water Power; Kaukauna Paper Co. Paper and Pulp Mill; Thilmany Pulp and Paper Mill; Kaukauna Lumber and Mfg. Co's; Kaukauna Electric Light. *Locks 2, 3, 4, and 5:* The area surrounding these properties is not shown on available Sanborn maps
Sanborn Map	1900	**Property** *Property southwest of dam:* Not shown on available Sanborn maps.
		Property northeast of dam: Land-use on Property appears similar to that in 1894. Address along Wisconsin Avenue: 61 – 71, 203 – 231, 30 – 42, 301 – 309, and 912 – 913 (south side); 1201 – 1208, 200 – 234, 801, 902 – 911, and 328 – 332 (north side). *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Land-use on the depicted southern and northern portions of the Lock 1 Property is similar to that in 1894. *Locks 2, 3, 4, and 5:* Not shown on available Sanborn maps.
		Surrounding *Property southwest of dam*: Land-use south of the Property is similar to that in 1894 (i.e., the roundhouse is still present). *Property northeast of dam*: Land-use surrounding the Property is similar to that in 1894.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map (cont.)	1900	*Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Land-use surrounding the northern portion of the Property is similar to that in 1894. The land-use surrounding the southern portion of the Property is similar to that in 1894. However, some occupants have changed and building composition may have changed (i.e., buildings were added and/or removed). Kaukauna Lumber and Mfg. Co. is no longer shown on the Sanborn map; buildings for that facility are no longer present. Manufacturing facilities listed west to east include: Russell Bro's Flour Mill/"Victoria Mills" Water Power; Union Bag and Paper Co.; Thilmany Pulp and Paper Mill; Kaukauna Electric Light Co.; and Solar Mfg Co. *Locks 2, 3, 4, and 5*: The area surrounding these properties is not shown on available Sanborn maps.
Sanborn Map	1906	**Property** *Property southwest of dam*: Not shown on available Sanborn maps. *Property northeast of dam*: Land-use on Property appears similar to that in 1900. *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Land-use on depicted portion of Property appears to be similar to that in 1900. *Lock 2*: Not shown on available Sanborn maps. However, the Sanborn map covering land west of this Property indicates the vicinity is "vacant." *Locks 3, 4, and 5:* Not shown on available Sanborn maps. However, the Sanborn map covering land further west of these properties indicates this vicinity is "vacant."
		Surrounding
		Property southwest of dam: Land-use is similar to that in 1900 (i.e., the roundhouse is still present). Standard Oil Co. (gasoline and kerosene tanks) is present southwest of the roundhouse, south of the rail yard.
		Property northeast of the dam: Land-use surrounding the Property is similar to that in 1900. Some address numbers appear to have changed along Wisconsin Avenue. *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. A few buildings are no longer present north of the Property; the bottling company is no longer depicted. South of the Property, Russell Bro's Flour Mill/"Victoria Mills" Water Power company is no longer present, nor is the land on which it once stood. Solar Mfg. Co. land is now occupied by Boyd Paper Co. The other occupants of the properties south of the Property are the same. However, it appears as though more structures have been added at the Union Bag and Paper Co. and Thilmany Pulp and Paper Co. properties. *Lock 2*: The area surrounding this Property is not shown on the available Sanborn maps. However, the Sanborn map covering the land west of this area indicates this area is "vacant." *Locks 3, 4, and 5*: The area surrounding these properties is not shown on the available Sanborn maps. However, the Sanborn map covering land further west of this area indicates this area is "vacant."

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
U.S. Government Historical Map (company records)	1910	**Property** *Property southwest of dam*: Small building with a well is shown approximately 200 feet west of the southern end of the dam. The purpose of this building is not identified. A railroad spur and water closet are shown on the Property west of the Kaukauna Water Power Co's. Power Canal. *Property northeast of dam*: "Guard Lock Skeleton Gates" and a needle house are shown immediately north of the dam. Three additional small buildings are shown on the Property which appear to be associated with the neighboring properties.
		Lock 1: A coal shed, U.S. Warehouse, U.S. Lock House (current Lockmaster's dwelling) and barn are shown in the immediate vicinity north of Lock 1. Small buildings associated with neighboring properties are on the Property north of the U.S. Canal between the area northeast of the dam and Lock 1. One half of a machine shop on Canal St. approximately 300 feet west of Catherine St. is on the Property. Buildings associated with the Union Bar and Paper Co. and Thilmany Paper Mill are also shown on the Property south of the U.S. Canal between Island St. and Lock 1. *Lock 2*: A U.S. Lock House and barn are shown immediately north of Lock 2. *Lock 3*: The timber shed, U.S. Dry Dock, and garage with lean-to are shown at the current locations. Other buildings shown are a shed, old pump house, shop, and outhouse. A handwritten note on this map indicates that the land currently holding the Project Office was acquired May 1, 1948. A U.S. Stone Dock is shown on the south side of the U.S. Canal midway between Lock 3 and Lock 4.
		Lock 4: No buildings are shown at Lock 4.
		Lock 5: A lock tender's dwelling (current Lockmaster's dwelling), shed, water closet, barn, and two unidentified small buildings are shown at Lock 5.
		Surrounding *Property southwest of dam*: Land-use is similar to that in 1906. The following buildings are identified: Engine House (roundhouse), office, shorehouse. blacksmith shop machine shop, carpenter shop, transfer table, and two paint shops. The land immediately south of the dam (current location of Cops Construction and the Kaunkauna Public Library) is identified as the Kaukauna fairground. *Property northeast of the dam:* Land-use surrounding the Property is similar to that in 1906 (i.e. mixed residential and commercial). *Lock 1*: Victoria Mills, Union Bag and Paper Co., Thilmany Paper Mill, Electric Light Plant, and Solar Manufacturing are shown south of the U.S. Canal between Island St. and Lock 1. The land north of the U.S. Canal is shown as residential. *Lock 2*: A Branch Track of Chicago & Northwestern Railway is shown south of and then crossing immediately east of Lock 2. The land north of Lock 2 appears to be platted for residential development. No development is shown immediately south of Lock 2. *Lock 3:* Development surrounding this Property is not shown.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
U.S. Government Historical Map (company records)	1910	*Lock 4:* The Grignon House is shown north of Lock 4. Buildings associated with the Outagamie Paper Co. (recovery building, carpenter shop, wood room, digester building, boiler room, engine room, bleach room, and office) are shown southwest of Lock 4. The Merritt Black quarry is shown immediately south of the U.S. Canal approximately 300 feet east of Lock 4. *Lock 5*: No development is shown around Lock 5.
Sanborn Map	1913	**Property** *Property southwest of dam*: Not shown on available Sanborn maps. *Property northeast of dam*: Land-use appears similar to that in 1910. *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Land-use appears to be similar to that in 1906; the Property continues to support portions of the adjacent property buildings. The uses of these adjacent buildings have undergone some minor changes, although their general use as commercial/light industrial and residential properties has remained consistent. See below for more details on surrounding property. *Locks 2, 3, 4, and 5:* Not shown on available Sanborn maps.
		Surrounding *Property southwest of dam:* Land-use south of the Property is similar to that in 1910 (i.e., the roundhouse and other railroad buildings are still present). Property is identified as Chicago & Northwestern railroad. *Property northeast of dam:* Land-use surrounding this Property is similar to that of 1906. Vacancies are noted in many of the commercial buildings. *Lock 1:* The maps do not show the eastern half of the Lock 1 Property. The foundry/machine shop (former black smith shop) located north of the Property has expended eastward. In addition, a "garage" with one 120-gallon UST is depicted east of the foundry. The Union Bag and Paper Co., Thilmany Pulp and Paper Co., Kaukauna Electric Light Co., and Cornell and Ward Toilet Paper Factory are shown south of the U.S. Canal west of Lock 1. *Locks 2, 3, 4, and 5:* The area surrounding these properties is not shown on the available Sanborn maps.
Sanborn Map	1925	**Property** *Property southwest of dam*: Not shown on available Sanborn maps. *Property northeast of dam:* Land-use appears similar to that in 1913. The uses of some adjacent buildings to the north have undergone some changes, although their general use as commercial/light industrial and residential properties has remained consistent. See below for more details on surrounding property. *Lock 1:* The maps do not show the eastern half of the Lock 1 Property. Land-use appears similar to that in 1913. *Lock 2, 3, 4, and 5*: Not shown on available Sanborn maps.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map (cont.)	1925	**Surrounding** *Property southwest of dam*: Land to the east is shown as being occupied by the municipal administration building at 101 Main Avenue (swimming pool, fire department, office, post office). This building is the current Cops Construction Building. The roundhouse and rail yard is still present south of the properties.
		Property northeast of the dam: A printing business and two "garages," each with a gas tank, are present on the south side of Wisconsin Avenue (215/900 Wisconsin Avenue, 179 Wisconsin Avenue; and 141/143 Wisconsin Avenue, respectively). Most other commercial businesses are depicted as stores or offices, with their specific operations omitted from the Sanborn descriptions. Addresses along Wisconsin Avenue appear to have been adjusted and most properties are shown with two addresses; Wisconsin Avenue has been separated into West and East Wisconsin Avenue. New addresses along W. Wisconsin Avenue: 101 – 265 (south side), 100-266 (north side); New address along E. Wisconsin Avenue: 101 – 141 (south side), 100 (north side).
		Lock 1: The maps do not show the eastern half of the Lock 1 Property. The garage located north of the Property is now occupied by office and general storage. The former foundry is now identified as Kaukauna Machine Co. Other land-use north of the Property is similar to that in 1913. Two manufacturing facilities are depicted south of the Property: Union Bag and Paper Corp. and Thilmany Pulp and Paper Company. Thilmany Pulp and Paper Company has expanded east to encompass land area formerly occupied by other manufacturing facilities.
		Locks 2, 3, 4, and 5: The area surrounding these properties is not shown on available Sanborn maps.
Reverse Directory	1943	**Property** *Property southwest of dam*: No Reverse directories were ascertained for this Property.
		Property northeast of dam: May support portions of the commercial businesses and residential properties identified along the south side of E. and W. Wisconsin Avenue. See below for more details on surrounding properties.
		Lock 1: Fox River Navigation Co. 8 identified at 250 Canal Street; U.S. Engineer's Office 275W and Richards Ripley 288J (Lockmaster at Lock 1) identified at "end" of Canal Street.
		Lock 2: Property not specifically identified.
		Locks 3, 4, and 5: East from the railroad tracks that bisect the Lock 3 Property, residential properties are identified south of Augustine Street. It is not known if these residences are specifically situated on the northern portions of the properties. They may be north adjacent to the properties.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory (cont.)	1943	**Surrounding** *Property southwest of dam*: No Reverse directories were ascertained for the area surrounding these properties. *Property northeast of dam*: Businesses identified on the south side of E. Wisconsin Avenue include beauty shop, taverns, and restaurant. Businesses identified on the south side of W. Wisconsin Avenue include grocery store, tavern, barber shop, restaurant, clothing store, shoe repair, and stationary and printing co. (215). The former garages identified on earlier Sanborn maps at 179 and 141/143 are listed as vacant and as a Ben Franklin Variety Store, respectively, in the Reverse directory. Businesses of note on the north side of W. Wisconsin Avenue include a gas station (200) and a jewelry store (124). Residential properties are also identified on E. and W. Wisconsin Avenue. *Lock 1*: No additional addresses identified for Canal Street. Outagamie County Teachers Training School was identified at 160 E. Wisconsin Avenue and is located immediately north of Canal Street. *Lock 2:* Residential properties are identified along Grignon. *Locks 3, 4, and 5:* Trinity Ev. Lutheran School identified north of Lock 2, on the south side of Augustine Street. Residential properties are identified on the north and south sides of Augustine Street from E. Tobacnoir to the northeast.
Sanborn Map	1945	**Property** *Property southwest of dam*: Not shown on available Sanborn maps. *Property northeast of dam:* Land-use appears similar to that in 1943. *Lock 1:* The maps do not show the eastern half of the Lock 1 Property. Buildings located on the south side of Canal Street include Office (250) and U.S. Government warehouses. Other buildings depicted south of Canal Street in earlier Sanborn maps are no longer present (including the machine shop). Land-use south of the canal appears similar to that in 1925. *Locks 2, 3, 4, and 5*: Not shown on available Sanborn maps.
		Surrounding *Property southwest of dam:* Municipal administration building still present. Municipal maintenance garage with gas UST is located further east of the Property, across Main Avenue (100 Main Avenue). Roundhouse and railyard are still present south. *Property northeast of dam:* Land-use appears similar to that in 1943. Former garages identified in 1925 are shown as vacant (179) and as a store (141/143) on the Sanborn map. However, gas tanks were still shown as present at the properties. The printing facility is apparent at 215. An outbuilding, formerly used for general storage in 1925, is identified as used auto storage in 1945. Although this building is located near the edge of the bluff, it is not situated on the Property. *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Buildings located south of Canal Street, including the machine shop, are no longer present. South of the Property, Thilmany Pulp and Paper Company occupies the entire land area; Union Bag and Paper Corp. is shown as a division of Thilmany Pulp and Paper Co. *Locks 2, 3, 4, and 5:* The area surrounding these properties is not shown on available Sanborn maps.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1951	**Property** *Property southwest of dam*: No Reverse directories were ascertained for this Property. *Property northeast of dam:* May support portions of the commercial businesses and residential properties identified along the south side of E. and W. Wisconsin Avenue. See below for more details on surrounding properties. *Lock 1:* Fox River Navigation Co., U.S. Engineer's Office, and Richards Ripley (Lockmaster) are identified at 250 Canal Street. Residential addresses are identified along Canal Street, and if these residences are south of the street, they may overlap part of the Property. However, the previous Sanborn map (1945) did not depict additional structures south of Canal Street between E. Wisconsin Avenue and 250 Canal Street. *Locks 2, 3, 4, and 5*: Similar listings as in 1943.
		Surrounding *Property southwest of dam*: No Reverse directories were ascertained for the area surrounding this Property. *Property northeast of dam*: Land-use appears similar to that in 1945. The following are changes of note: a printing company is identified north of E. Wisconsin Avenue (100); and Nu-Way Cleaners is identified south of W. Wisconsin Avenue (127). *Lock 1:* Land-use appears similar to that in 1945. However, residential properties, although not depicted on the south side of Canal Street on the 1945 Sanborn maps, are identified along Canal Street. *Locks 2, 3, 4, and 5:* Similar listings as in 1943.
Aerial Photograph	1952	**Property** *Property southwest of dam:* Approximately 300 feet of the western portion of Property is not shown on the available aerial photograph. Property appears wooded; possible surface water is present on eastern portion of Property. No structures are apparent. *Property northeast of dam*: Based on the review of the aerial photographs, Property does not appear to support any structures or portions of structures as previously discussed. The Property appears open/vacant and wooded. The remnants of the Guard Lock are obvious. *Lock 1*: The northern portion of Lock 1 Property supports approximately two or three structures in its eastern half. One of these buildings is at the current location of the Lockmaster's dwelling. The other buildings were previously identified as warehouses. The southern shore of the Property appears to support a roadway/driveway for Thilmany Paper. *Lock 2*: The former Lockmaster dwelling present at Lock 2. No other buildings observed. A railroad line crosses the canal at the boundary between Lock 2 and Lock 3. *Lock 3*: Timber Shed, garage with lean-to, and dry dock are evident. Additional buildings are also observed. *Locks 4 and 5*: Properties are not included in photograph.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph (cont.)	1952	**Surrounding** *Property southwest of dam*: The land south of the Property and north of the head race, is open/vacant. Buildings are apparent further east/southeast (including the municipal administration building and garage). The roundhouse and railyard are apparent to the south. Dark colored areas are apparent on the roundhouse property area. Two water tanks (Sanborn 1945) are also visible. *Property northeast of dam*: Land north/northwest of the Property along the riverbank, appears open/vacant. Land-use north/northeast appears similar as in 1951 (i.e., mostly commercial businesses). *Lock 1*: The area north of the Property supports small commercial or residential property; there are no structures south of Canal Street (with the exception of the buildings on the Property). The land south of the Property supports the paper company. The paper company extends further east than depicted on previous Sanborn maps. *Locks 2, 3, and 4*: A large manufacturing facility [Thilmany Pulp and Paper Company] is present south of these properties. This area was not shown on available Sanborn maps; therefore, the date of development of this area is not known. Dark surface patches, a smoke stack, potential disposal ponds, outdoor storage, and surface disturbances are apparent on this property to the south. Land-use north of these properties appears mostly open with some residential and/or agricultural development; Augustine Street is not paved. Land area surrounding Lock 5 Property is not shown on the aerial photograph.
Historic Map	1954	**Property** Only the eastern-most portion of the Lock 5 Property is shown and the scale makes assessment difficult. No structures are depicted.
		Surrounding Potential structures are depicted north of Lock 5.
Historic Map	1955	**Property** The scale makes assessment difficult. The Property land-use appears similar to that in 1952.
		Surrounding The scale makes assessment difficult. The land-use surrounding the Property appears similar to that in 1952.
Sanborn Map	1956	**Property** *Property southwest of dam*: Not shown on available Sanborn maps. *Property northeast of dam*: Land-use appears similar to that in 1952. *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Land-use appears similar to that in 1952. Parcel buildings are still depicted on the north side of the canal (office and U.S. Government Warehouse). The driveway/roadway on the south side of the canal is identified as Thilmany Road on the Sanborn map. *Locks 2, 3, 4, and 5:* Not shown on available Sanborn maps.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map (cont.)	1956	*Property southwest of dam*: Land-use south and east/southeast of the Property appears similar to that in 1952. Municipal administration building still present. Municipal maintenance garage with gas UST is located further east of the Property, across Main Avenue (100 Main Avenue). Roundhouse and railyard are still present south. *Property northeast of dam*: Land-use surrounding the Property appears similar to that in 1952. A filling station and auto sales and service shop are located north of E. Wisconsin Avenue (200 and 222 Lawe Street, respectively). The two gas tanks (179 and 141/143 W. Wisconsin Avenue) are no longer depicted; 215 E. Wisconsin Avenue is no longer identified as a printer. *Lock 1*: The maps do not show the eastern half of the Lock 1 Property. Land-use appears similar to that in 1952. One oil tank, three solvent USTs, and four wax tanks are depicted on the Thilmany Pulp and Paper Company property. *Locks 2, 3, 4, and 5:* Not shown on available Sanborn maps.
Aerial Photograph	1957	**Property** *Property northeast of dam*: Land-use appears similar to that in 1952 and 1956. Former guard lock remnants can be distinguished. *Lock 1:* Lockmaster's dwelling, garage, and two warehouses observed. *Lock 2:* Land-use appears similar to that in 1952. Lockmaster's dwelling can be seen. *Lock 3*: Land-use appears similar to that in 1952. Timbershed, garage with lean-to, and other structures can be seen. Dry dock is vegetated. *Locks 4 and 5:* Both properties are included in the aerial photograph. Both Lock 4 and 5 are apparent. Dense vegetation immediately north and south of Lock 4 so no structures can be seen. Lockmaster's dwelling at Lock 5 can be seen.
		Surrounding *Property southwest of dam*: Land-use surrounding these properties appears similar to that in 1952 and 1956. Municipal administration building still present. Municipal maintenance garage with gas UST is located further east of the Property, across Main Avenue (100 Main Avenue). Roundhouse and railyard are still present south. *Property northeast of dam*: Land-use surrounding these properties appears similar to that in 1952 and 1956. *Lock 1*: Land-use surrounding the Property is similar to that in 1952 and 1956. The oil and wax tanks depicted on the previous Sanborn map are visible on the Thilmany Pulp and Paper Co. property. A dark surface area is apparent surrounding the oil tank. *Locks 2, 3, 4, and 5*: Augustine Street, located parallel to the canal, appears completed (i.e., paved) past the eastern-most boundary of Lock 5 Property. A large disturbance, possibly a gravel pit, is visible north of Augustine Street; the other land-use north of the properties appears to be agricultural and/or residential. Land-use south of the properties is similar to that in 1952. Residence immediately north of Lock 5 is present.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1964	**Property** *Property southwest of dam*: Land-use appears similar to that in 1956. A surface disturbance (possible filling) is apparent on south end of dam. No structures are observed. *Property northeast of dam*: Land-use appears similar to that in 1957. *Lock 1:* Lockmaster's dwelling, garage, and two warehouses observed. *Lock 2:* Lockmaster's dwelling no longer observed. No structures evident at Lock 2. *Lock 3*: Timber shed, garage with lean-to, and Dry Dock evident. Possible construction activities at future location of Project Office. *Locks 4 and 5*: Land-use appears similar to that in 1957. A small, thin canal trends parallel north of the main canal. No buildings observed at Lock 4. Lockmaster's dwelling evident at Lock 5.
		Surrounding *Property southwest of dam:* Land-use surrounding the Property appears similar to that in 1957. *Property northeast of dam:* Land-use surrounding the Property appears similar to that in 1957. *Lock 1:* Land-use surrounding the Property appears similar to that in 1957. *Locks 2, 3, 4, and 5*: Land-use surrounding the properties appears similar to that in 1957. A surface disturbance, indicative of filling, is present south of Lock 3 Property; new settling basins are apparent south of Lock 5; and a large surface disturbance, indicative of a gravel pit, is present north of Locks 4 and 5. Residence north of Lock 5 is present.
Aerial Photograph	1971	**Property** *Property southwest of dam*: Land-use appears similar to that in 1964. The surface disturbance (filled area) on the south end of the dam includes all of the Property between the south end of the dam and the head race. *Property northeast of dam*: The land area along the northwest banks appears disrupted; an apparent access road from E. Wisconsin Avenue leads to the disturbance. *Lock 1*: Land-use appears similar to that in 1964. *Locks 2, 3, 4, and 5*: Land-use appears similar to that in 1964. Construction activities apparent at the current location of the Project Building.
		Surrounding *Property southwest of dam*: Land-use surrounding the Property appears similar to that in 1964. The land area surrounding the roundhouse and rail yard buildings appears disrupted and surface debris/storage is apparent in some areas. Building composition of the roundhouse property appears to have changed (i.e., some buildings were removed). *Property northeast of dam*: Land-use surrounding the Property appears similar to that in 1964. *Lock 1:* Land-use surrounding the Property appears similar to that in 1964. *Locks 2, 3, 4, and 5*: Land-use surrounding the properties appears similar to that in 1964.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1972	**Property** *Property southwest of dam*: No Reverse directories were ascertained for this Property. *Property northeast of dam*: Based on aerial photograph review, this Property does not appear to support any of the commercial buildings located on the south side of the E. and W. Wisconsin Avenue. *Lock 1*: U.S. Corps of Engineers and Kurt Hartstern (Lockmaster) were listed at 301 Canal Street. No listing for 250 Canal Street. *Locks 2, 3, 4, and 5*: Residential properties are listed for Augustine Street. Based on aerial photographs, these properties appear to support structures associated with the canal and the locks, not specifically residential properties. No listings for 1008 Augustine Street.
		Surrounding *Property southwest of dam*: No Reverse directories were ascertained for the area surrounding this Property. *Property northeast of dam*: Commercial businesses are listed along E. and W. Wisconsin Avenue. The printing company is no longer identified at 100 E. Wisconsin Avenue; and Nu-Way Cleaners is identified at 127 W. Wisconsin Avenue. *Lock 1:* Two additional residential listings were identified on Canal Street. *Locks 2, 3, 4, and 5:* Similar listings as in 1951 (i.e., residential listings)
Historic Map	1974	**Property** *Property southwest of dam*: No structures depicted. An unimproved roadway is present in eastern portion. *Property northeast of dam*: No structures depicted. Land-use appears similar to that in 1971. *Lock 1*: Several small structures are depicted north of the canal near Lock 1 (one west of the Lock is likely 301 Canal Street). *Lock 2*: One small structure is depicted on the north shore at the west end of Lock 2 itself. *Lock 3:* Two to three structures are depicted north of the canal extension, including the Project Office. *Locks 4 and 5*: No structures are depicted on these properties.
		Surrounding *Property southwest of dam*: The roundhouse is not depicted as present south of the Property. Other land-use surrounding the properties appears similar to that in 1971. *Property northeast of dam and Locks 1, 2, 3, 4, and 5*: Land-use surrounding these properties appears similar to 1971. Industrial waste ponds and a sewage disposal area are identified south of Lock 5 and a quarry is identified north of Locks 4 and 5.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1981	**Property** *Property southwest of dam*: Land-use appears similar to that in 1974. Small surface disturbances are apparent on the west portion of the Property near the bank of the river. Surface disturbances are no longer apparent on the east portion of the Property. The unimproved road depicted on the 1974 historical map is not apparent. *Property northeast of dam*: The surface disturbance seen in 1971 is no longer apparent on the river bank. Land-use appears similar to that in 1974. *Locks 1 and 2*: Large Oil House, Lockmaster's dwelling and garage are apparent north of Lock 1. No structures are apparent at Lock 2. *Lock 3:* Generator House, Project Office, timber shed, garage with lean-to, lockshelter, and oil house are apparent at Lock 3. Dry dock appears full of vegetation. *Locks 4 and 5*: Land-use appears similar to that in 1974.
		Surrounding *Property southwest of dam:* As depicted in the 1974 historical map, the roundhouse and rail yard associated buildings are no longer present. A new building is located west of the location of the former roundhouse. *Property northeast of dam*: Land-use surrounding the Property appears similar to that in 1974. The training school for teachers, located at the intersection of Wisconsin Avenue and Canal Street is no longer present. *Locks 1, 2, 3, 4, and 5*: Land-use surrounding these properties appears similar to that in 1974.
Historical Map	1984	**Property** *All properties*: The eastern most edge of Lock 5 Property is not shown. Land-uses depicted for these properties are similar to that depicted in 1974.
		Surrounding *Property southwest of dam*: Two new buildings are depicted to the south of the western portion of the Property. Land-use depicted for the remaining surrounding area is similar to that depicted in 1974. *Property northeast of dam and Locks 1, 2, 3, 4, and 5*: Land-use depicted for the area surrounding these properties is similar to that depicted in 1974
U.S. Government Historical Map (company records)	1986	**Property** *Property Southwest of the Dam*: No structrues are shown on the Property. *Property Northeast of the Dam*: No structures are shown on the Property. *Lock 1:* The large oil house and the Lockmaster's dwelling are shown north of Lock 1. *Lock 2*: No structures are identified. *Lock 3*: The project office, dry dock, and lockshelter are shown. *Lock 4*: The lockshelter is shown. *Lock 5*: The Lockmaster's dwelling and garage are shown.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
U.S. Government Historical Map (company records) (cont.)	1986	**Surrounding** *Southwest and Northeast of the Dam*: Land use is not specifically identified expect for the Kaukauna Public Library (current location) and Kaukauna Electric and Water Department (current Cops Construction location). *Locks 1, 2, 3, and 4:* Land use north of these locks is not identified. Thilmany Pulp & Paper Co. occupies the land south of these locks. *Lock 5:* Land use north of Lock 5 is not identified. The City of Kaukauna Sewage Plant and Thilmany Paper Waste Treatment Facility are located south of Lock 5.
Reverse Directory	1990	**Property** *Property southwest of dam*: No Reverse directories were ascertained for this Property. *Property northeast of dam*: No Reverse directories were ascertained for this Property. *Lock 1*: [redacted] was listed at 250 Canal Street. However, this address may no longer be associated with the Property. 301 Canal Street was not listed. *Locks 2 and 3:* Government of United States and State of Wisconsin are listed at 1008 Augustine Street (Lock 3). *Locks 4 and 5*: Residential properties are listed for Augustine Street and these residences are not likely situated on these properties.
		Surrounding *Property southwest of dam*: No Reverse directories were ascertained for the area surrounding these properties. *Property northeast of dam*: Commercial businesses are listed for Wisconsin Avenue (no longer identified as W. Wisconsin Avenue) and E. Wisconsin Avenue. Clark's Cleaners was identified at 211 Wisconsin Avenue; Nu-Way Cleaners was no longer listed at 127 Wisconsin Avenue. *Lock 1*: Residential properties were listed for Canal Street. *Locks 2, 3, 4, and 5:* Similar listings as in 1951 (i.e., residential listings on Augustine Street)
Historical Map	1992	**Property** *Property southwest of dam*: No structures depicted. An unimproved roadway is still depicted over an east portion of Property. However, that roadway is not apparent in the 1981 aerial photograph. *Property northwest of dam:* No structures depicted. This Property is not shaded-in, indicating no urban development of the Property. *Lock 1:* Two buildings are depicted near Lock 1. *Lock 2:* One structure is still depicted near Lock 2. *Lock 3*: Five structures are depicted in the vicinity of the canal extension portion of the Property. The historical map indicates Locks 2 and 3 have been combined into one long lock system and that the canal extension is no longer present. This is not observed during the site inspection. Lock 2 and 3 appeared as described for previous historical resources. *Locks 4 and 5*: No structures depicted. The small, thin canal, first observed in the 1964 aerial photograph, is not depicted on the historical map.

Table 5 – Kaukauna Locks and Dam (cont.)

Primary Resources Summary

Source	Date	
		Surrounding *Property southwest of dam*: The area surrounding the Property is shaded-in, symbolizing urban development for the area. Specific building footprints are not depicted.
		Property northeast of dam and Locks 1, 2, 3, 4, and 5: The area surrounding the properties is mostly shaded-in; the areas not shaded in depict building structures (i.e., development). The quarry and the sewage disposal area and industrial waste ponds depicted on the 1974 (and 1984) historical maps are still indicated south and north of Locks 4 and 5.
Aerial Photograph	1992	**Property** *Property southwest of dam:* The square-shaped disturbance, first apparent in the 1956 aerial photograph, but not seen in more recent photographs, is again apparent. A dark area, possibly trees, is apparent north of the disturbance. An unimproved road/driveway is present on the southeast portion of the Property, possibly utilized for dam access from the south shore. No structures are apparent on the properties. *Property northeast of the dam:* Land-use appears similar to that in the 1992 historical map. *Lock 1*: Large Oil House, Lockmaster's dwelling, and garage are apparent near Lock 1. A circular structure and a small area of surface disturbance/debris are located along the canal bank, west/southwest from the large Oil House. *Lock 2*: One or two structures are apparent. *Lock 3*: Project Office area is as observed during the April 2000 site inspection. The photograph does not indicate the merger of Locks 2 and 3 and the filling of the canal extension. *Locks 4 and 5:* Land-use at these properties appears similar to that in the 1992 historical map. The small, thin channel north of the canal that was not depicted on the historical map is partially apparent on the Lock 5 Property.
		Surrounding *Property southwest of dam*: The area of the former roundhouse and rail yard now supports multiple multifamily buildings. Other land-use in the area is similar to that in 1981. *Property northeast of the dam and Locks 1, 2, 3, 4, and 5:* Land-use surrounding these properties is similar to that in the 1992 historical map.

Table 6 – Kaukauna Depot 8 (Lock 2)

Primary Resources Summary

Source	Date	
U.S. Government Historical Map (company records)	1910	**Property** A U.S. Lock House and barn are shown immediately north of Lock 2.
		Surrounding A Branch Track of Chicago & Northwestern Railway is shown south of and then crossing immediately east of Lock 2. The land north of Lock 2 appears to be platted for residential development. No development is shown immediately south of Lock 2.
Reverse Directory	1943	**Property**
		Property not specifically identified.
		Surrounding Residential properties are identified along Grignon.
Reverse Directory	1951	**Property** Similar listings as in 1943.
		Surrounding Similar listings as in 1943.
Aerial Photograph	1952	**Property** The former Lockmaster dwelling present at Lock 2. No other buildings observed. A railroad line crosses the canal at the boundary between Lock 2 and Lock 3.
		Surrounding A large manufacturing facility [Thilmany Pulp and Paper Company] is present south of these properties. This area was not shown on available Sanborn maps; therefore, the date of development of this area is not known. Dark surface patches, a smoke stack, potential disposal ponds, outdoor storage, and surface disturbances are apparent on this property to the south. Land-use north of these properties appears mostly open with some residential and/or agricultural development; Augustine Street is not paved.
Historic Map	1955	**Property** The scale makes assessment difficult. The Property land-use appears similar to that in 1952.
		Surrounding The scale makes assessment difficult. The land-use surrounding the Property appears similar to that in 1952.
Aerial Photograph	1957	**Property** Land-use appears similar to that in 1952. Lockmaster's dwelling can be seen.
		Surrounding Augustine Street, located parallel to the canal, appears completed (i.e., paved). A large disturbance, possibly a gravel pit, is visible north of Augustine Street; the other land-use north of the properties appears to be agricultural and/or residential. Land-use south of the properties is similar to that in 1952.
Aerial Photograph	1964	**Property** Lockmaster's dwelling no longer observed. No structures evident at Lock 2.
		Surrounding Land-use surrounding the properties appears similar to that in 1957.

Table 6 – Kaukauna Depot 8 (Lock 2) (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1971	**Property** Land-use appears similar to that in 1964.
		Surrounding Land-use surrounding the properties appears similar to that in 1964.
Reverse Directory	1972	**Property** Residential properties are listed for Augustine Street. Based on aerial photographs, these properties appear to support structures associated with the canal and the locks, not specifically residential properties.
		Surrounding Similar listings as in 1951 (i.e., residential listings)
Historic Map	1974	**Property** One small structure is depicted on the north shore at the west end of Lock 2 itself.
		Surrounding Land-use surrounding these properties appears similar to 1971.
Aerial Photograph	1981	**Property** No structures are apparent at Lock 2.
		Surrounding Land-use surrounding these properties appears similar to that in 1974.
Historical Map	1984	**Property** The eastern most edge of Lock 5 Property is not shown. Land-uses depicted for these properties are similar to that depicted in 1974.
		Surrounding Land-use depicted for the area surrounding these properties is similar to that depicted in 1974
U.S. Government Historical Map (company records)	1986	**Property** No structures are identified.
		Surrounding Land use north of the lock is not identified. Thilmany Pulp & Paper Co. occupies the land south of the lock.
Reverse Directory	1990	**Property** Not specifically identified.
		Surrounding Similar listings as in 1951 (i.e., residential listings on Augustine Street)
Historical Map	1992	**Property** One structure is still depicted near Lock 2.
		Surrounding The area surrounding the Property is mostly shaded-in; the areas not shaded in depict building structures (i.e., development).
Aerial Photograph	1992	**Property** One or two structures are apparent.
		Surrounding Land-use surrounding the Property is similar to that in the 1992 historical map.

Table 7 – Little Chute Locks

Primary Resources Summary

Source	Date	
U.S. Government Historical Map	1910	**Property** Guard Lock: Both Guard lock and Second lock, the spillway north of Second Lock and the dam are located on the map. The lockmaster dwelling is shown in its current location. A 6' diameter cistern is located northwest of the dwelling. An unidentified building is located south of Second lock (lockshelter). Zeeland Mill and one support building are located on the property just off the north edge of the dam. Approximately ½ of the unidentified support building is on U.S. Government Property. A support building is also located on the dam. A draw bridge crosses over the Guard Lock and then the Highway Bridge crosses over the south portion of the Property and crosses the Fox River. Park: Property boundaries are current. The park area has not yet been filled. No buildings are shown on Property. Canal: Property boundaries are current. Combined Locks: The locks, dam and lockmaster dwelling are shown in current locations. The dam is identified as Combined Locks Paper Company Dam. A water closet is located northeast of the dwelling. An office is located on the southwest corner of the locks. This building and the water closet no longer remain on the Property.
		Surrounding Guard Lock: The area north of the Property is residential. Only two buildings, both adjacent to the Property, are drawn on the map. One of these buildings is at the current location of the "Down the Hill" bar. The second building is north of the U.S. Canal midway between the Guard Lock and the Second Lock. South of Fox River Little Chute Pulp Company is identified on the map. Park: No details of surrounding areas on the map. Canal: No details of surrounding areas on the map. Combined Locks: The Combined Locks Paper Company Mill is located on the south bank of Fox River. The buildings identified as part of the paper mill include a pulp mill and power house, wet machine room, engine room, machine rooms, finishing room, wood room, digester, washing room, acid room, boiler room, office, and storage shed.
Sanborn Map	1925	**Property** Guard Lock: Guard Lock has been removed. Area shown is where the draw bridge cross the canal. The street is identified as Monroe. No details regarding the lock structures are shown. Park: Not shown Canal: Not shown Combined Locks: Not shown
		Surrounding Area shown is north of Fox River between West and Canal Streets (north to south) and between Monroe and Wilson Streets (west to east). Parcel southwest of the intersection of Church and Pine identified as St. Johns R.C. School. Residences are shown

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
		along the south side of Canal Street (immediately north of the area between the Guard Lock and the Second Lock. Area south of the Guard Lock is identified as Little Chute Flour Mill Co.
Aerial Photograph	1938	**Property** Guard Lock: Guard lock has been removed. Second lock and the spillway, the dam, lockshelter, and lockmaster dwelling are visible on the map. Map is blurred and difficult to interpret. Park: Not yet developed. Lagoon in location of current Park area. Canal: Property boundaries are current. Combined Lock: Locks and dam shown at current locations. Lockmaster dwelling shown at current location. Map is blurred and difficult to interpret.
		Surrounding Guard Lock: The area north of the Property is residential. South of the property, on the south berm of the canal, the land is developed with a road and possibly an open lot or garage. South of Fox River Little Chute Pulp Company is visible followed by mainly agricultural land. Park: The area surrounding the park is woodland and residential. Canal: The property adjacent to the canal is vacant and wooded. North of this the area is residential. The Fox River is located south of the canal. Combined Locks: Just west of the dam a log boom is strung across the river which is collecting significant debris. North of the Property land is agricultural and woodland. The Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. Beyond the mill the land is primarily agricultural.
Sanborn Map	1943	**Property** Guard Lock: Guard lock removed. Second Lock, spillway, lockmaster dwelling, lockshelter, and bridge tenders house are shown in current location. An unidentified building is located east of the lockmaster dwelling. Park: Property not shown on this map. Canal: Property not shown on this map. Combined Locks: Property not shown on this map.
		Surrounding Guard Lock: The area north of the Property is residential. Sewage Treatment Plant located adjacent to the Property on the south berm of the canal. Fox River is located to the south of the Property. Park: North of the Property is primarily residential, Property and south not shown. The area north of the U.S. Canal between the Second Lock and the current park area is the Village Water Works. This area currently holds the park pool. Canal: North of the Property is residential, Property and south not shown. Combined Locks: North of the Property is residential, Property and south not shown.

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1943	**Property** Guard Lock: Not specifically identified. Park: Not specifically identified. Canal: Not specifically identified. Combined Locks: Not specifically identified.
		Surrounding Residences are identified along Bluff Avenue South between Taylor St. to Buchanan St. (north of U.S. Canal between current park area and approximately 1000 feet west of the Combined Locks). Residences are identified along Buchanan St. between the Fox River to Park Avenue. Residences and the VerKuilen Funeral Home are identified along Canal Street between Grand Ave. and Vanden Brook St. (north of Second Lock area). St. John's Catholic church and school is identified along Church St. (north of the Second Lock). Residences and the Riverside Club (bar?) are identified along Mill Street immediately north of Guard Lock. Residences are identified along Monroe Street north from the former Guard Lock area. Residences identified along Park Avenue between Wilson and Buchanan (north of park area). Residences and small commercial buildings (bars, bakery) identified along Pine St. and Vandenbrook north from the U.S. Canal. Residences and the Riverview Sanitorium are identified along Sanitorium Road north from the Fox River.
Reverse Directory	1951	**Property** Guard Lock: Not specifically identified. Park: Not specifically identified. Canal: Not specifically identified. Combined Locks: Not specifically identified.
		Surrounding Residences are identified along Bluff Avenue South between Taylor St. to Buchanan St. (north of U.S. Canal between current park area and approximately 1000 feet west of the Combined Locks). Residences are identified along Buchanan St. between the Fox River to Park Avenue. Residences and the VerKuilen Funeral Home are identified along Canal Street between Grand Ave. and Vanden Brook St. (north of Second Lock area). St. John's Catholic church and school is identified along Church St. (north of the Second Lock). Residences and Mitch's Bar are identified along Mill Street immediately north of Guard Lock. Residences are identified along Monroe Street north from the former Guard Lock area. Residences identified along Park Avenue between Wilson and Buchanan (north of park area). Residences and small commercial buildings (Radio & Television sales and service, knitting company, bars,barber) identified along Pine St., Vandenbrook, Grand Ave., and Franklin St. north from the U.S. Canal. Residences and the Riverview Sanitorium are identified along Sanitorium Road north from the Fox River.

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1953	**Property** Guard Lock: Second lock and the spillway, the dam, lockmaster dwelling, lockshelter and the bridge tenders house are visible on the photograph. An unknown building is located east of the lockmaster dwelling and one on the southeast corner of Second Lock. Map is blurred and difficult to interpret. Park: Not yet developed. Lagoon in location of current Park area. Canal: Property boundaries are current. Combined Lock: Locks and dam shown at current locations. Lockmaster dwelling and driveway shown at current locations. An unidentified small building is located between the driveway and dwelling. Map is blurred and difficult to interpret.
		Surrounding Guard Lock: The area north of the Property is residential. Additional developments since 1938. A school is located 500 feet directly north of the Property. A Sewage Treatment Plant, road, garage and four outdoor piles of unidentified substances are located south of the property, on the south berm of the canal. This area is the property of Little Chute. Construction south of Fox River. A new bridge is under development west of the property. Land is industrial south of Fox River followed by mixed residential and agricultural. Park: The area surrounding the park is vacant woodland and residential. Additional residential buildings east of the Property. Canal: The property adjacent to the canal is vacant and wooded. North of this the area is residential. The Fox River is located south of the canal. Combined Locks: Just west of the dam a log boom is strung across the river. North of the Property land is agricultural and woodland with a few residences. The Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. Beyond the mill the land is mixed residential and agricultural.
Historical Map	1955	**Property** Small-scale map. Individual property features are not discernable.
		Surrounding Area north of the Property identified as developed (town of Little Chute). Individual structures are not discernable. Area south of the Property identified as developed (town of Kimberly). Mill south of the Combined Locks is shown.
Aerial Photograph	1957	**Property** Guard Lock: Second lock and the spillway, the dam, lockmaster dwelling, lockshelter and the bridge tenders house are visible on the map. An unknown building is located on the southeast corner of Second Lock. Highway Bridge (Monroe St.) which previously crossed the site is no longer observed. Park: Not yet developed. Lagoon in location of current Park area. Canal: Property boundaries are current.

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
		Combined Lock: Locks and dam shown at current locations. Lockmaster dwelling and driveway shown at current locations. An unidentified small building is located between the driveway and dwelling.
		Surrounding Guard Lock: The area north of the Property is residential. Residential area has expanded further north. A school is located 500 feet directly north of the Property. A new bridge has been completed west of the Property. Activity on the City of Little Chute property south of the Property, Sewage Treatment Plant on the south berm of the canal. Additional residential expansion south of Fox River. Land is industrial along the bank of Fox River followed by mixed residential and agricultural. Park: The area west of the park is vacant woodland and followed by residential. Additional residential buildings east of the Property. Canal: The property adjacent to the canal is vacant and wooded. Possible filling north of U.S. Canal midway between the Second Lock and the Combined Locks. North of this the area is residential. The Fox River is located south of the canal. Combined Locks: Just west of the dam a log boom is strung across the river. North of the Property land is agricultural and woodland with a few residential houses. The Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. Beyond the mill the land is mixed residential and agricultural.
Aerial Photograph	1964	**Property** Guard Lock: Second lock and the spillway, the dam, lockmaster dwelling, lockshelter, garage and the bridge tenders house are visible on the map. Construction activity along Second Lock. Park: Not yet developed. Lagoon in location of current Park area. Canal: Property boundaries are current. Combined Lock: Locks and dam shown at current locations. The area appears to be under construction. No buildings are identifiable on the photograph.
		Surrounding Guard Lock: The area north of the Property is residential. A school is located 500 feet directly north of the Property. Sewage Treatment Plant and construction is occurring to expand east along the City of Little Chute property south of the Property, on the south berm of the canal. Additional residential expansion south of Fox River. Land is industrial along the bank of Fox River followed by residential. Park: The area west of the park is vacant woodland and followed by residential. Additional residential buildings east of the Property. Canal: The property adjacent to the canal is vacant and wooded. North of this the area is residential. Possible filling north of U.S. Canal midway between the Second Lock and the Combined Locks. The Fox River is located south of the canal. South of Fox River formerly agricultural land is under construction.

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
		Combined Locks: Debris along log boom has been removed. North of the Property land is agricultural and woodland with a few residential houses. The Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. Beyond the mill the land is primarily residential.
Aerial Photograph	1971	**Property** Guard Lock: Second lock and the spillway, the dam, lockmaster dwelling, lockshelter, garage and the bridge tenders house are visible on the map. Tree cover makes it difficult to identify buildings. Park: City of Little Chute is in the process of filling in the Lagoon. Approximately ¾ complete. The area which currently hold the city pool is also being filled. Canal: Property boundaries are current. Combined Lock: Locks and dam shown at current locations. Lockmaster dwelling, garage, oil house, and sanitary facility in current locations. The driveway is under construction.
		Surrounding Guard Lock: The area north of the Property is residential. A school is located 500 feet directly north of the Property. Sewage Treatment Plant and new garage and roads on the City of Little Chute property south of the Property, on the south berm of the canal. Construction still ongoing in this area. A new large warehouse is located on the south bank of Fox River. Land is industrial along the bank of Fox River followed by residential. Park: The area west of the park is vacant woodland and followed by residential. East of the Property the area is residential. Canal: The property adjacent to the canal is vacant and wooded. North of this the area is residential. The Fox River is located south of the canal. Combined Locks: North of the Property land is agricultural and woodland with a few residential houses. The Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. Additional industrial buildings along the bank and on-going construction. Beyond the mill the land is primarily residential.
Reverse Directory	1972	**Property** Guard Lock: Not specifically identified. Park: Not specifically identified. Canal: Not specifically identified. Combined Locks: Not specifically identified.
		Surrounding Residences are identified along Bluff Avenue South between Taylor St. to Buchanan St. (north of U.S. Canal between current park area and approximately 1000 feet west of the Combined Locks). Residences are identified along Buchanan St. between the Fox River to Park Avenue. Residences and the VerKuilen Funeral Home are identified along Canal Street between Grand Ave. and Vanden Brook St. (north of Second Lock area). Little Chute swimming pool identified at east end of Canal Street. St. John's

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
		Catholic church and school is identified along Church St. (north of the Second Lock). Residences are identified along Mill Street immediately north of Guard Lock. Residences and an elementary school are identified along Monroe Street north from the former Guard Lock area. Residences identified along Park Avenue between Wilson and Buchanan (north of park area). Residences and small commercial buildings (Lamers Furniture & Mattress Co., bars,barber) identified along Pine St., Vandenbrook, Grand Ave., and Franklin St. north from the U.S. Canal.
Historical Map	1974	**Property** Small-scale map. Individual property features are not readily discernable. Lockmaster's shelter at Guard Lock is shown. Park area is shown as filled. Two structures are shown at the Combined Locks at or near the current location of the Lockmaster's Dwelling.
		Surrounding Area north of the Property identified as developed (town of Little Chute). Sewage Disposal plant shown south of the Guard Lock. Individual structures are not discernable. Area south of the Property identified as developed (town of Kimberly). Mill south of the Combined Locks is shown.
Aerial Photograph	1981	**Property** Guard Lock: Second lock and the spillway, the dam, lockmaster dwelling, lockshelter, garage and the bridge tenders house are visible on the map. Park: Lagoon is now completely filled in. Softball diamonds are being constructed. Canal: Property boundaries are current. Combined Lock: Locks and dam shown at current locations. Lockmaster dwelling, garage, oil house, and sanitary facility in current locations. The driveway is complete.
		Surrounding Guard Lock: The area north of the Property is residential. A school is located 500 feet directly north of the Property. Sewage Treatment Plant, garage and roads on the City of Little Chute property south of the Property, on the south berm of the canal. Construction still ongoing in this area. A large warehouse is located on the south bank of Fox River. Land is industrial along the bank of Fox River followed by residential. Residential area has expanded east. Park: The area west of the park is vacant woodland and followed by residential. East of the Property the area is residential. Canal: The property adjacent to the canal is vacant and wooded. North of this the area is residential. The Fox River is located south of the canal. Construction activities are occurring south of the Fox River approximately halfway between the Second Lock and the Combined Locks. Combined Locks: North of the Property land is residential and woodland Residential area has expanded over former agricultural land. Parkside Care Center located just north of the dam. The

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
		Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. New ASTs located east of the mill. Beyond the mill the land is primarily residential.
Historical Map	1984	**Property** Small-scale map. Individual property features are not readily discernable. Lockmaster's shelter at Guard Lock is shown and building on southwest corner of the Second Lock. Park area is shown as filled. Two structures are shown at the Combined Locks at or near the current location of the Lockmaster's Dwelling.
		Surrounding Area north of the Property identified as developed (town of Little Chute). Sewage Disposal plant shown south of the Guard Lock. Individual structures are not discernable. Area south of the Property identified as developed (town of Kimberly). Mill south of the Combined Locks is shown.
U.S. Government Historical Map	1986	**Property** Three buildings are shown north of the Guard Lock. Two are at the locations of the Lockmaster's Dwelling and the garage, but are not identified. The third building is identified as the sanitary facility. The ballfields are shown on the Property within the park. Four buildings are shown at the Combined Locks. Three of the buildings are at the locations of the current Lockmaster's Dwelling, lockshelter, and garage, but are not specifically identified. The fourth buildings is identified as the oil house.
		Surrounding The sewage plant with associated garages is shown immediately south of the Guard Lock. The Kaukauna Hydroelectric Plant and Water Plant and a warehouse are shown south of the river. Expanded park facilities are shown north of the canal. Riverview Sanitorium and hospital is shown northeast of the Combined Locks. Appleton Papers, Inc. is shown south of the Combined Locks and Fox River.
Reverse Directory	1990	**Property** Guard Lock: Not specifically identified. Park: Not specifically identified. Canal: Not specifically identified. Combined Locks: Not specifically identified.
		Surrounding Residences are identified along Bluff Avenue South between Taylor St. to Buchanan St. (north of U.S. Canal between current park area and approximately 1000 feet west of the Combined Locks). Residences are identified along Buchanan St. between the Fox River to Park Avenue. Residences and the VerKuilen Funeral Home are identified along Canal Street between Grand Ave. and Vanden Brook St. (north of Second Lock area). Residences and the Old Time Inn are identified along Mill Street immediately north of Guard Lock. Residences and an elementary school are

Table 7 – Little Chute Locks (cont.)

Primary Resources Summary

Source	Date	
		identified along Monroe Street north from the former Guard Lock area. Residences identified along Park Avenue between Wilson and Buchanan (north of park area). Residences and small commercial buildings (church, insurance agency) identified along Pine St., Vandenbrook, Grand Ave., and Franklin St. north from the U.S. Canal. S&E Storage and Sanderfoot Construction, Inc. identified on Sanitorium Road northeast of the Combined Locks.
Aerial Photograph	1992	**Property** Guard Lock: Second lock and the spillway, the dam, lockshelter, oil house and the bridge tenders house are visible on the map. Tree cover hides the lockmaster dwelling and garage. Park: Lagoon is now completely filled in. Baseball diamonds, a park shelter, and an asphalt parking lot and driveway are complete. Canal: Property boundaries are current. Combined Lock: Locks and dam shown at current locations. Lockmaster dwelling, garage, oil house, lockshelter, and sanitary facility in current locations.
		Surrounding Guard Lock: The area north of the Property is residential. A school is located 500 feet directly north of the Property. Sewage Treatment Plant has been removed and a lift station is in its place. Garage structure has been removed and the foundation remains on the City of Little Chute property south of the Property, on the south berm of the canal. A small foundation is also east of the former garage. Roads have been partially removed. A large warehouse is located on the south bank of Fox River. Land is industrial along the bank of Fox River followed by residential. Park: Much of the woodland west of the park has been cleared. The area surrounding the park is mainly residential. Canal: The property adjacent to the canal is vacant and wooded. North of this the area is residential. The Fox River is located south of the canal. Combined Locks: North of the Property land is residential and woodland Residential area has expanded. Parkside Care Center located just north of the dam. The Fox River is south of the Property. The Combined Locks Paper Company mill is shown on the south bank of Fox River. Additional ASTs located east of the mill. Beyond the mill the land is primarily residential. New developments in this area.
Historical Map	1992	**Property** Small-scale map. Individual property features are not readily discernable. Building shown on southwest corner of the Second Lock. Park area is shown as filled. Three structures are shown at the Combined Locks at or near the current location of the Lockmaster's Dwelling and garage.
		Surrounding Building foundations and lift station shown on the Little Chute property south of the Second Lock. Area north of the Property identified as developed (town of Little Chute). Area south of the Property identified as developed (town of Kimberly).

Table 8 – Cedars Lock and Dam

Primary Resources Summary

Source	Date	
U.S. Government Historical Map (company records)	1910	**Property** Lock and dam are both identifiable on the map. The location of a former dam upstream from the current location is drawn on the map. A "U.S. Lock House" is located just north of the west end of the lock. Three small buildings are located just west of the House. The uses of these buildings are not identified. None of these buildings remain on the Property.
		Surrounding The area north of the lock is vacant. A road labeled *Public Road from Appleton to Kaukauna* runs parallel to Fox River 500 feet north of the lock. On the south end of the dam Kimberly & Clark Paper Mill is located along the shoreline of Fox River. Buildings associated with the paper mill include a wood preparing house, machine shop, boiler house, wash house, digesters, machine room, engine room, bleach house, stock house, lime house, boiler house, grinder buildings, and wet machine building. The only other development labeled south of Fox River and the paper mill is a hotel and the streets of the Village of Kimberly.
Aerial Photograph	1953	**Property** The lock and dam are both identifiable on the map. No buildings are evident on the Property area.
		Surrounding North of the Property land use is agricultural and residential, but only sparsely populated. There is a building on the agricultural land adjacent to the Property on the north. Chicago and North Western Railroad runs along the Fox River less than ½ mile north of the Property. Land north of the railroad tracks is a meandering streambed. A bridge crosses Fox River just west of the dam. Directly South of the dam, across the Fox River from the Property, is a paper mill. Additional industrial buildings have been constructed in this area. Railroad tracks run along Fox River. South of the industrial buildings is a densely populated residential area. Towards the east of the residential area some agricultural land remains.
Historical Map	1955	**Property** Small-scale map. Lock and dam are visible, but not labeled on the map. Buildings are not discernable.
		Surrounding Small-scale map, neighboring properties not discernible. Heavy population areas along Fox River. North and south of the River the population thins.

Table 8 – Cedars Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1957	**Property** Lock and dam visible. Lockmaster dwelling north of the lock and lockshelter south of the lock now obvious. No additional buildings were observed.
		Surrounding North of the lock construction of Circle Acres Trailer Park has begun, the east half of the circle is complete and already houses several trailers. There is some scaring on the land located between Main and Washington streets. The bridge that formerly crossed Fox River just west of the Dam has been removed. South of Fox River additional industrial buildings have been constructed including one holding tank located just west of the dam.
Aerial Photograph	1964	**Property** Lock and dam, lockshelter, and lockmaster dwelling visible. No additional buildings were observed.
		Surrounding A driveway, one building, and excavation activities are occurring on the agricultural land adjacent to the Property on the north. Circle Acres Trailer Park is now complete. Addition residential development east of Washington Street. Altergott Plumbing building constructed north of the site. South of Fox River land use is similar to 1957.
Aerial Photograph	1971	**Property** Lock and dam, lockshelter, and lockmaster dwelling visible. No additional buildings were observed.
		Surrounding Construction on the land adjacent to the Property on the north is now completed. Some scaring visible on the land located just north of the Railroad, 500 feet northwest of the Property (possible demolition filling). South of Fox River there is a new addition to the main building of the Mid-tech Corporation/Inter Lake Papers. Otherwise land use unchanged since 1964.
Historical Map	1974	**Property** Small scale map. Lock and dam are labeled on the map. Lockmaster dwelling also visible.
		Surrounding The trailer park is labeled on the map and industrial area is indicated south of the dam and Fox River. Small-scale map.
Aerial Photograph	1981	**Property** Lock and dam, lockshelter, lockmaster dwelling, garage, and one additional buildings (likely the oil house) visible.
		Surrounding As 1971. Additional residential development east of Washington Street. Former agricultural land east of Mid-tech Corporation/Inter Lake Papers has been developed into industrial property.

Table 8 – Cedars Lock and Dam (cont.)

Primary Resources Summary

Source	Date	
Historical Map	1984	**Property** Small scale map. Lock and dam are labeled on the map. Lockmaster dwelling also visible.
		Surrounding The Trailer Park is labeled on the map and industrial area is indicated south of the dam and Fox River. Small-scale map.
U.S. Government Historical Map	1986	**Property** Lock, dam, oil house, lockmasters dwelling, and garage are identified on Property.
		Surrounding Circle Acres Trailer Park identified north of Property. Residential properties shown northwest of Property. Mid-Tech Corp. paper mill shown on south side of dam.
Aerial Photograph	1992	**Property** Lock and dam, lockshelter, lockmaster dwelling, garage, oil house all evident.
		Surrounding Filling evident on the land located just north of the Railroad, 500 feet northwest of the Property (demolition landfill). Additional residential development east of Washington Street. Additional industrial development south of the Fox River. Addition to Mid-tech Corporation/Inter Lake Papers and the area east.
Historical Map	1992	**Property** Small scale map. Lock and dam are labeled on the map. Lockmaster dwelling also visible.
		Surrounding Small-scale map. Mobile Home Park labeled north of the Property. Sewage Disposal facility is located South of the Fox River east of the Property. Paper mill is not identified, but it is likely that it remained at former location.

Table 9 – Appleton Locks

Primary Resources Summary

Source	Date	
Sanborn Map	1883	**Property** **Lock 1 –** Lock 1 is shown at approximately the current position. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as Mississippi & Green Bay Canal Co. Warehouse and platform (2816 Lake Street). Land south of U.S. Canal is not shown.
		Lock 2 – Area south of Lock 2 not shown. Lock is shown at current location. No buildings identified as being associated with Lock 2.
		Lock 3 - Lock is shown at current location. No buildings identified as being associated with Lock 3. A portion of the Appleton Toy factory is also located immediately south of Lock 3 (woodworking and painting buildings).
		Lock 4 - Lock is shown at current location. No buildings identified as being associated with Lock 4. Two parcels west and east of dam are not shown.
		Surrounding Atlas Paper Company pulp mill shown immediately north of Lock 1. Land immediately northeast of Lock 1 area is identified as coal yard. Land north and across from Lock 1 on the north side of the Fox River as identified as the Appleton Gas Light Co., Fox River Flour Mill, A. Spiering Custom Caring and Dye House, Outagamie Paper Mills, and Briggs, Whorton, and Beveridge Planning Mill. Kimberly Clark Company Paper Mill shown at current location north of Fox River (northeast of Lock 1). The land north of the Mississippi & Green Bay Canal Co. is identified as a coal yard. The Appleton Boot & Shoe Manufacturing Co. (2810 ½ Lake Street), M.L.S. & W.R.R. Depot (2808 Lake Street), Appleton Machine Co. and Appleton Crochet and Knitting Co. are located between the coal yard and the Fox River to the north. The Appleton Water Works and Appleton Manufacturing Co. are located north of the Fox River. Area immediately north of Lock 2 identified as the Ramsay & Jones Lumber Yard (piles of lumber, shingles, stone, lime). North of lumber yard are railroad tracks with a depot, warehouse, and roundhouse. North of railroad yard are the Valley Pulp & Paper Co. Mill, Fox River Straw Board Mills, Appleton Woolen Mills, and the Valley Iron Works between the South Channel and West's Canal. The W.M. Webster's Planing Mill, Appleton Hub and Spoke Factory, Patten Paper Company, Vulcan St. Appleton Furnace Co. and A.D. Fleming Linen Works are located between West's Canal and the Fox River. Immediately west of lumber yard west to Lake Street (current S. Oneida Street) is residential. Immediately east of lumber yard is the Appleton Tannery and Appleton Toy factory (woodworking and painting buildings). Southeast of intersection of South River Street and Lake Street (current Oneida Street) is an Ice House/brewery. Furnace Factory shown north of South Channel (north of Lock 3). Area east of Lock 4 identified as G.N. Richmond and Bros. paper mill.
Sanborn Map	1886	**Property** **Lock 1 –** Lock 1 is shown at approximately the current position. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as Mississippi & Green Bay Canal Co. Warehouse and platform and Edison Electric Light Company (office). Land south of U.S. Canal is not shown.
		Lock 2 – Area south of Lock 2 not shown. Lock is shown at current location. No buildings identified as being associated with Lock 2.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Lock 3 – Lock is shown at current location. Dwelling is shown at current location of bridge house (immediately west of Lawe St.). Area south of Lock 3 is not shown.
		Lock 4 – No coverage.
		Surrounding Atlas Paper Company pulp mill shown immediately north of Lock 1. Land immediately north of the Fox River and across from Lock 1 identified as the Appleton Gas Light Co., A. Spiering Custom Carding and Dyeing, Ravine Paper Co., Lawrence Flour Mill, Outagamie Flour Mills, and the ruins of Briggs, Whorton, and Beveridge Planning Mill (burnt July 1886). The land north of the Mississippi & Green Bay Canal Co. is identified as a coal yard and Edison Electric Light Co. offices and flume. The Appleton Boot & Shoe Manufacturing Co., M.L.S. & W.R.R. Depot, Edison Electric Light Co., and Champion Horse Nail Co. are located between the coal yard and the Fox River to the north. Area immediately north of Lock 2 identified as the Ramsay & Jones Lumber Yard (piles of lumber, shingles, stone, lime). North of lumber yard are railroad tracks with a depot, warehouse, locomotive house with turntable, and roundhouse with turntable. South Channel borders the railroad on the north. North of the South Channel (and south of West's Canal) are the Appleton Straw Board Co. Mills, Appleton Woolen Mills, Valley Iron Works and the Patten Pulp Mill. The Patten Paper Co., A.D. Fleming and Co. Linen Works, Appleton Furnace Company, W.M. Webster's Planning Mill, and Appleton Hub & Spoke Factory are located north of West's Canal and south of the Fox River in the area north of Lock 2. Immediately west of lumber yard west to Lake Street (current S. Oneida Street) is residential. Immediately east of lumber yard is the Appleton Tannery and Gem Toy factory (woodworking and painting buildings). Southeast of intersection of South River Street and Lake Street (current Oneida Street) just southwest of Lock 2 is a brewery. A portion of the Appleton Furnace Factory is also shown north of South Channel (north of Lock 3).
Sanborn Map	1891	**Property** **Lock 1 –** Lock 1 is shown at approximately the current position. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as Canal Co. Warehouse and platform and Edison Electric Light Company. Land south of U.S. Canal is not shown.
		Lock 2 – Area south of Lock 2 not shown. Lock is shown at current location. No buildings identified as being associated with Lock 2.
		Lock 3 – Lock 3 is shown at current location. Building (garage?) is shown immediately northwest of Lock 3 (not specifically identified as Property building). Dwelling and 2 small buildings shown at location of current Lockmaster Dwelling. Union Toy and Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Union factory is on Property.
		Lock 4 – Lock 4 shown in current location. Power house for the Manufacturing Investment Co. paper and pulp mills on Property. No buildings shown associated with Lock 4. Champion Pulp Co. machine room and Head Race shown on Property west of dam. Railroad switch shown on eastern edge of parcel.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Atlas Paper Company pulp mill shown immediately north of Lock 1. Land immediately northeast of Lock 1 identified as Appleton Edison Light Co. (dynamo house, repair shop, office) and Appleton boot and shoe manufacturing. North of these properties are railroad tracks, a depot, the Appleton Machine Co. and the Standard Lamp Co. Area south of Lock 2 not shown. Area immediately north of Lock 2 identified as J.H. Marston and Co. (coal, wood, and lime). North of lumber yard are railroad tracks with a depot and warehouse. The Patten Pulp Mill, Appleton Woolen Mills, Telulah Paper Co. and the Valley Iron Works are located north of the Lock 2 area between the South Channel and West's Canal. The Patten Paper Co., A.D. Fleming Co. Linen Factory, Fourth Ward Planing Mill, and Appleton Hub and Spoke Factory are located between West's Canal and the Fox River. Immediately west of lumber yard west to Lake Street (current S. Oneida Street) is residential. Southeast of intersection of South River Street and Lake Street (current Oneida Street) just southwest of Lock 2 is a brewery. Appleton Chair Co. is located just north of the U.S. Canal and west of S. Division at current location of Riverside Paper Company. Furnace Factory north of South Channel (north of Lock 3) no longer shown. Manufacturing Investment Company paper and pulp mill immediately east of Lock 4 (current MI Drilling Fluids building). Baum Guenther's Flour Mill is shown at the current location of the Foremost Dairy.
Sanborn Map	1895	**Property** **Lock 1** – Lock 1 is not shown. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as Canal Co. Warehouse and platform and Edison Electric Light Company. Land south of U.S. Canal is not shown.
		Lock 2 – Lock is shown at current location. No buildings identified as being associated with Lock 2.
		Lock 3 – Lock 3 is shown at current location. Dwelling and 1 small building shown at location of current Lockmaster Dwelling. Union Toy and Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Union factory is on Property.
		Lock 4 – Lock 4 shown in current location. Power house for the Manufacturing Investment Co. paper and pulp mills on Property. Three buildings shown associated with Lock 4 (dwelling and two small buildings). Champion Pulp Co. machine room (vacant) and Head Race shown on Property west of dam. Railroad switch shown on eastern edge of parcel.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding The Atlas Paper Co. Pulp Mills is located immediately north of Lock 1. Land immediately northeast of Lock 1 and north of the Green Bay and Mississippi Canal Co. warehouse identified as Appleton Edison Light Co. (dynamo house, repair shop, office), and Johnson and Schlosser Coal and Wood yard. North of these properties are railroad tracks, a depot, and the Standard Lamp Co. (vacant). Area immediately north of Lock 2 identified as J.H. Marston and Co. (coal, wood, and lime). North of lumber yard are railroad tracks with a depot and warehouse. The Fourth Ward Planing Mill, Appleton Hub & Spoke Factory, Patten Paper Co. and A.D. Fleming & Co. are located north of Lock 2 between West's Canal and the Fox River. The Appleton Iron Works, Appleton Woolen Mills, Valley Iron Works, and Telulah Paper Co. are located northof Lock 2 between the South Channel and West's Canal. Immediately west of lumber yard west to Lake Street (current S. Oneida Street) is residential. Southeast of intersection of South River Street and Lake Street (current Oneida Street) just southwest of Lock 2 is a brewery. Land south of U.S. Canal between Locks 2 and 3 is shown as residential. Riverside Fibre Co. and Appleton Chair Co. shown northwest of Lock 3 at current location of Kervin Paper Co. Manufacturing Investment Company paper and pulp mill immediately east of Lock 4 (current MI Drilling Fluids building). Stone quarry immediately north of parcel west of dam. The Pride and Guenther Flour Mill is shown at the current location of the Foremost Dairy building. The Appleton Knitting Co. and Appleton Electric Street R.R. Co. Power House are also shown on the Foremost Dairy property.
Sanborn	1901	**Property** **Lock 1 –** Lock 1 is not shown. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as Canal Co. Warehouse and platform and Edison Electric Light Company. Land south of U.S. Canal is not shown.
		Lock 2 – Lock 2 is not shown.
		Lock 3 – Lock 3 is shown at current location. No buildings shown. Union Toy and Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Union factory is on Property.
		Lock 4 – Lock 4 shown in current location. Power house for the Interlake Pulp and Paper Mill on Property. Two buildings shown associated with Lock 4 (dwelling and one small building).

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Land immediately north of Lock 1 identified as the Wisconsin Traction, Light, Heat, and Power Co. Land immediately northeast of Lock 1 identified as Appleton Edison Light Co. (dynamo house, repair shop, office), and Johnson and Schlosser Coal and Wood yard. North of these properties are railroad tracks and a depot. Kimberly Clark Company Paper Mill shown at current location north of Fox River (northeast of Lock 1). Area immediately north of Lock 2 identified as Marston Brothers (coal, wood, and lime). North of Marston Brothers are railroad tracks with a depot and warehouse. The W.M. Webster & Son Planing Mill, Appleton Hub & Spoke Factory, Fairbanks and Timm. Machine and Boiler Shop, Patten Paper Co. and A.D. Fleming & Co. (vacant) are located north of Lock 2 between West's Canal and the Fox River. The Appleton Machine Co., Appleton Woolen Mills, Valley Iron Works, and Telulah Paper Co. are located north of Lock 2 between the South Channel and West's Canal. Immediately west of lumber yard west to Lake Street (current S. Oneida Street) is residential. Southeast of intersection of South River Street and Lake Street (current Oneida Street) just southwest of Lock 2 is a brewery. Land south of U.S. Canal between Locks 2 and 3 is shown as residential. Riverside Fibre Co. and Appleton Chair Co. shown northwest of Lock 3 at current location of Kervin Paper Co. Inter-Lake Pulp and Paper Co. pulp mill immediately east of Lock 4 (current MI Drilling Fluids building).
U.S. Government Map	1910	**Property** **Lock 1 –** Old Lock is shown north of current Lock 1. Five buildings are shown on the Property: U.S. Warehouse, U.S. Timber Shed, bath, U.S. Lock Tender's House and an unidentified small building on the northwest corner of Lock 1. The 1910 map shows a "turning basin" (widening of the river), U.S. Public Dock, and U.S. Public warehouse north of U.S. Canal and between current Oneida Skyline and Oneida Street. On the 1912(?) map the "turning basin" has been filled in and a warehouse built at that location.
		Lock 2 – Lock 2 is shown at current location. A "Lock Tenders Dwelling" and three additional small buildings are shown on the north side of the U.S. Canal approximately 300 feet east of Lock 2.
		Lock 3 – Lock 3 is shown at current location. The Lockmasters Dwelling and three additional buildings are shown on the 1910 map. These buildings are not shown on the 1911 updated map. No additional buildings shown related to U.S. Government activities. Five buildings for Appleton Toy and Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Appleton Toy and Furniture factory is on Property.
		Lock 4 – Lock 4 shown in current location. A portion of the Power house for the Interlake Pulp and Paper Mill and portions of two other small unidentified buildings on Property. One building shown associated with Lock 4 (dwelling). "Old Sawmill" shown on west end of dam. Railroad switch shown on eastern edge of parcel.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Land immediately north of Lock 1 identified as Atlas Pulp Mill. Land immediately northeast of Lock 1 identified as Fox River Valley Electric Railway Co. and Johnson & Schlosser coal shed. The Kimberly & Clark Paper and Pulp Mill, Atlas Paper Mill, "water works", Appleton Manufacturing Co. and "gas works" shown north of the Fox River. The 1912(?) map shows the Electric Power Station Light Heat and Power Co. north of Lock 1 and Riverside Fiber & Paper Co. Paper Mill in the place of the Atlas Pulp Mill, Fox River Valley Electric Railway Co. and the Johnson & Schlosser coal shed. Area immediately north of Lock 2 identified as coal and wood yard. North of the coal and wood yard are railroad tracks with a depot, warehouse, stockyard, engineers house, roundhouse, and coal shed. The Webster's Planing Mill, Appleton Hub & Spoke Factory, warehouses, Patten Paper Co. and large industrial sized buildings at the future site of Hackworthy Construction Co. are located north of Lock 2 between West's Canal and the Fox River. The Appleton Machine Co., Appleton Woolen Mills, Valley Iron Works, and Telulah Paper Co. are located north of Lock 2 between the South Channel and West's Canal. Immediately west of the coal and wood yard west to Lake Street (current S. Oneida Street) is residential and commercial (saloons). Southeast of intersection of South River Street and Lake Street (current Oneida Street) just southwest of Lock 2 is a brewery. Land south of U.S. Canal between Locks 2 and 3 is shown as residential. The Riverside Fiber and Pulp Co. is shown immediately northwest of Lock 3. Interlake paper and pulp mill immediately east of Lock 4 (current MI Drilling Fluids building). Appleton Knitting Mills and Wisconsin Tissue Paper Co. are shown north of the Property on the west end of the dam.
Sanborn Map	1911	**Property** **Lock 1 –** Lock 1 is not shown. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as U.S. Gov. storage. Land south of Lock 1 is not shown.
		Lock 2 – Lock 2 is not shown.
		Lock 3 – Lock 3 is shown at current location. No buildings shown. Appleton Toy and Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Appleton Toy and Furniture factory is on Property.
		Lock 4 – Lock 4 shown in current location. Power house for the Interlake Pulp and Paper Mill on Property. Two buildings shown associated with Lock 4 (dwelling and one small building). Interlake Paper Co. grinding water wheel shown on west end of dam. Railroad switch shown on eastern edge of parcel.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Land immediately north of Lock 1 identified as Wisconsin Traction Light, Heat and Power Co. Land immediately northeast of Lock 1 identified as Riverside Fibre and Paper Co. and Wisconsin Traction Light Heat and Power Co. North of these properties are railroad tracks and a depot. Kimberly Clark Company Paper Mill shown at current location north of Fox River (northeast of Lock 1). Area immediately north of Lock 2 identified as coal and wood yard. North of the coal and wood yard are railroad tracks with a depot and warehouse and Standard Oil Co. The Webster's Planing Mill, Appleton Hub & Spoke Factory, Appleton Stove Co., Patten Paper Co. and Hackworthy Construction Co. are located north of Lock 2 between West's Canal and the Fox River. The Appleton Machine Co., Appleton Woolen Mills, Valley Iron Works, and Telulah Paper Co. are located north of Lock 2 between the South Channel and West's Canal. Immediately west of the coal and wood yard west to Lake Street (current S. Oneida Street) is residential. Southeast of intersection of South River Street and Lake Street (current Oneida Street) just southwest of Lock 2 is a brewery. Land south of U.S. Canal between Locks 2 and 3 is shown as residential. The Riverside Fiber and Pulp Co. and the former Appleton Chair Co. (ruins by fire) are shown immediately northwest of Lock 3. Interlake paper and pulp mill immediately east of Lock 4 (current MI Drilling Fluids building).
Reverse Directory	1921	**Property** **Lock 1 -** From the Fox River south along Lake Street (current Oneida Street) the following addresses are identified: 696 Bridge Tender's House
		Lock 2 – Not identified in directory.
		Lock 3 - From the Fox River south along Lake Street (current Oneida Street) the following addresses are identified: 696 Bridge Tender's House
		Lock 4 - Not identified in directory.
		Surrounding From the Fox River south along Lake Street (current Oneida Street) the following addresses are identified: 615 Appleton-Superior Knitting Works 642 C&N W Pass Depot 643 CM& St. Depot 644-646 Northern Boiler & Structural Iron Works 701-715 Appleton Wonder Instant Heat Company 750 Riverview Country Club Residences identified along Jackson and Jefferson Streets south of East South River Street between Locks 2 and 3. Thilmany Pulp and Paper Co. identified at 425 John St. (immediately north of parcel on west end of dam).

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Sanborn Map	1924	**Property** **Lock 1 -** Lock 1 is not shown. Map coverage is as far west as current Oneida Skyline. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as U.S. Gov. storage and office. Land south of Lock 1 is not shown.
		Lock 2 - Lock 2 is shown at current location. No buildings are shown associated with Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling is shown at current location. Appleton Toy and Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Union factory is on Property.
		Lock 4 - Lock 4 shown in current location. Power house for the Consolidated Water Power and Paper Co. on Property. One dwelling shown associated with Lock 4 (dwelling).
		Surrounding Land immediately northeast of Lock 1 identified as Riverside Fibre and Paper Co. and Wisconsin Traction Light Heat and Power Co. North of these properties are railroad tracks, a depot, and warehouse. Kimberly Clark Company Paper Mill and water treatment plant shown at current location north of Fox River (northeast of Lock 1). Area immediately north of Lock 2 identified as pulp wood storage yard. North of yard are railroad tracks with a depot and roundhouse and Wadhams Oil Company. Appleton Manufacturing and Lumber Co., Appleton Hub & Spoke Factory, and Patten Paper Co. are located north of Lock 2 between West's Canal and the Fox River. The Appleton Machine Co., Lake Superior Knitting Works, Appleton Woolen Mills, Valley Iron Works (manufacturers of paper mill machinery), and Fox River Paper Co. (Telulah Mills) are located north of Lock 2 between the South Channel and West's Canal. Immediately west of pulp wood yard west to Lake Street (current S. Oneida Street) is residential. Land south of U.S. Canal between Locks 2 and 3 is shown as residential. Riverside Fiber and Paper Co. shown at current location of Riverside Paper Co. immediately northwest of Lock 3. Consolidated Water Power and Paper Co. immediately east of Lock 4 (current MI Drilling Fluids building).
U.S. Government Map	1925	**Property** **Lock 1 –** Old Lock is shown north of current Lock 1. Five buildings are shown on the Property: U.S. Warehouse, U.S. Timber Shed, bath, U.S. Lock Tender's House and an unidentified small building on the northwest corner of Lock 1. The "turning basin" previously shown on the 1910 U.S. Government Map has been filled in and a warehouse built at that location.
		Lock 2 – Not shown
		Lock 3 – Not shown
		Lock 4 – Not shown

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Electric Power Station Light Heat and Power Co. is shown north of Lock 1 and Riverside Fiber & Paper Co. Paper Mill in the place of the Atlas Pulp Mill, Fox River Valley Electric Railway Co. and the Johnson & Schlosser coal shed.
Reverse Directory	1930	**Property** **Lock 1 –** From the Fox River south along Oneida Street the following addresses are identified: 905 U.S. Engineers Office
		Lock 2 - Not identified in directory.
		Lock 3 - From the Fox River south along Oneida Street the following addresses are identified: 933 Bridge Tender's House
		Lock 4 - Not identified in directory.
		Surrounding From the Fox River south along Oneida Street the following addresses are identified: 612 Appleton-Superior Knitting Works 727 C&N W Pass Depot 728 CM& St. Depot 807 Northern Boiler and Structural Iron Works 1101 Riverview Country Club From Oneida Street to East John Street along South River Street the following addresses are identified: 424 Success Fertilizer Storage Bin and Loading Co. multiple residences
Reverse Directory	1936	**Property** **Lock 1 –** From the Fox River south along Oneida Street the following addresses are identified: 905 U.S. Engineers Office
		Lock 2 - Not identified in directory.
		Lock 3 - From the Fox River south along Oneida Street the following addresses are identified: 933 Bridge Tender's House
		Lock 4 - Not identified in directory.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding From South Oneida Street toward the east along E. North Island the following addresses are identified: 228 Appleton Manufacturing and Lumber Co. 430 Patten Paper Co. From the Fox River south along Oneida Street the following addresses are identified: 614 Appleton-Superior Knitting Works 618 Appleton Machine Co. 707 Appleton Pattern Works 725 C&N W Pass Depot 728 CM& St. Depot 807 Northern Boiler and Structural Iron Works 1101 Riverview Country Club From Oneida Street to East John Street along South River Street the following addresses are identified: multiple residences Interlake Pulp and Paper Co. is identified at 1130 East John Street near Lock 4.
Aerial Photograph	1938	**Property** **Lock 1** – Lock 1 seen in current location. Three or four buildings observed south of Lock, including Lockmasters Dwelling. U.S. Government office and storage building observed immediately west of Oneida and north of U.S. Canal.
		Lock 2 – Lock 2 is shown at current location. No buildings observed at Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling observed at current location. Toy factory south of Lock 3 appears active.
		Lock 4 – Lock 4 is shown at current location. One building (?) observed. Large industrial mill appears active (current MI Drilling Fluids location). Parcel west of dam appears vacant.
		Surrounding Land south of Lock 1 appears to be developed as country club (current use). Land north of Lock 1 industrial and a power plant. No tanks observed. Land immediately north of Lock 2 appears generally vacant. Two small buildings observed north and west of Lock 2 near Oneida. Large ASTs shown immediately west of building identified as Wadhams Oil Co. on 1924 Sanborn. Paper mill observed immediately north of U.S. Canal between Locks 2 and 3. Residential south of U.S. Canal between Locks 2 and 3. Building observed north and west of Lock 3 at current Kervin Paper Co. offices. Industrial facility immediately east of Lock 4 at current MI Drilling Fluids location. Industrial facility north of parcel west of the dam.
Reverse Directory	1943	**Property** **Lock 1** – From the Fox River south along Oneida Street the following addresses are identified: 905 U.S. Engineers Office
		Lock 2 - Not identified in directory.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Lock 3 - From the Fox River south along Oneida Street the following addresses are identified: 933 Bridge Tender's House
		Lock 4 - Not identified in directory.
		Surrounding From the Fox River south along Oneida Street: 614 Appleton-Superior Knitting Works 618 Appleton Machine Co. 705 Appleton Machine Co. Foundry 710 Appleton Pattern Works 725 C&N W Pass Depot 726 C&NW Ry Roundhouse 728 CM& St. Depot 807 Northern Boiler and Structural Iron Works 824 Allen Oil Co. 825 Appleton Intercity Motor Coach Line 1004 Kaminsky Junk Dealer 1101 Riverview Country Club Interlake Pulp and Paper Co. is identified at 1130 East John Street near Lock 4.
Sanborn Map	1950	**Property** **Lock 1 -** Lock 1 is not shown. Map coverage is as far west as current Oneida Skyline. Land north of U.S. Canal and between current Oneida Skyline and Oneida Street identified as U.S. Gov. storage and office. Land south of Lock 1 is not shown.
		Lock 2 - Lock 2 is shown at current location. No buildings are shown associated with Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling is shown at current location. Appleton Juvenile Furniture (woodworking and painting) shown immediately south of Lock 3. Portion of Appleton Juvenile Furniture factory is on Property.
		Lock 4 - Lock 4 shown in current location. Power house for the Consolidated Water Power and Paper Co. on Property. One dwelling shown associated with Lock 4 (dwelling).

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Land immediately northeast of Lock 1 identified as Wisconsin-Michigan Power Co. storage, Appleton Intercity Bus Co. and Northern Boiler and Structural steel. North of these properties are railroad tracks and Appleton Machine Co. Kimberly Clark Company Paper Mill and water treatment plant shown at current location north of Fox River (northeast of Lock 1). A large fuel oil tank shown at water treatment plant. Area immediately north of Lock 2 identified as pulp wood storage yard. North of yard are railroad tracks with a depot and Wadhams Oil Company (large ASTs). Appleton Manufacturing Co., Kurz & Root Co. (manufacturing of electric generators), Fox River Paper Corporation, and Appleton Manufacturing Co. are located north of Lock 2 between West's Canal and the Fox River. The Appleton Machine Co., Appleton Pattern Works, Appleton Woolen Mills, Valley Iron Works, and Fox River Paper Co. (Telulah Mills) are located north of Lock 2 between the South Channel and West's Canal. Immediately west of pulp wood yard west to S. Oneida Street is residential and filling station (ASTs shown east of filling station). Land south of U.S. Canal between Locks 2 and 3 is shown as residential. Riverside Fiber and Paper Co.. shown at current location of Riverside Paper Co. Consolidated Water Power and Paper Co. immediately east of Lock 4 (current MI Drilling Fluids building).
Reverse Directory	1951	**Property** **Lock 1 –** From the Fox River south along Oneida Street the following addresses are identified: 905 U.S. Engineers Office
		Lock 2 - Not identified in directory.
		Lock 3 - From the Fox River south along Oneida Street the following addresses are identified: 931 Bridge Tender's House
		Lock 4 - Not identified in directory.
		Surrounding From the Fox River south along Oneida Street the following addresses are identified: 614 Appleton Woolen Mills 618 Appleton Machine Co. 712 Appleton Pattern Works 723 C&N W Pass Depot 728 CM& St. Depot 807 Northern Boiler and Structural Iron Works 824 Allen Oil Co. 825 Appleton Intercity Motor Coach Line From Oneida Street to East John Street along South River Street the following addresses are identified: multiple residences 1404 Grishaber's Service Station (corner of East John St.) Interlake Pulp and Paper Co. is identified at 1130 East John Street near Lock 4.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Historical Map (small scale map)	1955	**Property** **Lock 1 -** Lock 1 is observed in current location. Buildings are not discernible.
		Lock 2 - Lock 2 is observed in current location. Buildings are not discernible.
		Lock 3 - Lock 3 is observed in current location. Buildings are not discernible.
		Lock 4 - Lock 4 is observed in current location. Buildings are not discernible. Large tanks observed on Property southeast of Lock 4.
		Surrounding Large industrial-type buildings shown north of Locks 1, 2, and 3. Large industrial-type building shown south of Lock 3 and east of Lock 4. Small residential-type buildings shown south of Locks 2 and 3.
Aerial Photograph	1957	**Property** **Lock 1 –** Lock 1 seen in current location. Three or four buildings observed south of Lock, including Lockmasters Dwelling. U.S. Government office and storage building observed immediately west of Oneida and north of U.S. Canal.
		Lock 2 – Lock 2 is shown at current location. No buildings observed at Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling observed at current location. Toy factory south of Lock 3 appears active.
		Lock 4 – Lock 4 is shown at current location. One building (?) observed. Large industrial mill appears active (current MI Drilling Fluids location). Large tanks observed on Property southeast of Lock 4. Parcel west of dam appears vacant.
		Surrounding Land south of Lock 1 appears to be developed as country club (current use). Land north of Lock 1 industrial and a power plant. No tanks observed. Large buildings observed north of U.S. Government office and storage building. Land immediately north of Lock 2 appears generally vacant. Possible construction immediately northwest of Lock 2. Two small buildings observed north and west of Lock 2 near Oneida. Large ASTs shown immediately west of building identified as Wadhams Oil Co. on 1950 Sanborn. Paper mill observed immediately north of U.S. Canal between Locks 2 and 3. Residential south of U.S. Canal between Locks 2 and 3. Building observed north and west of Lock 3 at current Kervin Paper Co. offices. Industrial facility immediately east of Lock 4 at current MI Drilling Fluids location. Industrial facility north of parcel west of the dam.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1964	**Property** **Lock 1 –** From the Fox River south along Oneida Street the following addresses are identified: 905 U.S. Engineers Office and Lockmasters Dwelling
		Lock 2 – Not identified in directory.
		Lock 3 - From the Fox River south along Oneida Street the following addresses are identified: 931 Bridge Tender's House
		Lock 4 - Not identified in directory.
		Surrounding Foremost Dairies, Inc. identified at 935 E. John Street. Dairy is located immediately north of the parcel west of the dam near Lock 4. Consolidated Papers, Inc. is identified at 1130 E. John Street near Lock 4. From the Fox River south along Oneida Street the following addresses are identified: 614 Appleton Woolen Mills 618 Appleton Machine Co. 712 Appleton Pattern Works 728 CM& St. Depot 807 Wisconsin-Michigan Power Co. Offices 824 Buck's Zephyr Service 825 Wisconsin-Michigan Power Co. Garage 1004 Gold Bond Roofing & Siding Co. and Presto Products, Inc. 1112 Roemer Commercial Printing Co. 1201 Riverview Country Club From Oneida Street to East John Street along South River Street the following addresses are identified: multiple residences 1404 Grishaber's Service Station (corner of East John St.)
Aerial Photograph	1964	**Property** **Lock 1 –** Lock 1 seen in current location. Heavily treed, no buildings observed. U.S. Government office and storage building observed immediately west of Oneida and north of U.S. Canal.
		Lock 2 – Lock 2 is shown at current location. No buildings observed at Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling observed at current location. Appears that trees between Lockmaster Dwelling and Lawe recently removed. Toy factory south of Lock 3 appears active.
		Lock 4 – Lock 4 is shown at current location. No buildings observed. Large industrial mill appears active (current MI Drilling Fluids location). Large tanks observed on Property southeast of Lock 4. Parcel west of dam appears vacant.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Land south of Lock 1 appears to be developed as country club (current use). Land north of Lock 1 industrial and a power plant. No tanks observed. Large buildings observed north of U.S. Government office and storage building. Land immediately north of Lock 2 now occupied by large building(s). Two small buildings observed north and west of Lock 2 near Oneida. Large ASTs shown immediately west of building identified as Wadhams Oil Co. on 1950 Sanborn. Paper mill observed immediately north of U.S. Canal between Locks 2 and 3. Residential south of U.S. Canal between Locks 2 and 3. Building observed north and west of Lock 3 at current Kervin Paper Co. offices. Industrial facility immediately east of Lock 4 at current MI Drilling Fluids location. Industrial facility north of parcel west of the dam. New E. College Avenue bridge over site.
Sanborn Map	1970	**Property** **Lock 1 -** Lock 1 is not shown.
		Lock 2 - Lock 2 is shown at current location. No buildings are shown associated with Lock 2.
		Lock 3 – Lock 3 shown at current location. Toy/furniture factory identified as vacant. Building is still seen. Lockmaster Dwelling and Garage shown west of Lawe Street.
		Lock 4 - Lock 4 shown in current location. Power house for the Consolidated Water Power and Paper Co. on Property. One dwelling shown associated with Lock 4 (dwelling). Large tank on Lock 4 Property is identified as Settling Basin.
		Surrounding Land immediately northeast of Lock 1 identified as Wisconsin-Michigan Power Co. storage and a private garage. North of these properties are railroad tracks and Appleton Machine Co. Kimberly Clark Company Paper Mill and water treatment plant shown at current location north of Fox River (northeast of Lock 1). A large fuel oil tank shown at water treatment plant. Area immediately north of Lock 2 contains railroad spurs and storage buildings owned by Riverside Paper Corp. North of yard are railroad tracks with a depot, Marston Bros. Oil Company (large ASTs), and Allis-Chalmers Manufacturing Co. Appleton Manufacturing Co., Kurz & Root Co. (manufacturing of electric generators), Fox River Paper Corporation, and Appleton Manufacturing Co. are located north of Lock 2 between West's Canal and the Fox River. The Appleton Machine Co., Appleton Pattern Works, Appleton Woolen Mills, Allis-Chalmers Manufacturing (manufacturers of paper mill machinery), and Fox River Paper Co. (Telulah Mills) are located north of Lock 2 between the South Channel and West's Canal. Immediately west of pulp wood yard west to Lake Street (current S. Oneida Street) is filling station (ASTs shown east of filling station). Land south of U.S. Canal between Locks 2 and 3 is shown as residential. Riverside Fiber and Paper Co. shown at current location of Riverside Paper Co. northwest of Lock 3. Consolidated Water Power and Paper Co. immediately east of Lock 4 (current MI Drilling Fluids building). Large tank on Lock 4 Property is identified as Settling Basin.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1971	**Property** **Lock 1 –** Lock 1 seen in current location. Heavily treed, no buildings observed. U.S. Government office and storage building observed immediately west of Oneida and north of U.S. Canal.
		Lock 2 – Lock 2 is shown at current location. No buildings observed at Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling and garage observed at current location. Toy/furniture factory has fewer buildings that observed in previous aerial photograph.
		Lock 4 – Lock 4 is shown at current location. No buildings observed. Large industrial mill appears active (current MI Drilling Fluids location). Large tanks observed on Property southeast of Lock 4. Parcel west of dam appears vacant.
		Surrounding Land south of Lock 1 appears to be developed as country club (current use). Land north of Lock 1 industrial and a power plant. No tanks observed. Large buildings observed north of U.S. Government office and storage building. Land immediately north of Lock 2 now occupied by large building(s). Two small buildings observed north and west of Lock 2 near Oneida. Building identified as Marston Oil Co. on 1970 Sanborn no longer present. New large building seen at that location. Paper mill observed immediately north of U.S. Canal between Locks 2 and 3. Residential south of U.S. Canal between Locks 2 and 3. Building observed north and west of Lock 3 at current Kervin Paper Co. offices. Industrial facility immediately east of Lock 4 at current MI Drilling Fluids location. Industrial facility north of parcel west of the dam. New E. College Avenue bridge over site.
Reverse Directory	1972	**Property** **Lock 1 –** From the Fox River south along Oneida Street the following addresses are identified: 905 U.S. Engineers Office and Lockmasters Dwelling
		Lock 2 – Not identified in directory.
		Lock 3 - Not identified in directory.
		Lock 4 - Not identified in directory.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		Surrounding Foremost Foods Co. identified at 935 E. John Street. Dairy is located immediately north of the parcel west of the dam near Lock 4. Consolidated Papers, Inc. is identified at 1130 E. John Street near Lock 4. From the Fox River south along Oneida Street the following addresses are identified: 618 Appleton Machine Co. 712 Appleton Pattern Works 728 CM& St. Depot 807 Wisconsin-Michigan Power Co. Offices 825 Wenzel Bros. Garage 1112 Commercial Printing Co. From Oneida Street to East John Street along South River Street the following addresses are identified: multiple residences 1404 Grishaber's Service Station (corner of East John St.)
Historical Map	1975	**Property** **Lock 1 -** Lock 1 is observed in current location. Building shown at location of Lockmaster Dwelling.
		Lock 2 - Lock 2 is observed in current location. Buildings are not discernible.
		Lock 3 - Lock 3 is observed in current location. One building shown immediately north of Lock 3.
		Lock 4 - Lock 4 is observed in current location. One building shown immediately west of Lock 4. Large tanks observed on Property southeast of Lock 4.
		Surrounding Large industrial-type buildings shown north of Locks 1, 2, and 3. Large industrial-type building shown east of Lock 4. No buildings shown south of Lock 3. Small residential-type buildings shown south of Locks 2 and 3.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1981	**Property** **Lock 1 –** Lock 1 seen in current location. Heavily treed, no buildings observed. U.S. Government office and storage building no longer immediately west of Oneida and north of U.S. Canal.
		Lock 2 – Lock 2 is shown at current location. No buildings observed at Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling and garage observed at current location. Toy/furniture factory no longer present south of Lock 3.
		Lock 4 – Lock 4 is shown at current location. No buildings observed. Large industrial mill appears active (current MI Drilling Fluids location). Large tanks observed on Property southeast of Lock 4. Parcel west of dam appears vacant.
		Surrounding Land south of Lock 1 appears to be developed as country club (current use). Land north of Lock 1 industrial and a power plant. No tanks observed. Large buildings observed north of former U.S. Government office and storage building location. Land immediately north of Lock 2 occupied by large building(s). Paper mill observed immediately north of U.S. Canal between Locks 2 and 3. Residential south of U.S. Canal between Locks 2 and 3. Building observed north and west of Lock 3 at current Kervin Paper Co. offices. Toy/furniture factory has been removed. Industrial facility immediately east of Lock 4 at current MI Drilling Fluids location. Industrial facility north of parcel west of the dam. New E. College Avenue bridge over site.
Reverse Directory	1983	**Property** **Lock 1 –** From the Fox River south along Oneida Street the following addresses are identified: 905 Gallenberger J. (lockmaster?)
		Lock 2 – Not identified in directory.
		Lock 3 - Not identified in directory.
		Lock 4 - Not identified in directory.
		Surrounding Foremost Foods Co. identified at 935 E. John Street. Dairy is located immediately north of the parcel west of the dam near Lock 4. Consolidated Papers, Inc. is identified at 1130 E. John Street near Lock 4. From the Fox River south along Oneida Street the following addresses are identified: 505 Fox River Paper Company Dam Tender 712 US Vinylux 807 Wisconsin Industrial Police 820 Amricon Corp. Coating Inc.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
		From Oneida Street to East John Street along South River Street the following addresses are identified: multiple residences religious facilities Lawrence University addresses 1404 Grishaber's Service Station (corner of East John St.)
Historic Map	1984	**Property** **Lock 1 -** Lock 1 is observed in current location. Building shown at location of Lockmaster Dwelling. Second building shown north of Lock 1.
		Lock 2 - Lock 2 is observed in current location. Buildings are not discernible.
		Lock 3 - Lock 3 is observed in current location. One building shown immediately north of Lock 3.
		Lock 4 - Lock 4 is observed in current location. One building shown immediately west of Lock 4. Large tanks observed on Property southeast of Lock 4.
		Surrounding Large industrial-type buildings shown north of Locks 1, 2, and 3. Large industrial-type building shown east of Lock 4. No buildings shown south of Lock 3. Small residential-type buildings shown south of Locks 2 and 3.
U.S. Government Map	1986	**Property** **Lock 1 -** Lock 1 is observed in current location. Buildings shown at current locations of Lockmaster Dwelling, two garages, and Oil House. A fifth building is shown at the southwest corner of Lock 1.
		Lock 2 - Lock 2 is observed in current location. One building is shown on the northwest corner of Lock 2.
		Lock 3 - Lock 3 is observed in current location. Two buildings are shown north of Lock 3. The purposes of these buildings are not identified. The Lockmasters Dwelling, garage, and bridge control house are shown at the current locations.
		Lock 4 - Lock 4 is observed in current location. One building shown immediately east of Lock 4 (Oil House). Large tanks observed on Property southeast of Lock 4. No structures observed west of the dam.
		Surrounding Wisconsin Electric Power shown north of Lock 1 and former U.S. Government buildings location. Appleton Machine Co. shown on both sides of Oneida St. immediately south of West's Power Canal. Riverside Paper Co. shown north of the U.S. Canal between Locks 2 and 3. Consolidated Papers, Inc. shown immediately east of Lock 4. Foremost Foods Co. shown immediately north of the Property west of the dam.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1990	**Property** **Lock 1 –** Not identified in directory.
		Lock 2 – Not identified in directory.
		Lock 3 - Not identified in directory.
		Lock 4 - Not identified in directory.
		Surrounding Foremost Whey Products identified at 935 E. John Street. Foremost is located immediately north of the parcel west of the dam near Lock 4. MI Drilling Fluids Co. identified at 1130 E. John Street near Lock 4. From the Fox River south along Oneida Street the following addresses are identified: 807 Trolley Car 86, Inc. 1112 Fox Valley Printing Co. From Oneida Street to East John Street along South River Street the following addresses are identified: multiple residences religious facilities Lawrence University addresses 1404 Grishaber's Service Station (corner of East John St.)
Aerial Photograph	1992	**Property** **Lock 1 –** Lock 1 seen in current location. Lockmaster Dwelling and one garage observed. Two additional smaller buildings also observed (?) next to Lock.
		Lock 2 – Lock 2 is shown at current location. No buildings observed at Lock 2.
		Lock 3 – Lock 3 is shown at current location. Lockmaster Dwelling and garage observed at current location. Two additional smaller buildings also observed (?) next to Lock.
		Lock 4 – Lock 4 is shown at current location. No buildings observed. Large industrial mill has fewer buildings, now MI Drilling Fluids location. Large tanks formerly on south portion of Property are gone. Parcel west of dam recently graded. Propane tank observed in current location.
		Surrounding Land south of Lock 1 appears to be developed as country club (current use). Land north of Lock 1 industrial and a power plant. No tanks observed. Large buildings observed north of former U.S. Government office and storage building location. Land immediately north of Lock 2 occupied by large building(s). Paper mill observed immediately north of U.S. Canal between Locks 2 and 3. Residential south of U.S. Canal between Locks 2 and 3. Building observed north and west of Lock 3 at current Kervin Paper Co. offices. Industrial facility immediately east of Lock 4 at current MI Drilling Fluids location. Industrial facility north of parcel west of the dam.

Table 9 – Appleton Locks (cont.)

Primary Resources Summary

Source	Date	
Historic Map	1992	**Property** **Lock 1 -** Lock 1 is observed in current location. Buildings shown at location of Lockmaster Dwelling and garage. Third building shown north of Lock 1.
		Lock 2 - Lock 2 is observed in current location. Buildings are not discernible.
		Lock 3 - Lock 3 is observed in current location. Buildings are not discernible.
		Lock 4 - Lock 4 is observed in current location. Buildings are not discernible.
		Surrounding Large industrial-type buildings shown north of Locks 1, 2, and 3. Large industrial-type building shown east of Lock 4. No buildings shown south of Lock 3. Small residential-type buildings shown south of Locks 2 and 3.

Table 10— Brothertown Harbor

Primary Resources Summary

Source	Date	
Historical Map	1910	**Property** Small-scale map, the harbor is visible and labeled "Landing." Road into Property from north.
		Surrounding Small scale map, neighboring properties not discernible. Buildings shown immediately east of Property. Area shown is east of Lake Winnebago.
Aerial Photograph	1941	**Property** Harbor and dike visible. Tree cover surrounds the Property making it difficult to discern Property boundaries. Access road from north visible.
		Surrounding Area shown is west of Lake Winnebago between the lake and Lakeshore Drive (west to east) and surrounding Harbor Road (north to south). Land use is mainly agricultural with some residential property areas along Lakeshore Drive.
Aerial Photograph	1953	**Property** Harbor and dike visible. Tree cover surrounds Property making it difficult to discern Property boundaries.
		Surrounding Area shown is west of Lake Winnebago between the lake and Lakeshore Drive (west to east) and surrounding Harbor Road (north to south). Land use is mainly agricultural with some residential property areas along Lakeshore Drive, similar to 1941.
Historical Map	1955	**Property** Small-scale map, the Harbor is visible and now labeled "Brothertown Harbor."
		Surrounding Small scale map, neighboring properties not discernible. Buildings shown immediately north of Property. Area shown is east of Lake Winnebago
Aerial Photograph	1962	**Property** Harbor and dike visible. Tree cover surrounds Property making it difficult to discern Property boundaries.
		Surrounding Area shown is west of Lake Winnebago between the lake and Lakeshore Drive (west to east) and surrounding Harbor Road (north to south). Land has remained agricultural with some residential. Additional residential development 100 feet north of the Harbor. About eight docks extend into the lake.

Table 10— Brothertown Harbor (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1971	**Property** Dike has been extended further out into the harbor. Tree cover has been cut back in some areas. Property boundaries appear as they currently are.
		Surrounding Area shown is west of Lake Winnebago between the lake and Lakeshore Drive (west to east) and surrounding Harbor Road (north to south). Farmland east and south of the Harbor has been developed into a recreational area (Lakeshore Christian Camp) with 4 baseball diamonds and artificial ponds. The Camp has also constructed several cabins and administrative buildings. Approximately ¾ of a mile southeast of the harbor, artificial ponds have also been constructed. A new trailer park is located northeast of the Property. Additions to the residential area 100 feet north of the harbor.
Historical Map	1974	**Property** Property boundaries and features are current.
		Surrounding The area is east of Lake Winnebago between the lake and South Tower Road (west to east) and Driftwood Beach Road and Indian Road (north to south). Two buildings are located on the map in the current locations of the Brothertown Harbor Incorporated commercial boat launch and concession building. The trailer park and Lakeshore Drive are labeled on the map. The artificial ponds are part of a golf course also labeled on the map in the recreational area east of the harbor. Additional residential growth in the area.
Aerial Photograph	1981	**Property** Property boundaries and features are current.
		Surrounding Area shown is west of Lake Winnebago between the lake and Lakeshore Drive (west to east) and surrounding Harbor Road (north to south). Land use is similar to 1971. Brothertown Harbor Incorporated is visible. Only two baseball diamonds remain. The other two have been incorporated into a golf course. The trailer park has doubled in size.
U.S. Government Map	1986	**Property** Property boundaries and harbor shown. No structures are shown on Figure.
		Surrounding No features are shown on surrounding properties.

Table 10— Brothertown Harbor (cont.)

Primary Resources Summary

Source	Date	
Historical Map	1992	**Property** Property boundaries and features are current.
		Surrounding Similar to 1974 historical Map. The area is east of Lake Winnebago between the lake and South Tower Road (west to east) and Driftwood Beach Road and Indian Road (north to south). Additional residential growth in the area.
Aerial Photograph	1992	**Property** Property boundaries and features are current. Docks now extend from the dike.
		Surrounding Area shown is west of Lake Winnebago between the lake and Lakeshore Drive (west to east) and surrounding Harbor Road (north to south). Trees have been removed in the area surrounding the Harbor. Several docks along the Harbor and Mill Creek are now visible. No baseball diamonds remain.

Table 11 – Menasha Lock

Primary Resources Summary

Source	Date	
U.S. Government Historical Map	1910	**Property** The lock is shown at current location. The lockmaster dwelling is located at or near the current location. Two unidentified support buildings are located east of the lock. Both support buildings have since been removed.
		Surrounding Map includes Little Lake Butte Des Morts (part of the Fox River), the North Channel of Fox River, and the US Canal. The only developments shown are along Water Street. G.A. Whiting Paper Mill, S.A. Cook Shingle and Paper Mill, a wagon shop, and warehouse are shown on Water Street between the Lake and Tayco Street. Additional commercial developments line Water Street east of Tayco Street including three paper mills, wooden ware company pail and factory, a repair shop, saw mill, paint shop, two cooper shops, and two factories.
Historical Map	1911	**Property** Small-scale map. Lock appears to be in current location.
		Surrounding Small-scale map, hard to distinguish surrounding property area. Map area includes the cities of Neenah and Menasha. Lake Winnebago, the North and South Channels of the Fox River, the U.S. Canal (location of the lock), Little Lake Butte Des Mortes, and the Fox River are all pictured. The area surrounding the North and South Channels of Fox River are densely populated with unidentified developments. Chicago North Western Railroad crosses the Little Lake Butte Des Morts approximately 1/8 mile south of the Property and then parallels the Menasha Channel south of the lock.
Reverse Directory	1931	**Property** Not specifically identified in directory. Lock Master's Office identified at the west end of Broad Street.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Lush, and Chute Streets. A vacant boiler works is identified on Water Street between Barlow and Soo Line Railroad (between Barlow and High). Menasha Manufacturing Co. and Menasha Woodenware Corp. are identified on Canal Street between the basin and Tayco. Specific addresses for these manufacturers are not given.
Aerial Photograph	1938	**Property** The lock is in its current location. The only building distinguishable on the Property is the lockmaster dwelling, located off Broad Street east of the lock. Land mass features are very similar to current, less vegetation then current photographs. A small harbor is cut into the bank east and north of the lock. A portion of this harbor may be on the Property, however, the majority of the harbor appears to be north of the Property.

Table 11 – Menasha Lock (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph (cont.)	1938	**Surrounding** North of the canal, land use is mainly densely populated residential. An industrial building/facility is located in the residential area less than ½ mile northeast of the Property on Third Street at the future location of GP Tissue. Adjacent to the Property on the east, the land shows some scarring from recent or on going construction activities. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the river, land is industrial followed by residential.
Reverse Directory	1940	**Property** Not specifically identified in directory. Lock Master's Office identified at the west end of Broad Street.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Lush, Water, and Chute Streets. Menasha Manufacturing Co., Menasha Woodenware Corp., and the John Strange Paper Co. are identified on Canal Street between the basin and Tayco. Specific addresses for these manufacturers are not given.
Reverse Directory	1948	**Property** Not specifically identified in directory. Lock Master's Office identified at the west end of Broad Street.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Lush, Water, and Chute Streets. Twin City Bottling Works is identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Aerial Photograph	1950	**Property** The lock and lockmaster dwelling are shown in current location. A lockshelter may be located east of the dam (difficult to distinguish). Lockmaster's dwelling is evident. Small harbor on the northeast portion of the Property is still evident. Large amounts of sediment or other debris surrounds the lock to the north. The path into the lock has been cleared, possibly recently dredged.
		Surrounding A significant amount of sediment is located in the Channel. North of the canal, land use remains densely populated residential. The industrial facility (GP Tissue) on Third Street is under construction and expanding. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the river, land is industrial followed by residential.
Historical Map	1955	**Property** The Menasha Lock is identified on the map in its current location.
		Surrounding The area surrounding the lock is shaded to represent densely populated residential areas. The industrial facilities located between the US Canal and Fox River Channel and on Third Street are indicated. Owners of these facilities are not specifically identified.

Table 11 – Menasha Lock (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1956	**Property** Not specifically identified in directory. Lock Master's Office identified at the west end of Broad Street.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Lush, Water, and Chute Streets. Valley Marine Mart, Prosser Beer Depot, Twin City Bottling Works, and Nelson Vending Service are identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Aerial Photograph	1957	**Property** The lock and lockmaster dwelling are shown in current location. Tree cover and shadows cover large portions of the Property making it difficult to distinguish additional property features. The sediment surrounding the lock in 1950 is beginning to disperse. Much of the sediment has settled along the railroad bridge west of the lock.
		Surrounding North of the canal, land use remains densely populated residential. The industrial facility (GP Tissue) on Third Street is under construction and expanding. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the river, land is industrial followed by residential.
Reverse Directory	1962	**Property** U.S. Government Corps of Engineer property identified on the west end of Broad Street.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Water, and Chute Streets. Valley Marine Mart, the US Coast Guard light attendant station, Prosser Beer Depot, Menasha Maytag Laundry, Twin City Bottling Works, and Nelson Vending Service are identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Aerial Photograph	1964	**Property** The lock and lockmaster dwelling are shown in current location. Tree cover and shadows cover large portions of the Property making it difficult to distinguish additional property features. Sediment has settled along the railroad bridge west of the lock and small amounts east of the lock.
		Surrounding Land use has remained similar to previous photographs. A significant amount of sediment is still located in the channel. North of the canal land use remains densely populated residential. The industrial facility (GP Tissue) on Third Street is under construction and expanding. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the river, land is industrial followed by residential.

Table 11 – Menasha Lock (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1967	**Property** Not specifically identified in directory.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Water, and Chute Streets. Blue Jay Tree Service, Valley Refrigeration Incorporated Workshop, Marine Mart are identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Aerial Photograph	1971	**Property** The lock and lockmaster dwelling are shown in current location. The lockmaster garage and driveway are under construction. Sediment is still present along the railroad bridge west of the lock and in small amounts east of the lock.
		Surrounding Land use had remained similar to previous photographs. North of the canal land use remains densely populated residential. The industrial facility (GP Tissue) on Third Street is under construction and expanding. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the River land is industrial followed by residential. Further south of the area viewed in previous photographs, at least four holding tanks (owner of tanks unknown) are identified.
Reverse Directory	1972	**Property** US Government Menasha Locks identified in directory.
		Surrounding Numerous residences are identified near the lock along Broad, Lock, Water, and Chute Streets. Valley Marine Mart, the US Coast Guard light attendant station, Menasha Waterfront Laundromat, Twin City Bottling Company, and Valley Refrigeration, Inc. are identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Historical Map	1975	**Property** The Menasha Lock is identified on the map in its current location. No buildings are shown.
		Surrounding The area surrounding the lock is shaded to represent densely populated residential areas. The industrial facilities located between the US Canal and Fox River Channel are indicated. The facility on third street (current GP Tissue location) is also indicated. Holding tanks south of the lock identified in the 1971 aerial photograph are identified as sewage disposal/treatment holding tanks.

Table 11 – Menasha Lock (cont.)

Primary Resources Summary

Source	Date	
Aerial Photograph	1981	**Property** The lock, lockmaster dwelling, driveway, garage, lockshelter, sanitary facility, and oilhouse are shown in current location. Sediment is still present along the railroad bridge west of the lock. Most of the sediment west of the lock has been eroded.
		Surrounding Land use has remained similar to previous photographs. North of the canal, land use remains densely populated residential. The industrial facility (current GP Tissue location) on Third Street is under construction and expanding and now includes ASTs. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the river, land is industrial followed by residential. A new industrial facility is under construction south of Channel and directly south of the lock. Two large holding tanks and several smaller ASTs are located southwest of Mathewson Ave.
Reverse Directory	1982	**Property** Corps of Engineers Menasha lock identified in directory.
		Surrounding Numerous residences are identified along Broad and Lock Streets. Valley Marine Mart, Island Cleaners Incorporated, the US Coast Guard light attendant station, Water Street Laundromat, Poly-Wide Incorporated, VanLinn's Transmission Service, Bob's Locksmith are identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Historical Map	1984	**Property** The Menasha Lock is identified on the map in its current location. No buildings are shown.
		Surrounding The area surrounding the lock is shaded to represent densely populated residential areas. The industrial facilities located between the US Canal and Fox River Channel are indicated. The facility on third street is also indicated (current GP Tissue location). The large holding tanks and several smaller ASTs southwest of Mathewson Ave are identified on the map as a sewage disposal facility. A large gas tank is located two blocks south of the sewage disposal facility (approximately ½ mile south of the Property).
U.S. Government Historical Map	1986	**Property** Lockmaster's dwelling, garage, sanitary facility, and two small unidentified buildings north of the Lockmaster's dwelling are identified on the Property.
		Surrounding Wisconsin Tissue Mills is identified at the current location of GP Tissue on Third Street. The U.S. Coast Guard Station is shown on Water Street approximately 500 feet southeast of the Property. The George A. Whiting Paper Co. is shown at it's current location. Marathon – Division of American Co. is shown at the current location of Pechiney Canal Plant Plastic Packaging. The Menasha Electric and Water Utility Steam Plant is shown at the current location.

Table 11 – Menasha Lock (cont.)

Primary Resources Summary

Source	Date	
Reverse Directory	1988	**Property** Menasha City lock identified in directory.
		Surrounding Numerous residences are identified along Broad, Chute, and Lock Streets. Valley Marine Mart, Island Cleaners Incorporated, Government of United States and VanLinn's Transmission Service Incorporated are identified between Barlow and Soo Line Railroad on Water Street. Soo Line Railroad intersects Broad Street between Lush and Tayco and Water Street between Barlow and High.
Aerial Photograph	1992	**Property** The lock, lockmaster dwelling, driveway, garage, lockshelter, sanitary facility, and oilhouse are shown in current locations. Sediment has been removed (dredged) or eroded from the area along the railroad bridge west of the lock. All of the sediment west of the lock has been removed or eroded.
		Surrounding Land use has remained similar to previous photographs. North of the canal, land use remains densely populated residential. The industrial facility (current GP Tissue location) on Third Street is no longer under construction; several ASTs surround the facility. Land between the canal and river is industrial with large industrial facilities and railroad tracks. South of the river, land is industrial followed by residential. The new industrial facility has been completed south of Channel and directly south of the lock. Three large holding tanks and several smaller ASTs are located sat the sewage disposal facility southwest of Mathewson Avenue (approximately ½ mile south of the Property).
Historical Map	1992	**Property** The Menasha Lock is identified on the map in its current location.
		Surrounding The area surrounding the lock is shaded to represent densely populated areas. The sewage disposal facility is labeled southwest of Mathewson Ave.
Reverse Directory	1995	**Property** Property not included in directory.
		Surrounding Valley Marine Mart, Custom Marine Incorporated, Wisconsin Central LTD-Lake, and VanLinn's Transmission Service Inc. are identified on Water Street.

Figures

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REVIEW

A review on polycyclic aromatic hydrocarbons: Source, environmental impact, effect on human health and remediation

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KEYWORDS

Polycyclic aromatic hydrocarbons (PAHs);
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Effect on human health;
Environmental risk;
Removal of PAHs

Abstract Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants generated primarily during the incomplete combustion of organic materials (e.g. coal, oil, petrol, and wood). Emissions from anthropogenic activities predominate; nevertheless, some PAHs in the environment originate from natural sources such as open burning, natural losses or seepage of petroleum or coal deposits, and volcanic activities. Major anthropogenic sources of PAHs include residential heating, coal gasification and liquefying plants, carbon black, coal-tar pitch and asphalt production, coke and aluminum production, catalytic cracking towers and related activities in petroleum refineries as well as and motor vehicle exhaust. PAHs are found in the ambient air in gas-phase and as sorbet to aerosols. Atmospheric partitioning of PAH compounds between the particulate and the gaseous phases strongly influences their fate and transport in the atmosphere and the way they enter into the human body. The removal of PAHs from the atmosphere by dry and wet deposition processes are strongly influenced by their gas/particle partitioning. Atmospheric deposition is a major source for PAHs in soil.

Many PAHs have toxic, mutagenic and/or carcinogenic properties. PAHs are highly lipid soluble and thus readily absorbed from the gastrointestinal tract of mammals. They are rapidly distributed in a wide variety of tissues with a marked tendency for localization in body fat. Metabolism of PAHs occurs via the cytochrome P450-mediated mixed function oxidase system with oxidation or hydroxylation as the first step.

Several different remediation technologies have been tested in efforts to remove these environmental contaminants. Among them, bioremediation is showing particular promise as a safe and cost-effective option. In spite of their xenobiotic properties, a variety of genera of gram-positive and -negative bacteria, fungi and algae have been isolated and characterized for their ability to utilize PAHs.

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The aim of this review is to discuss PAHs impact on the environmental and the magnitude of the human health risks posed by such substances. They also contain important information on concentrations, burdens and fate of polycyclic aromatic hydrocarbons (PAHs) in the atmosphere. The main anthropogenic sources of PAHs and their effect on the concentrations of these compounds in air are discussed. The fate of PAHs in the air, their persistence and the main mechanisms of their losses are presented. Health hazards associated with PAH air pollution are stressed.

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1. Introduction

Polycyclic aromatic hydrocarbons (PAHs) are organic compounds that are mostly colorless, white, or pale yellow solids. They are a ubiquitous group of several hundred chemically related compounds, environmentally persistent with various structures and varied toxicity. They have toxic effects on organisms through various actions. Generally, PAHs enter the environment through various routes and are usually found as a mixture containing two or more of these compounds, e.g. soot. Some PAHs are manufactured in the industry. The mechanism of toxicity is considered to be interference with the function of cellular membranes as well as with enzyme systems which are associated with the membrane. It has been proved that PAHs can cause carcinogenic and mutagenic effects and are potent immune-suppressants. Effects have been documented on immune system development, humoral immunity and on host resistance [1,2]. PAHs can be formed both during biological processes and as products of incomplete combustion from either natural combustion sources (forest and brush fires) or man-made combustion sources (automobile emissions and cigarette smoke). Thus, PAHs are commonly detected in air, soil, and water. Therefore, PAHs are considered ubiquitous in the environment [3,4]. The ubiquitous nature of PAHs in the environment has been well summarized by Menzie et al. [5].

The term "PAH" refers to compounds consisting of only carbon and hydrogen atoms. Chemically the PAHs are comprised of two or more benzene rings bonded in linear, cluster, or angular arrangements [6,7]. Such molecular arrangements are illustrated in (Fig. 1). Although there are many PAHs, most regulations, analyses, and data reporting focus on only a limited number of PAHs, typically between 14 and 20 individual PAH compounds.

Polycyclic aromatic hydrocarbons have two or more single or fused aromatic rings with a pair of carbon atoms shared between rings in their molecules. PAHs containing up to six fused aromatic rings are often known as "small" PAHs, and those containing more than six aromatic rings are called "large" PAHs. The majority of research on PAHs has been conducted on small PAHs due to the availability of samples of various small PAHs. The simplest PAHs, as defined by the International Agency for Research on Cancer [8], are phenanthrene and anthracene, which both contain three fused aromatic rings. On the other hand, smaller molecules, such as benzene, are not PAHs. Naphthalene, which consists of two coplanar six-membered rings sharing an edge, is another aromatic hydrocarbon. Therefore, it is not a true PAH, though is referred to as a bicyclic aromatic hydrocarbon. The most extensively studied PAHs are 7, 12-dimethylbenzo anthracene (DMBA) and benzo(a)pyrene (BaP) [2]. The most commonly analyzed PAHs are given in (Fig. 2).

The general characteristics of PAHs are high melting and boiling points (therefore they are solid), low vapor pressure, and very low aqueous solubility [10]. The latter two characteristics tend to decrease with increasing molecular weight, on the contrary, resistance to oxidation and reduction increases [10]. Aqueous solubility of PAHs decreases for each additional ring [11]. Meanwhile, PAHs are very soluble in organic solvents because they are highly lipophilic. PAHs also manifest various functions such as light sensitivity, heat resistance, conductivity; emit ability, corrosion resistance, and physiological action [12].

PAHs possess very characteristic UV absorbance spectra. Each ring structure has a unique UV spectrum, thus each isomer has a different UV absorbance spectrum. This is especially useful in the identification of PAHs. Most PAHs are also fluorescent, emitting characteristic wavelengths of light when they are excited (when the molecules absorb light).

The major source of PAHs is the incomplete combustion of organic material such as coal, oil and wood. PAHs are not synthesized chemically for industrial purposes. Nevertheless, there are a few commercial uses for many PAHs. They are mostly used as intermediaries in pharmaceuticals, agricultural products, photographic products, thermosetting plastics, lubricating materials, and other chemical industries [13]. However, the general uses of some PAHs are:

- *Acenaphthene:* manufacture of pigments, dyes, plastics, pesticides and pharmaceuticals.
- *Anthracene:* diluent for wood preservatives and manufacture of dyes and pigments.
- *Fluoranthene:* manufacture of agrochemicals, dyes and pharmaceuticals.
- *Fluorene:* manufacture of pharmaceuticals, pigments, dyes, pesticides and thermoset plastic.
- *Phenanthrene:* manufacture of resins and pesticides.
- *Pyrene:* manufacture of pigments.

Other PAHs may be contained in asphalt used for the construction of roads, in addition to roofing tar. Furthermore, specific refined products, of precise PAHs, are used also in the field of electronics, functional plastics, and liquid crystals.

2. Source of polycyclic aromatic hydrocarbons (PAHs)

The following three types: *pyrogenic*, *petrogenic*, and *biological* are the major PAH sources to the environment. In a

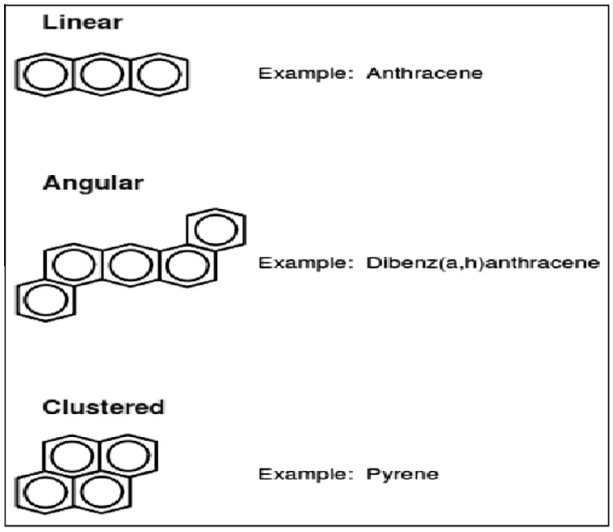


Figure 1 Molecular arrangement of the polycyclic aromatic hydrocarbons (PAHs) [6,7].

process called pyrolysis, *Pyrogenic* PAHs are formed whenever organic substances are exposed to high temperatures under low oxygen or no oxygen conditions. The destructive distillation of coal into coke and coal tar, or the thermal cracking of petroleum residuals into lighter hydrocarbons are Pyrolytic processes that occur intentionally. Meanwhile, other unintentionally processes occur during the incomplete combustion of motor fuels in cars and trucks, the incomplete combustion of wood in forest fires and fireplaces, and the incomplete combustion of fuel oils in heating systems. The temperatures at which the pyrogenic processes occur are ranging from about (350 °C to more than 1200 °C). Pyrogenic PAHs are generally found in greater concentrations in urban areas and in locations close to major sources of PAHs. In addition, PAHs can also be formed at lower temperatures. It is worth mentioning that crude oils contain PAHs that formed over millions of years at temperatures as low as (100–150 °C).

In this respect, PAHs formed during crude oil maturation and similar processes are called *petrogenic*. Such *petrogenic* PAHs are common due to the widespread transportation, storage, and use of crude oil and crude oil products. Some of the major sources of *petrogenic* PAHs include oceanic and freshwater oil spills, underground and above ground storage tank leaks, and the accumulation of vast numbers of small releases of gasoline, motor oil, and related substances associated with transportation. It is well-known that PAHs can be formed during the incomplete combustion of organic substances. PAHs are also found in petroleum products.

On the other hand, it is not well-known that PAHs can be produced *biologically*. For example, they can be synthesized by certain plants and bacteria or formed during the degradation of vegetative matter. The mode of PAHs formation can be either natural or anthropogenic. (Fig. 3) illustrate such mode of PAHs formation [14–17].

Examples of natural sources of PAHs formation include: forest and brush fires, volcanoes, bacterial and algal synthesis, petroleum seeps, erosion of sedimentary rocks containing petroleum hydrocarbons, and decomposition of vegetative liter fall. Examples of anthropogenic sources of PAHs range from:

- Large point sources include incomplete combustion (such as incinerators and some industrial processes.
- Smaller point sources include , dispersed sources (such as automotive emissions, smoke from wood-burning stoves, jet aircraft exhausts, cigarette and cigar smoke, and backyard barbecues).
- Other anthropogenic sources of PAHs include petroleum product spills, sewage sludge, and tarry or creosote waste materials.

It is important to mention that the incomplete combustion, either naturally or anthropogenically derived, has been identified as the single largest contributor of PAHs to the environment [18].

Sources of PAHs to the environment are numerous and generally well-known. The identification of the PAH content is based mainly on real environmental samples. Chemical fingerprinting includes several techniques which can help distinguish between groups of PAH sources. Such groups include coal-based, wood-based, or oil-based sources. This can be done by examining specific chemical indicators that contained in many samples. As such, source identification techniques often compliment studies involved in the establishment of general "background" ranges of PAHs in the environment. Chemical fingerprinting can also help identify and allocate non-point sources of PAHs to the environment in both industrial and residential areas [19].

As previously mentioned, the temperature of formation can provide one key to identifying PAH sources because higher temperatures of formation tend to produce PAHs with fewer alkylated chains than PAHs formed under lower temperature processes. For instant, PAHs in a power plant stack effluent, which are formed rapidly at very high temperatures will have a different pattern of PAHs than the PAH distribution found at a crude oil spill site. The later PAHs were, generally, formed at lower temperatures over millions of years [20].

Another method used to distinguish *pyrogenic* PAHs from *petrogenic* PAHs is to examine the number of five-member hydrocarbon rings in the PAHs. Five-member rings are more abundant in petroleum hydrocarbons than in *pyrogenic* substances, because the extensive time of petroleum hydrocarbon formation favors the marshaling of the rings. For materials formed pyrolytically the source material is rapidly converted into more stable six-member rings [21]. Thus, although the sources of PAHs to the environment are many, advances have been and continue to be made in the identification of these sources, and the distinction between *pyrogenic* PAHs and those not derived from pyrolytic sources [22].

3. Transport and Fate of PAHs in the environment

Fig. 4 illustrates PAHs dispersion through air and move through terrestrial and aquatic environments as a result of various processes. Fig. 4 shows some of these processes in broad form and shows how PAHs are added, dispersed, and degraded in the environment. It also illustrates how people can be exposed to PAHs through inhalation, ingestion, or direct dermal contact.

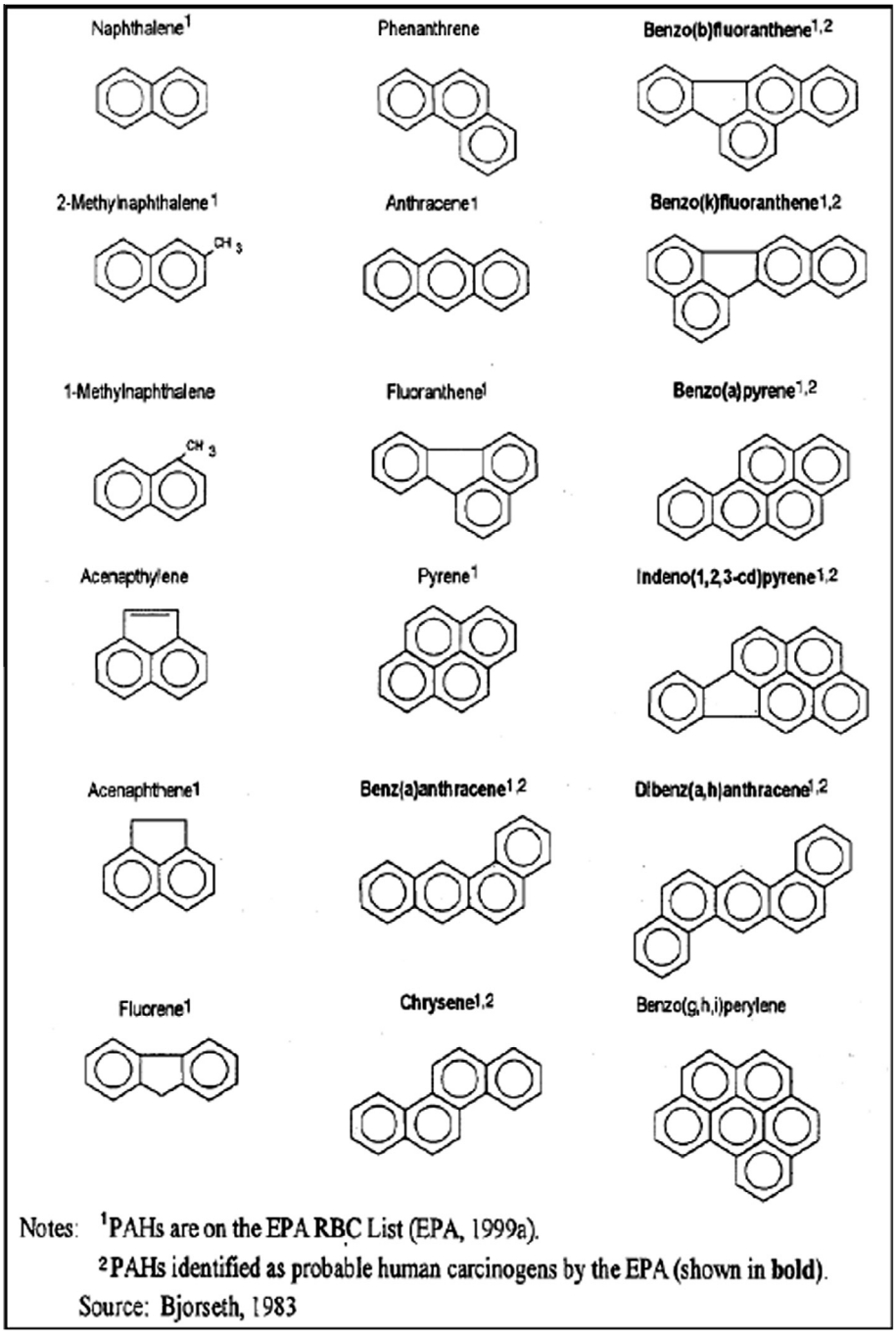


Figure 2 The most commonly analyzed polycyclic aromatic hydrocarbons (PAHs) [9].

3.1. Atmospheric emission and deposition of PAHs

The atmosphere is the most important means of PAH dispersal, it receives the bulk of the PAH environmental load resulting in PAHs being ubiquitous in the environment. PAHs are emitted to the atmosphere primarily from the incomplete combustion of organic matter. The combustion sources can be either natural or anthropogenic. The natural sources include volcanoes and forest fires. While the anthropogenic sources are vehicle exhaust, agricultural fires, power plants, coke plants, steel plants, foundries and other industrial sources. PAHs tend to be found in greater concentrations in urban environments than in rural environments because most PAH sources are located in or near urban centers. Once released to the atmosphere, PAHs are found in two separate phases, a vapor phase and a solid phase in which the PAHs are sorbet onto particulate matter [24,25,18]. Hydrophobic organic chemicals with low vapor pressures, such as PAHs, are sorbet to atmospheric particulates more readily than chemicals with higher vapor

pressures, such as benzene. The variability in vapor pressures of different PAH compounds cause the individual PAHs to distribute in different concentrations in the vapor [26] and other sorbet phases [27].

Relationship between vapor pressure and molecular weight for typical PAHs is given in (Fig. 5) [29]. As shown in this figure, benzo(a)pyrene has the lowest vapor pressure and naphthalene has the highest vapor pressure. In addition, the correlation between vapor pressure and molecular weight is quite good with a correlation coefficient of 0.9017 [28]. PAHs with lower vapor pressures (e.g., benzo(a)pyrene) will tend to be sorbet to particles, while PAHs with higher vapor pressures (e.g., naphthalene) will tend to be associated with the vapor phase. As a result, the relative distribution of PAHs in the two phases will be different, for an air sample.

It was stated by "Electric Power Research Institute (EPRI)" [29] for air samples collected from Portland, Oregon, that there are two differences between the PAH concentrations in the vapor and particulate phases. First, the total PAH concentration for the vapor phase (741 ng/m^3) is much higher than that of the particulate phase (12 ng/m^3). Second, the lower molecular weight, higher vapor pressure PAHs are detected in the vapor phase whereas the higher molecular weight, lower vapor pressure PAHs is not. In contrast, the vapor phase has

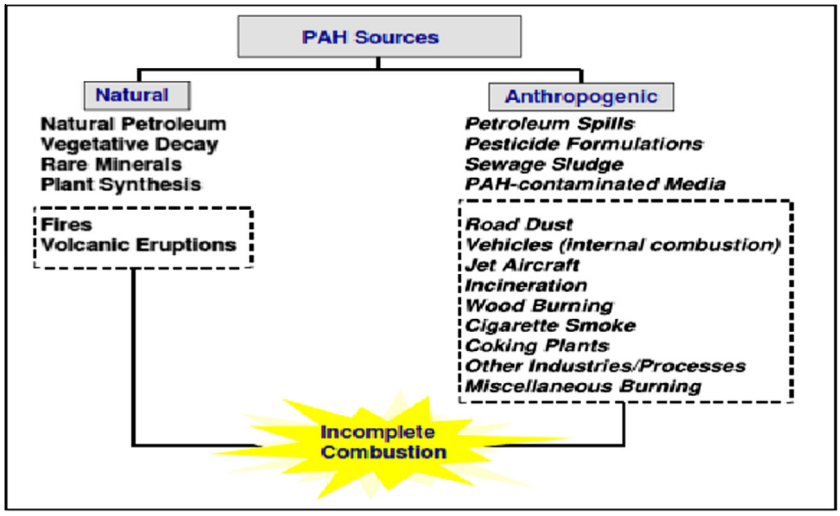
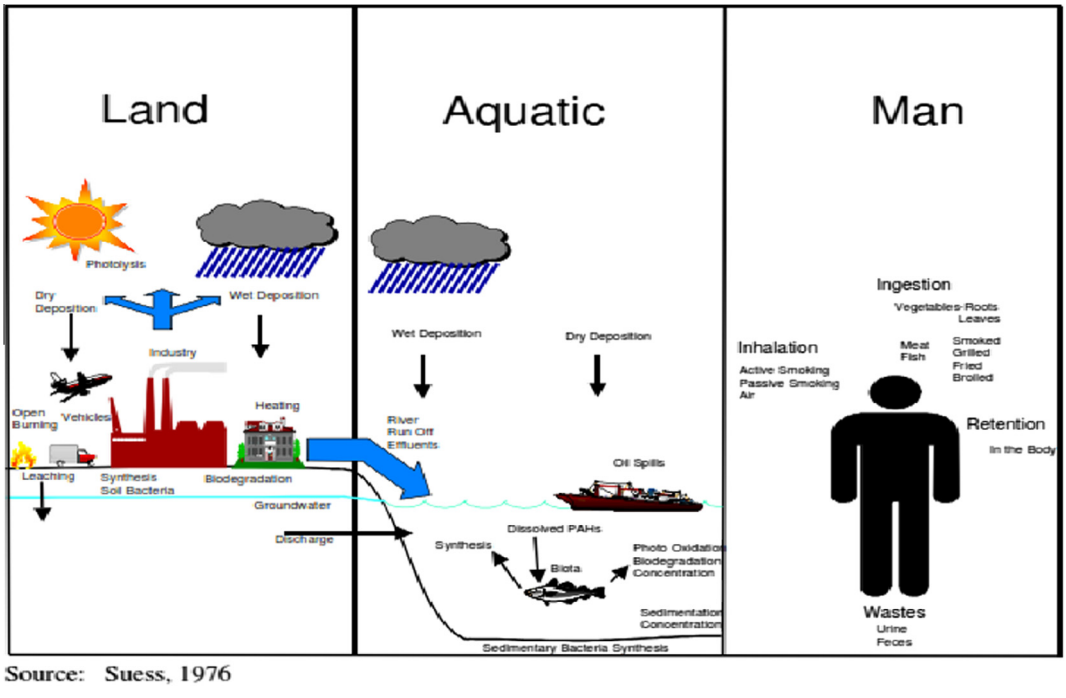


Figure 3 Natural and anthropogenic sources of polycyclic aromatic hydrocarbons (PAHs).



Source: Suess, 1976

Figure 4 Dispersion of PAHs through the air, the terrestrial and aquatic environments [23].

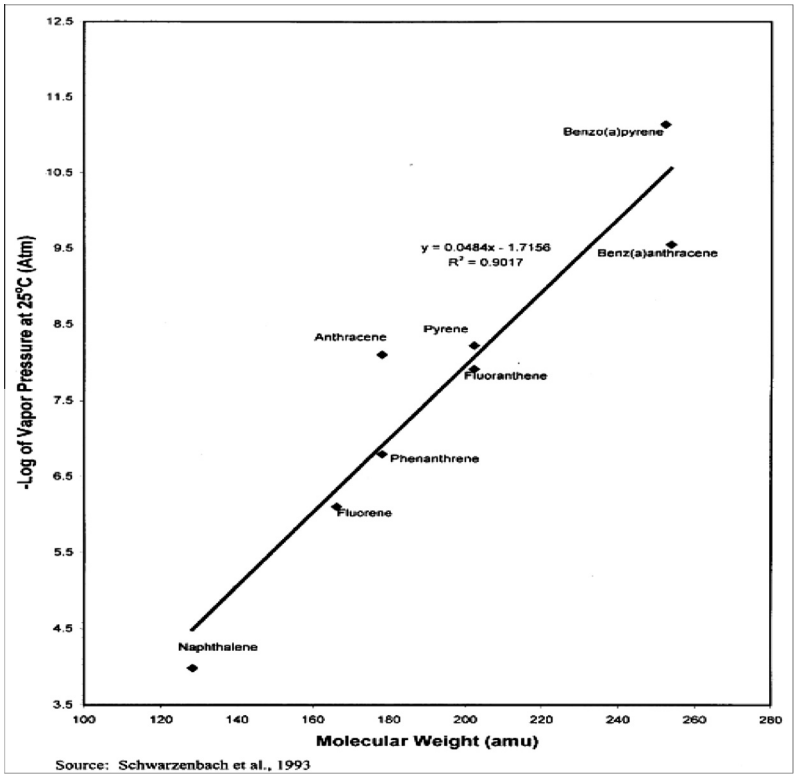


Figure 5 Relationship between vapor pressure and molecular weight for typical PAHs [28].

much lower concentrations of the higher molecular weight PAHs than the particulate phase [29]. A significant correlation was also found between the amounts of dust in the air and PAH concentrations in the particulate phase [27]. Hence, the concentrations of PAHs in the gas phase increase in summer or in general in tropical regions, whereas particulate phase PAHs are dominant during winter or in general in Arctic regions [30,31]. Meanwhile, humidity has an effect on the adsorption of PAHs onto particulate phases [32]. Moreover, PAH adsorption also depends on the types of suspended particulates (e.g., soot, dust, fly-ash, pyrogenic metal oxides, pollens, etc.) [18].

PAHs are to be collected on filter or sorbent followed by extraction that is normally carried out by a number of organic solvents using Soxhlet or ultrasonication treatments. Such solvent-based methods are successfully used for a wide range of PAHs. Detection of PAHs and their derivatives can be achieved using GC–MS method. It is reliable and accurate to determine the concentrations of PAHs and their derivatives [33].

3.2. PAHs in surface soils

Atmospheric PAHs are continuously deposited to the earth by dry or wet deposition processes. Some of these PAHs are from nearby sources, such as automotive exhaust from adjacent roadways. Other PAHs are from more distant sources and have been carried various distances through the air. In the mean time, PAHs can be added to soils if fill materials contain PAHs. When PAHs are deposited onto the earth's surface, they can become mobile. Since the majority of PAHs in the soil will be bound to soil particles [16,34], the most important factors influencing PAH mobility of particulates in the subsurface will be sorbent particle size and the pore throat size of the soils. Such pore throat can be defined as the smallest opening found between individual grains of soil [35]. If particles to which PAHs are sorbet cannot move through the soil then the movement of PAHs will be limited because they tend to remain sorbet to particles.

The tendency of PAHs to be sorbet to soil depend on both the properties of the PAH and the soil. Therefore, PAH sorption is one of the processes that govern the soil mobility of individual PAHs. Numerous studies of the correlation of the partition coefficient with soil properties have found that the organic carbon content (f) usually yields the most significant correlation [29].

The octanol–water partitioning coefficient of PAHs is also important in determining the sorption of PAHs to soils. The octanol–water partitioning coefficient (K_{ow}) is related to the solubility of an organic compound in water [28]. As the K_{ow} increases, the aqueous solubility decreases and the tendency for sorption to a particular soil increases. Nevertheless, the K_{ow} and solubility can affect PAH mobility in soil. Other factors such as soil conductivity also have a significant influence on PAH movement.

A simplified solvent extraction and GC/MS/MS is employed for a rapid determination of 18 polycyclic aromatic hydrocarbons (PAHs) in soil. The GC/MS/MS is to be operated in pseudo multiple reactions monitoring mode (PMRM) [36].

3.3. PAHs in sediments

PAHs are deposited to the sedimentary environment by similar processes that govern the deposition to surface soils. In rural areas, the PAHs sorbet to atmospheric particles can settle on the surface of lakes, streams, and oceans by dry or wet deposition. There they are dispersed by currents and eventually become integrated with the sediment. On the other hand, sediments near urban centers are influenced by atmospheric deposition of PAHs. They also receive inputs of PAHs from storm and sanitary sewer effluents as well as roadway runoff. Eventually, some of the PAHs will be sorbet to particles, settle, and become part of the sedimentary record. This record has been used by several authors by examining the depositional history in sediment cores to identify trends of PAH input into the environment. These cores are usually taken in anoxic sediment, where there is no oxygen in the water [29,37].

Once PAHs are incorporated into sediments they are somewhat immobile because their non-polar structures inhibit them from dissolving in water. Nevertheless, PAHs are not completely insoluble, particularly the lower molecular weight PAHs. Thus, small amounts of PAHs do dissolve and become included in the pore water where they are bioavailable. The presence of pore water organic colloids can increase the concentrations of PAHs beyond their aqueous solubility because PAHs will be sorbet onto these organic colloids. These in turn are easily transported through the pore spaces of the sediment. Thus, the sorption to colloids can increase the mobility and bioavailability of PAHs in sediments [38].

3.4. Ecotoxic effects of PAHs

The toxicity of PAHs to aquatic organisms is affected by metabolism and photo-oxidation. They are generally more toxic in the presence of ultraviolet light. PAHs have moderate to high acute toxicity to aquatic life and birds. PAHs in soil are unlikely to exert toxic effects on terrestrial invertebrates, except when the soil is highly contaminated. Adverse effects on these organisms include tumors, reproduction, development, and immunity.

Mammals can absorb PAHs by various routes e.g. inhalation, dermal contact, and ingestion [38–40]. On the other hand, plants can absorb PAHs from soils through their roots and translocate them to other plant parts. Uptake rates are generally governed by concentration, water solubility, and their physicochemical state as well as soil type. PAH-induced phytotoxic effects are rare. Full information and the database on this are still limited. Certain plants contain substances that can protect against PAH effects. Other plants can synthesize PAHs that act as growth hormones [40].

PAHs are moderately persistent in the environment, and can be bio-accumulated. The concentrations of PAHs found in fish and shellfish are expected to be much higher than in the environment from which they were taken. Bioaccumulation has been also shown in terrestrial invertebrates. Nevertheless, metabolism of PAHs is sufficient to prevent biomagnifications [41,42].

4. Occurrence of PAH in foods

Raw foods should usually not contain high levels of PAH. In areas remote from urban or industrial activities, levels of PAH found in unprocessed foods reflect the background contamination. Such PAH usually originates from long distance airborne transportation of contaminated particles as well as natural emissions from volcanoes and forest fires. In the neighborhood of industrial areas or along highways, the contamination of vegetation can be ten-fold higher than in rural areas. Processing of food (such as drying and smoking) and cooking of foods at high temperatures (grilling, roasting, frying) are major sources generating PAH [43,44]. Levels as high as 200 μg/kg of PAH have been found in smoked fish and meat. In barbecued meat, 130 μg/kg of PAH has been reported (Standing Committee on Foodstuffs, 2001). Generally, the average background values are in the range of 0.01–1 μg/kg in uncooked foods. Contamination of vegetable oils (including olive residue oils) with PAH usually occurs during technological processes like direct fire drying. In this respect, the combustion products may come into contact with the oil seeds or oil [45,46].

The occurrence of PAH in foods is governed mainly by the same physicochemical factors that determine their absorption and distribution in man. These factors are the relative solubility of PAH in water and organic solvents. Such solubility determines their capacity for transport and distribution between different environmental compartments and their uptake and accumulation by living organisms. The transportation of PAH in the atmosphere is influenced by their volatility. The chemical reactivity of PAH influences adsorption to organic material or degradation in the environment. All these factors determine the persistence and capacity of PAH to be bio-accumulated in the food chain [47,48]. PAH are lipophilic and generally have a very poor aqueous solubility. On the contrary, PAH accumulate in lipid tissue of plants and animals. On the other hand, PAH will not tend to accumulate in plant tissues with a high water content and limited transfer from the soil to root vegetables will occur. The rate of transfer varies widely and is also influenced by soil characteristics, the plant and the presence of co-pollutants. PAH is strongly adsorbed to the organic fraction of soils and do not penetrate deeply into most soils, therefore limiting both leaching to groundwater and availability for uptake by plants. Some PAH are semi volatile but most of them tend to adsorb on organic particulate matter.

Heavier PAH preferentially associate with particulate matter so atmospheric fall out is a principal route of contamination [49]. PAH with 5 or more aromatic rings are found predominantly on particulates, (usually on small (<2.5 μm) particles such as fly ash and soot). PAH with 2 or 3 rings are almost entirely in the vapor phase. PAH with 4 rings is in an intermediate position. Consequently, vegetables with large leafs, grazing cattle and poultry which may ingest particulate matter from soil are susceptible to contamination by PAH adsorbed to particles. The waxy surface of vegetables and fruits can concentrate low molecular mass of PAH mainly through surface adsorption. PAH concentrations are generally greater on plant surface (peel, outer leaves) than on internal tissue. Careful washing may remove up to 50% of the total PAH. Particle bound PAH are easily washed off the surface whereas those in the waxy layer are less efficiently removed. Washing may alter the apparent high to low molecular mass PAH profile. When particulates fall out into surface water, they are transported in suspension and surface. The adsorbed PAH finally end up in fresh water or

marine sediments. PAH are strongly bound to these sediments which constitute a potential pollution reservoir for PAH release under specific conditions. Thus, sediment-dwelling and filtering organisms are most susceptible to contamination. Most organisms have a high bio-transformation potential for PAH resulting in no significant bio-magnification in the aquatic food chain. Nevertheless, filter-feeding bivalves (e.g. mussels and oysters) filter large volumes of water and have a low metabolic capacity for PAH. They may accumulate PAH. The water-soluble low molecular mass PAHs are rapidly degraded in water. However, the continuous release of PAH by wastewater, which is discharged to the marine environment, can result in elevated concentrations in bivalves grown close to industrialized areas. The accumulation of sediment-adsorbed PAH depends on the characteristics of the contaminant [50]. The main route of human exposure to sedimentary PAHs is through marine lives which make up part of the human diet. PAHs contained in sediments and pore water are taken in by benthic organisms such as lobsters, muscles, and clams which are either consumed directly by humans or are consumed by higher predators which also are a part of the human diet, such as squid and fish [51].

Processing procedures, such as smoking and drying, and cooking of food is commonly thought to be the major source of contamination by PAH. Depending on a number of parameters including time, type of fuel, distance from the heat source and drainage of fat, type (grilling, frying, roasting), cooking number of compounds including PAH are formed in the food.

A comparison of PAH levels in duck breast steaks, undergoing various processing and cooking treatments for 0.5–1.5 h, showed that charcoal grilled samples without skin contained the highest amount of total PAH (320 μg/kg), followed by charcoal grilling with skin (300 μg/kg), smoking (210 μg/kg), roasting (130 μg/kg), steaming (8.6 μg/kg) and liquid smoke flavoring (0.3 μg/kg). For PAH that are classified as carcinogenic (IARC class 1 or 2 A and B), the trend was the same with the exception that smoked samples contained the highest amount (35 μg/kg). In addition, the highest amounts of total and carcinogenic PAH were observed after smoking of duck breast samples for 3 h (53 μg/kg) [52].

Contamination of water may lead to intake of PAH through drinking water and cooked foods. The levels are usually below 1 ng/L in drinking water. However, the level can be higher when asphalt or coal tar coating of storage tanks and water distribution pipes are used.

5. Effect on human health

17 PAHs have been identified as being of greatest concern with regard to potential exposure and adverse health effects on humans and are thus considered as a group. Biological monitoring of exposure to PAHs is of primary interest, due to the widespread diffusion of these compounds and to their toxicological relevance. However, the health effects of individual PAHs are not exactly alike. In fact, the International Agency for Research on Cancer [8] classifies some PAHs as known, possibly, or probably carcinogenic to humans (Group 1, 2A or 2B). Among these are benzo[*a*]pyrene (Group 1), naphthalene, chrysene, benz[*a*]anthracene, benzo[*k*]fluoranthene and benzo[*b*]fluoranthene (Group 2B) [8]. Some PAHs are well known as carcinogens, mutagens, and teratogens and therefore pose a serious threat to the health and the well-being of humans. The most significant health effect to be expected from inhalation exposure to PAHs is an excess risk of lung cancer [53].

5.1. Routes of exposure

The major route of exposure to PAHs in the general population is from breathing ambient and indoor air, eating food containing PAHs, smoking cigarettes, or breathing smoke from open fireplaces [54]. Tobacco smoke contains a variety of PAHs, such as benzo(a)pyrene, and more than 40 known or suspected human carcinogens [55]. Some crops, such as wheat, rye, and lentils, may synthesize PAHs or absorb them via water, air, or soil. Water can also contain certain amounts of PAHs since those chemicals can leach from the soil into water or they can enter water from industrial effluents and marine accidental spills during oil shipment. Soil also contains PAHs, primarily from airborne fallout [56]. Therefore, PAH exposure occurs on a regular basis for most people.

Routes of exposure include ingestion, inhalation, and dermal contact in both occupational and non-occupational settings. Occupational exposure may also occur in workers breathing exhaust fumes, such as mechanics, street vendors, motor vehicle drivers, including workers in mining, metal working, or oil refining. Some exposures may involve more than one route simultaneously, affecting the total absorbed dose (such as dermal and inhalation exposures from contaminated air) [57,1,58]. People can be exposed to PAHs in the air and surface soil by direct inhalation, ingestion or dermal contact.

5.2. Metabolism

Exposure to PAHs is never to single PAHs. Understanding what differences may occur in mixtures of PAHs gives an accurate assessment of the dangers of PAHs. Therefore, understanding the dynamics of single metabolism of PAHs and possible toxic effects is a necessary. This will guide to understand the accurately impact of PAHs and will guide to a well remediation strategies.

Studies were carried out comparing the metabolism of the PAHs Phenanthrene (PHE), Flouranthene (FLA) and Benzo (a)pyrene (BAP) in single, binary, and ternary mixtures by monitoring the disappearance of the parent compound. It was observed that PAH metabolism in the single PAH experiment differed from metabolism in both binary and ternary mixtures. Enzyme competition was evident in the metabolism of mixtures, changing significantly the metabolism patterns of individual PAHs. PAH structure was also seen to affect metabolism in mixtures and the possible creation of toxicity effects during mixture metabolism. PAH concentration changed over time with faster change during single PAH metabolism followed by ternary mixture metabolism and finally binary metabolism [59,60].

Due to the high lipophilicity of this class of compounds, their bioavailability after ingestion and inhalation is significant. Scientific investigations have shown that detectable levels

of PAH occur in almost all internal organs, particularly in organs that are rich in adipose tissue. These organs can serve as storage depots from which the hydrocarbons can be gradually released. Once the PAHs enter the organism they require a multistep metabolic activation by specific enzymes. The enzyme system that is primarily responsible for PAH metabolism is the mixed-function oxidase system. The first reaction is an epoxidation. PAH epoxides can then be conjugated with glutathione and this is regarded as a true detoxification reaction. The epoxides that are not conjugated with glutathione are converted into phenols and diols. Such PAH metabolites, nevertheless, are sometimes not sufficiently polar to be excreted. Therefore, they have to be conjugated with glucuronic or sulfuric acids to enable excretion. Most metabolites of PAH are excreted in feces and urine [61].

5.3. Short-term health effects (acute)

The impact of PAHs on human health depend mainly on the length and route of exposure, the amount or concentration of PAHs one is exposed to, as well as the relative toxicity of the PAHs [54]. A variety of other factors can also affect health impacts including subjective factors such as pre-existing health status and age. The ability of PAHs to induce short-term health effects in humans is not clear. Occupational exposures to high levels of pollutant mixtures containing PAHs have resulted in symptoms such as eye irritation, nausea, vomiting, diarrhoea and confusion [62]. Nevertheless, it is not known which components of the mixture were responsible for these effects and other compounds commonly found with PAHs may be the cause of these symptoms. Mixtures of PAHs are also known to cause skin irritation and inflammation. Anthracene, benzo(a)pyrene and naphthalene are direct skin irritants. But, anthracene and benzo(a)pyrene are reported to be skin sensitizers, i.e. cause an allergic reaction in skin in animals and humans [63].

5.4. Long-term health effects (chronic)

Health effects from long-term or chronic exposure to PAHs may include decreased immune function, cataracts, kidney and liver damage (e.g. jaundice), breathing problems, asthma-like symptoms, and lung function abnormalities. Meanwhile, repeated contact with skin may induce redness and skin inflammation. Naphthalene, a specific PAH, can cause the breakdown of red blood cells if inhaled or ingested in large amounts. If Man is exposed to PAHs, the harmful effects that may occur largely depend on the way of exposure [64–66].

5.5. Carcinogenicity

Although unmetabolized PAHs can have toxic effects, a major concern is the ability of the reactive metabolites, such as epoxides and dihydrodiols, of some PAHs to bind to cellular proteins and DNA [1]. Biochemical disruptions and cell damage occurrence lead to mutations, developmental malformations, tumors, and cancer. Evidence indicates that mixtures of PAHs are carcinogenic to humans. The evidence comes primarily from occupational studies of workers exposed to mixtures containing PAHs. Such long-term studies have shown an increased risk of predominantly skin and lung as well as bladder and gastrointestinal cancers. Nevertheless, it is not clear from these studies whether exposure to PAHs was the main cause as workers were simultaneously exposed to other cancer-causing agents (e.g. aromatic amines) [64].

In laboratory studies, animals exposed to levels of some PAHs over long periods have developed lung cancer from inhalation, stomach cancer from ingesting PAHs in food, and skin cancer from skin contact [67]. Benzo(a)pyrene is notable for being the first chemical carcinogen to be discovered. In addition, it is the most common PAH to cause cancer in animals. Based on the available evidence, a number of PAHs are classified as carcinogenic to animals [67]. Meanwhile, some PAH-rich mixtures are also classified as carcinogenic to humans [68]. The EPA has classified the following seven PAH compounds: benz(a)anthracene, benzo(a)pyrene, benzo (b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(ah) anthracene, and indeno(1,2,3-cd) pyrene as probable human carcinogens [67].

5.6. Effects of PAH on the immune system

It has been reported that the PAHs induce suppress immune reaction in rodents [63]. The precise mechanisms of PAH-induced immune-toxicity are still not clear. It was concluded that the immune-suppression may be involved in the mechanisms by which PAH induce cancer. The immune-toxic effects of PAH have been investigated for many years. Whatever the route of exposure, the resulting effects have been considered mostly at the systemic level. However, very few studies have looked for alterations of the local gut immune system. Immuno-suppression is associated with an increased susceptibility of the exposed individuals to the development of cancers or of infectious diseases. It was sated that the immune-potentiation results in an increased secretion of cytokines by immune cells, that leads to inflammation. Under specific circumstances, this may facilitate tumor development, expression of hypersensitivity (allergy, contact hypersensitivity) or auto immunity. Depending on various parameters in the design of the protocol such as route of exposure, end point, high or low level of dosage, model used, immune-suppression or immune-potentiation can be observed [68]. Nevertheless, the published reports indicate that the immune-suppression is the most frequent effect reported after exposure to PAH [68]. In addition, the literature stated that the immune-potentiation is reported to occur after either atmospheric or topic exposure, or by using in vitro systems [68]. In term of the route of exposure, most of literature have used either subcutaneous and intra-peritoneal injection or inhalation [68–70]. Experimental studies were conducted on the immuno-toxicity that resulted from ingestion of PAH in contaminated food after oral intake of a diet contaminated with PAH.

Furthermore, it has been reported that some PAH when taken into the diet may induce DNA adducts in the lungs. In addition, translocations from one organ to another may result in "at distance" effects. It is worth mentioning that most of the immune-toxic effects that are reported for PAH are not

thought to be due to parent compounds but it refers to their reactive epoxide metabolites [68,69].

5.7. Genotoxicity of PAH

Geno-toxic effects for some PAH have been demonstrated both in rodents and in vitro tests using mammalian (including human) cell lines. Most of the PAHs are not geno-toxic by themselves and they need to be metabolised to the diol epoxides which react with DNA, thus inducing geno-toxic damage. Geno-toxicity plays important role in the carcinogenicity process and could be also in some forms of developmental toxicity [71,72].

PAHs undergo multiple metabolic transformations which may lead to the formation of electrophilic derivatives (e.g. diolepoxides, quinones, conjugated hydroxyalkyl derivatives) capable of covalent interaction with nucleophilic centers of macromolecules. The mechanism of mutagenicity of PAH has been mainly investigated using benzo[a]pyrene and ben zo[a]pyrene-7,8-diol-9,10-epoxide (BaPDE) as model compounds [73,74]. Binding of benzo[a]pyrene and BaPDE to nucleic acids mainly occurs at exocyclic amino groups of purines. The mutational spectrum induced by BaPDE in bacteria shows a prevalence of G > T transversions [73,74]. A similar spectrum of base-pair substitutions is induced by BaPDE in mammalian cells in vitro [75], and by benzo[a]pyrene in vivo in transgenic mice [76] and in the Ha-ras oncogene in mouse skin tumours [77,78]. Molecular analysis of p53 mutations in lung cancers of smokers shows a similar prevalence of G > T transversions [79], possibly reflecting the contribution of PAH to tobacco smoke carcinogenesis. In addition to base pair substitutions, bulky adducts of PAH to DNA bases can induce frameshift mutations, deletions, S-phase arrest, strand breakage and a variety of chromosomal alterations [80,81].

5.8. Teratogenicity

Embryotoxic effects of PAHs have been described in experimental animals exposed to PAH such as benzo(a)anthracene, benzo(a)pyrene, and naphthalene [82]. Laboratory studies conducted on mice have demonstrated that ingestion of high levels of benzo(a)pyrene during pregnancy resulted in birth defects and decreased body weight in the offspring [83]. It is not known whether these effects can occur in humans. Nevertheless, it was reported and demonstrated that exposure to PAH pollution during pregnancy is related to adverse birth outcomes including low birth weight, premature delivery, and heart malformations [84]. High prenatal exposure to PAH is also associated with lower IQ at age three, increased behavior problems at ages six and eight, and childhood asthma. Cord blood of exposed babies shows DNA damage that has been linked to cancer [85,86].

6. Removal of polycyclic aromatic hydrocarbon

PAHs are removed from the environment by several methods, including: biodegradation [87,88] and photochemical degradation. On the other hand, removal of PAHs from Atmosphere was also reported [89–91].

6.1. PAH degradation

Degradation of PAHs in the environment includes: biodegradation, photooxidation, and chemical oxidation adsorption to soil particles, leaching, bioaccumulation [92]. Each of these processes affects individual PAHs in a different manner. This is mainly due to the fact that each PAH has a unique structure and a set of physical, chemical, and biological properties. The majority of the articles examined for this literature study discussed biodegradation by either anaerobic or aerobic microorganisms. Few articles studied other modes of PAH degradation, such as photolysis or oxidation.

6.1.1. PAH biodegradation

Biodegradation of PAHs was the most frequently studied degradation process described in the literature. The first PAH biodegradation studies focused on aerobic degradation. Nevertheless, anaerobic degradation has been demonstrated, more recently, under denitrifying conditions [93,94]. In order for bacteria to degrade any given PAH, it must be made available for uptake by the bacteria [95–97]. PAHs become bioavailable when they are in either the dissolved or the vapor phase. PAHs sorbet onto soil particles cannot be readily degraded by bacteria because the PAHs are separated from the enzymes that are used by bacteria to break them down [98–101]. However, the bioavailability of a given PAH is complicated. For example, the age of PAHs in the soil has been shown to affect how rapidly they will be desorbed from the soil [102]. PAHs will also desorb at different rates over time.

Hatzinger and Martin [98] demonstrated that fresh C-14 labeled phenanthrene and chrysene desorbed rapidly. On the other hand, phenanthrene and chrysene that had been exposed to soil for a long period of time desorbed more slowly. Initially, PAHs are desorbed rapidly followed by a period of slower desorption [103]. Such a change in desorption rate is caused mainly by decreases in the concentration gradient as the PAHs desorbed. As the concentrations of the individual PAHs reach the aqueous solubility levels, the rate of desorption will decrease because the concentration gradients between the sorbet and aqueous phases have decreased. The important factor in the PAHs bioavailability is their solubility character. The aqueous solubility of PAHs is strongly dependent on their molecular weights [104,105]. For example, angular carbon ring arrangements are thermodynamically the most stable configuration, but the open areas (referred to as bay regions) formed between the angled benzene rings are subject to attack by enzymes. This makes these angular structures more biodegradable than the linear or clustered structures. PAH degradation also can be impacted by competitive inhibition.

On the other hand, the rate of PAH degradation can be reduced if the bacteria involved in degrading PAHs find a chemical that is utilized more easily as a food source. Competitive inhibition occurs when the active sites of enzymes used by bacteria to break down PAHs as a carbon source are non-specific. These non-specific enzymes can attach themselves to a number of different chemicals. If other chemicals are present that are more easily broken down, the enzyme will degrade those chemicals as its carbon source and the PAHs will persist [106]. It is also evident that anthracene could be completely mineralized by Sphingomonas, Nocardia, Beijerinckia,

Paracoccus, and Rhodococcus with dihydriol as the initial oxygenated intermediate [107].

6.1.2. Photolysis degradation

Photolysis is defined as the destruction of a compound from reactions initiated by the absorption of light [108]. These reactions occur when light absorbed by PAHs excites the electrons within the molecules. This excitation creates an unstable structural arrangement. Consequently, such unstable structural arrangement allows several physical and chemical processes to act on the compound [28]. Photolysis reactions involving PAHs are similar to biodegradation reactions (i.e. the PAHs degrade more effectively when they are in the vapor or aqueous phases) [109]. Little photo-degradation occurs when PAHs are sorbet to particles in the atmosphere or soil. These reactions occur more effectively with increasing particle surface area. Photolysis reactions are also greater on light colored particles, such as silica gel or alumina, than on darker particles, such as carbon black. For example, anthracene has a half-life of 0.5 h on alumina and 310 h on carbon black [110].

As in microbial degradation, photodegradation reactions depend heavily on the structure of the PAH being degraded. In general, linear, 2-ring, and some clustered PAHs degrade rapidly under direct light. Angular PAHs (e.g., phenanthrene and dibenz(a,h)anthracene) is the slowest in degradation. This is mainly because they are the most structurally stable molecules [111]. Furthermore, photolysis tends to be more effective for low molecular weight compounds, such as naphthalene, because these compounds are more bioavailable and will have longer exposure times to sunlight [111]. Finally, PAH molecules, when they are sorbet to fly ash particles, may be deposited inside the fly ash pore structure. When this occurs, the portion of the PAHs in the pore structure becomes shielded from sunlight which stops photolytic reactions from occurring [112]. Other methods of PAH degradation appear less frequently in the scientific literature than microbial degradation and photolysis. Often chemical oxidation is included as a subsection of articles on biodegradation and photolysis.

6.1.3. Chemical degradation

Chemical oxidation appears to be a minor PAH degradation mechanism under most environmental conditions. In the case of chemical oxidation, either naturally or as part of treatment technologies [113], the rates of PAH oxidation depend on several properties of the system. The molecular weight and structure of the compound, its physical state, temperature, and the strength of the oxidizing agent all impact the outcome. It was reported that chemical treatment and/or physical treatment could remove PAHs efficiently from surface water [114]. Alebic–Juretic et al. reported that fluoranthene was the most stable of the PAHs tested for oxidation by ozone [115]. This could be one reason why fluoranthene is often present in high concentrations in the soil data reviewed. Zhang et al. also reported that the synergistic effect of UV irradiation and TiO_2 or ZnO catalysis was efficient for degradation of PAHs in contaminated soil [116,117]. Iron oxides and oxalic acid can set up a photo-Fenton-like system without additional H_2O_2 in solid phase to enhance the photodegradation of pyrene under UV irradiation [118]. On the other hand, sono-chemical degradation of PAHs using high frequency of ultrasound was also investigated [119,120].

6.2. Removal of PAHs from atmosphere

PAHs are removed from the atmosphere either by dry deposition or wet deposition, as well as degradation by various pathways [89–91].

6.2.1. Dry deposition

Dry deposition occurs when PAHs sorbet to atmospheric particles settle to earth in the absence of precipitation as shown in Fig. 6 [108,121–123]. Dry deposition rates vary depending on the specific properties of the PAH, sorbent particle, and atmospheric conditions. For example, large particles will tend to settle faster than small particles because large particles tend to be heavier than smaller particles. Such heavier particles require stronger atmospheric currents to keep them suspended as compared to small particles. Therefore, atmospheric condition is the most important factor affecting the rate of dry deposition. Moreover, particles will settle faster in a more placid atmosphere than in an unstable one because the wind and atmospheric currents in an unstable atmosphere have enough energy to prevent particles from settling.

On the other hand, temperature will also affect the rate at which PAHs are deposited from the atmosphere. For example, higher temperatures will cause a greater fraction of the total PAHs to be in the vapor phase and lower temperatures will increase sorption of PAHs [124,125]. This phenomenon can be seen in the particle/vapor PAH distributions from winter to summer displayed in Fig. 7 [126]. In this figure, the PAH compounds are shown so that the vapor pressures decrease from left to right on the x-axis. In addition, the y-axis is in terms of percentage of each individual PAH, rather than concentration, with the sum of the vapor and particulate phases for each PAH compound adding up to 100%. Fig. 7 clearly demonstrates the effects of vapor pressure and temperature on the vapor/particle phase distribution of some PAHs. For example, about 93% of naphthalene was found in the vapor phase in air sampled in summer while only about 53% of naphthalene was in the vapor phase in air sampled during winter (Harrison et al., 1996). Nevertheless, for PAHs with very low vapor pressures, such as benzo(a)pyrene and dibenz(a,h)anthracene, there were no significant differences between the vapor and particulate phase distributions in either summer or winter. Therefore, temperature will have a significant impact on the concentrations and distribution of PAHs in the vapor and particulate phases [127,128].

6.2.2. Wet deposition

Wet deposition is illustrated in Fig. 6 according to US.EPA (2000). Wet deposition is defined as the scrubbing of contaminants sorbed onto particulates out of the atmosphere by precipitation, as well as the dissolution of vapor phase contaminants into precipitation [129,130]. The amounts of PAHs removed from the atmosphere by wet deposition vary

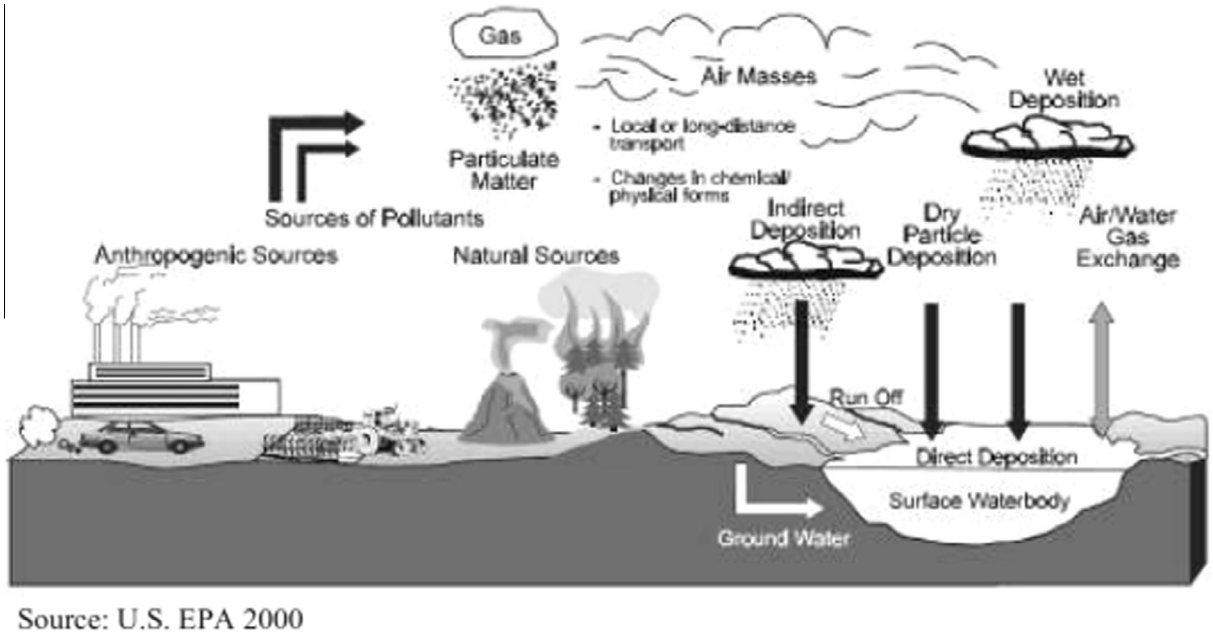


Figure 6 Removal of PAHs from atmosphere by either dry deposition or wet deposition [121].

depending on the phase. Generally, sorbed PAHs are more easily removed from the atmosphere than vapor phase PAHs. It was reported by Dickhut and Gustafson that very little of the total phenanthrene in the atmosphere was associated with particulates. Nevertheless, a considerable amount of the total phenanthrene removed from the atmosphere during a precipitation event as particle-based phenanthrene. This finding suggests that precipitation is more effective in removing the sorbed rather than the vapor phase PAHs [131]. In general, vapor phase PAHs are more efficiently removed from the atmosphere under cold conditions as compared to warm conditions [132,133]. Therefore, more vapor phase PAHs should be removed from cold climates and higher latitudes than from warmer areas. This, potentially, results in the enrichment of lower molecular weight PAHs (i.e., those with higher vapor pressures) in the soils of cold climate areas. According to Gustafson and Dickhut, PAHs are more efficiently removed from the air in the spring and summer than in the winter and fall. Therefore, PAH concentrations in the soil of cold climate areas may be greater than in warm climate areas. This finding appears to contradict the finding of Gustafson and Dickhut which indicated that particulates are more readily removed in the warmer seasons than in the colder seasons [134]. This difference may be attributed to PAHs being associated with larger particles in the warmer months, which are more easily removed from the atmosphere. Nevertheless, another study showed that snow is about two orders of magnitude more effective at removing atmospheric particles than rain [135]. Based on the results from different scientific studies, it can be seen that more work needs for better characterizing the patterns of PAH removal from the atmosphere so that these processes can be better understood.

7. Controlling the PAHs concentration in the environment

- U.S. government agencies have regulated standards that are relevant to PAHs exposures in the workplace and the environment. U.S. government agencies have also established a standard relating to PAH in the workplace as well as a standard for PAH in drinking water.
- The Occupational Safety and Health Administration (OSHA) [136] have established standards that are relevant to PAHs exposures under OSHA's Air Contaminants Standard for substances termed coal tar pitch volatiles (CTPVs) and coke oven emissions. Employees exposed to CTPVs in the coke oven industry should be covered by the coke oven emissions standard. This OSHA standard requires employers to control employee exposure to coke oven emissions. It requires that the employers should use engineering controls and work practices for employee protection. The employer through the engineering and work practice controls shall, nonetheless, supply the employee with respiratory protection to reduce exposures to or below the permissible exposure limit. The OSHA standard also includes elements of medical surveillance for workers exposed to coke oven emissions.
- The OSHA PEL (permissible exposure levels) for PAHs in the workplace is 0.2 mg/m^3 for 8-h TWA (time-weighted average).
- The National Institute for Occupational Safety and Health (NIOSH) [137] has recommended that the workplace exposure limit for PAHs be set at the lowest detectable concentration, which was 0.1 mg/m^3 (REL = recommended exposure limit) for coal tar pitch volatile agents for a 10-h workday, 40-h workweek.

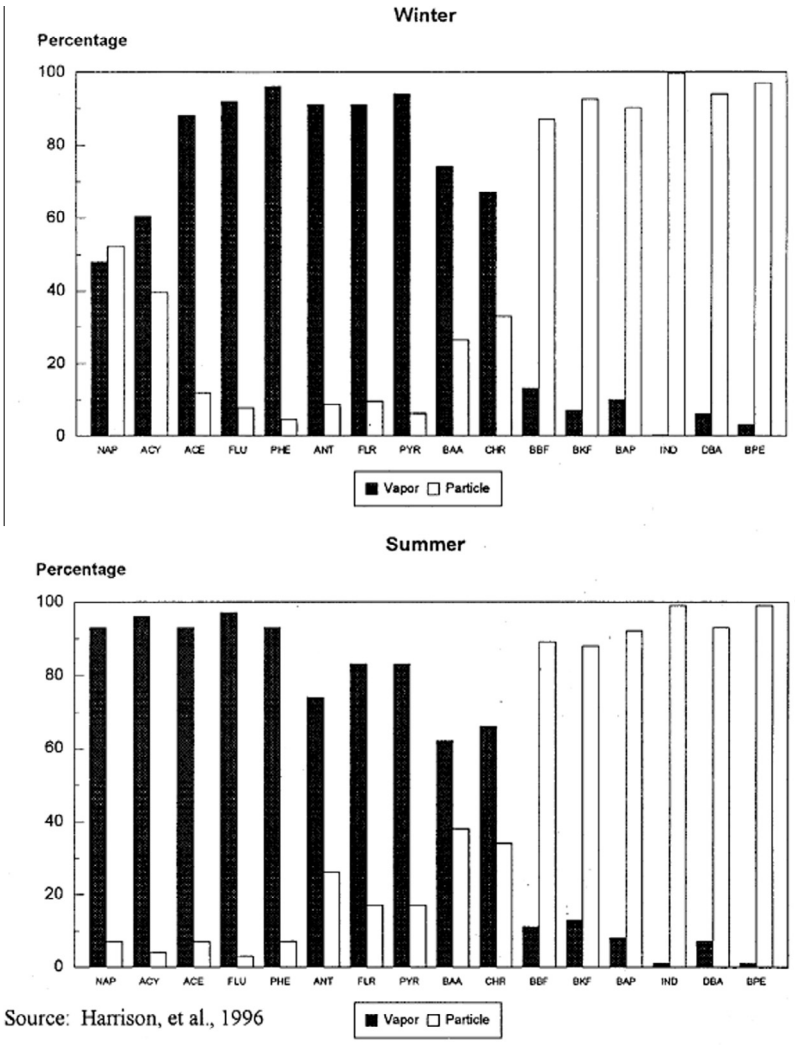


Figure 7 Illustration of the particle/vapor PAH distributions from winter to summer [126].

- In 2000, EPA [121] has established ambient water quality criteria to protect human health from the carcinogenic effects of PAH exposure. The goal of these criteria was to set a non-detectable level (zero concentration for carcinogenic PAHs in ambient water). The EPA developed a maximum contaminant level (MCL) for benzo(a)pyrene at 0.2 ppb. It is well known that benzo(a)pyrene (BaP) is the most carcinogenic PAH.
- WHO guidance (2003) [15] set the unit risk of lung cancer of BaP at 87×10^{-6} ng m^{-3} for lifetime exposure. According to many member states of WHO, the guideline values for BaP is between 0.1 and 1.3 ng m^{-3}
- According to the European Commission [138], the target annual average concentration is not to be exceeded in the PM10 fraction in 1 ng m^{-3}. It is reported in recent data that this target has been exceeded in many locations around Europe, particularly in the east countries.
- According to the Egyptian Environmental Association Affairs (EEAA) [139] the Water Quality Standards and Guidelines limits the benzo(a)pyrene (BaP) at 0.7 μg/L.

8. Conclusion

- PAHs are subset of a set of compounds known as polycyclic organic matters (POM). They are, originally, organic compounds primarily that are formed from the incomplete combustion of organic materials or pyrolysis of organic material. These compounds are related to the use of oil, gas, coal and wood in energy production. Other contributors to ambient air levels include indoor smoking and heating.
- Polycyclic aromatic hydrocarbons (PAHs) are transported in the atmosphere in gas and/or particle phases and they are deposited by wet and dry deposition.
- Particulate matters play significant and continuous role in the chemistry of the atmosphere. They also play significant role in human health.
- Daily exposures to particulate matter associated with increased incidences of premature death, chronic asthma and increased hospital admissions as well as respiratory problems in children.

- The occurrence of PAHs in foods is due both: deposition from the air on the surface of plants, and the pollution resulting from manufacture processes such as drying, roasting, or smoking. Moreover, the presence of PAHs in baby foods results in health risk to the infant, since they are more sensitive than adults to such contaminants.
- Many PAHs compounds are classified as probable human carcinogens.
- PAHs constitute a major class of chemical carcinogens present in the environment.
- Several PAHs and their epoxides are highly toxic, mutagenic and/or carcinogenic to microorganisms as well as to higher systems including humans.
- The polycyclic aromatic hydrocarbons compounds (PAHs) require activation to electrophilic metabolites to exert their mutagenic or carcinogenic effects.
- Exposure to PAHs always involves complex mixtures that may induce synergistic or antagonistic effects on the genotoxic properties that make risk assessment more difficult.
- The PAH-degrading microorganism includes algae, bacteria, and fungi. It involves the breakdown of organic compounds through biotransformation into less complex metabolites, and through mineralization into inorganic minerals, H_2O, CO_2 (aerobic) or CH_4 (anaerobic).
- Polycyclic aromatic hydrocarbons compounds (PAHs) may undergo adsorption, volatilization, photolysis, and chemical degradation. However, microbial degradation is the major degradation process.
- Bioremediation is the tool to transform such compounds to less hazardous/nonhazardous forms with less input of chemicals, energy, and time. Polycyclic aromatic hydrocarbons degradation depends on several factors including: the environmental conditions, number and type of the microorganisms, nature and chemical structure of the chemical compound being degraded.

9. Recommendations for the protection of human health and the environment

- Assessment of exposure to PAHs is important due to the widespread presence of PAHs in the environment and their toxicological relevance. Particular assessment of exposure to PAHs should be given to workers (e.g. involved in production of metallurgic coke, aluminum, or carbon electrodes, asphalt workers) and for the general population.
- The biological impact in terms of the total PAHs intake into the body via respiratory, dermal, and gastrointestinal routes should be monitored precisely.
- Owing to their proven immune-toxic effects, coal-tar shampoos should be used for anti-dandruff therapy only if no other treatment is available.
- Due to the immune-toxic and carcinogenic effects of PAH in coke-oven workers, exposure to PAH in occupational settings should be eliminated or minimized. This could be done by reducing emissions to the maximum extent. If this not possible, then at least an effective personal protection should be provided.
- Public awareness and education about the sources and health effects of exposure to PAH should be improved.
- In many countries, the use of unvented indoor fires should be avoided. They should be replaced by more efficient, well-vented combustion devices.
- Protection of non-smoker as well as the risk of exposure to PAH from passive smoking should be stressed. Besides, measures should be taken to avoid it.
- Urban air pollution should be monitored all year round and not only seasonally.
- Filtration of industrial emissions should be taken.
- Treatment of industrial effluents must be carried out strictly, particularly in the developing countries.
- The use of catalytic converters and particle traps on motor vehicles should strictly be taken.

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Dermal bioaccessibility and absorption of polycyclic aromatic hydrocarbons (PAHs) in indoor dust and its implication in risk assessment ☆

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Highlights

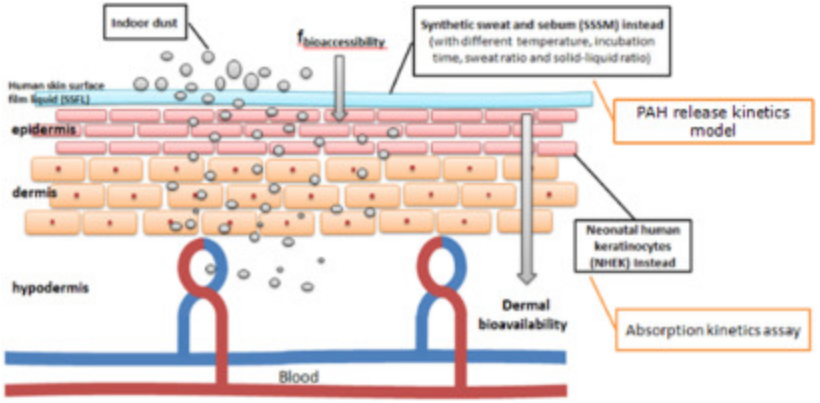
- The dermal bioaccessbility of PAHs is generally correlated with K_{ow}.
- LMW PAHs are more easily absorbed via dermal contact than HMW PAHs.

- Dermal bioavailability of PAHs ranged from 0.12 to 51.0%.

Abstract

Numerous studies have focused on assessing the risk of human exposure to polycyclic aromatic hydrocarbons (PAHs) in indoor dust via dermal contact. However, the dermal bioaccessibility and dermal absorption of PAHs in indoor dust have seldom been reported. In the present study, the effects of temperature, sweat ratio, solid-liquid ratio and incubation time on the dermal bioaccessibility of PAHs were examined. Naphthalene, phenanthrene, pyrene and benzo[a]pyrenewere selected for examination in an absorption assay with keratinocyte cells. The results showed the release of PAHs from indoor dust fitted a first-order one-compartment model. Naphthalene had the highest rate of release, which was consistent with the bioaccessibility assay results. In addition, the absorption rate of naphthalene and phenanthrene by keratinocytes was higher than that of pyrene and benzo[a]pyrene, with the latter being of higher molecular weight. These results indicated that low molecular weight PAHs were much more easily absorbed via dermal contact than were high molecular weight PAHs. The dermal bioavailability of PAHs in indoor dust was estimated by multiplying the bioaccessibility of PAHs in indoor dust by the ratio of dermal absorption by skin cells, and ranged from 0.12 to 51.0%. These data will be useful in risk assessments.

Graphical abstract



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Keywords

Dermal bioaccessibility; PAHs; Dermal absorption; Risk assessment

1. Introduction

It has been reported that most pollutants, such as polycyclic aromatic hydrocarbons (PAHs) and polybrominated diphenyl ethers (PBDEs), are sorbed onto particles suspended in indoor air, and that these particles eventually become indoor dust (Ali, 2019; Kang et al., 2010; Sanderson and Farant, 2004; Yang et al., 2015). The concentration of PAHs in indoor dust has been found to be significantly higher than that in outdoor dust and soil (Lambert and Lane, 2004). PAHs in indoor dust can enter the human body via non-dietary ingestion, inhalation and dermal contact(Ali, 2019; Lao et al., 2018; VanRooij et al., 1993). A recent study showed that under certain conditions, human intake of low molecular weight PAHs occurs more by dermal

contact than via inhalation or non-dietary ingestion (Lao et al., 2018). In other studies evaluating the risk of dermal exposure to chemicals, several sampling methods (i.e. skin wiping, hand-washing and tape-stripping) were employed to estimate the role of indoor dust in human exposure to PAHs (Fenske, 1993; Nylander-French, 2001; Strandberg et al., 2018). However, in these studies the dermal bioaccessibility of pollutants was not considered, which is a shortcoming of the risk assessments reported.

The skin is the largest organ of the human body, and is composed of three principal layers: the epidermis, dermis and hypodermis (Abdel-Shafy and Mansour, 2016; Pannatier et al., 1978). The outermost layer of the skin, the epidermis, is covered with a skin-surface film liquid (SSFL), which is a mixture of different proportions of sweat and sebum, within which various pollutants from the environmental matrix are dissolved and absorbed (Pawar et al., 2016). Therefore, in this study we selected a simulated artificial sweat and sebum mixture (SSSM) as an extraction solvent to estimate the bioaccessible proportion of PAHs in indoor dust.

Invitro bioaccessibility tests have become a popular method for studying the effectiveness of dermal absorption of heavy metals, drugs and some organic pollutants (Ertl and Butte, 2012; Pawar et al., 2016; Ruby et al., 1996). Dermal bioaccessibility is considered to be the proportion of the total concentration of compound that, when exposed to the epidermis, is released into the body and can be absorbed by one or more target organs (Abdel-Shafy and Mansour, 2016). To evaluate the absorption kinetics of PAHs released from indoor dust into SSSM, human cadaver skin may be the best model, however, it is difficult to obtain and poses anethicaldilemma. Keratinocytes are the major components of the epidermis, and are useful models for skin penetration since they can also enzymatically metabolize organic pollutants (Mertsching et al., 2008). We thus selected neonatal human keratinocytes (NHEK) to be cultured for use in the absorption assay in our study.

The objectives of our study were as follows: (1) to quantify the bioaccessibility of PAHs in indoor dust in SSSM under different conditions, and thereby propose a model of *invitro* dermal bioaccessibility; and (2) to investigate the absorption kinetics of selected PAHs by a NHEK-based model.

2. Materials and methods

2.1. Chemicals and materials

2.1.1. House dust

Vacuum cleaners were used to collect house dust samples (n=21) in Guangzhou, China. The samples collected were passed through a stainless-steel mesh (<100μm) to remove large particles, and then wrapped in aluminium foil and stored in a desiccator until extraction. For the bioacessibilty assays, three samples of sufficient size (>1g) were pooled into one, then divided into three sub-samples. Most PAHs in the three sub-samples were less than 10% of the average value (Table1) indicating that levels of PAHs in the pooled sample were homogeneous.

Table1. PAH concentrations in house dust (ng/g).

Compound	Abbreviation	Number of aromatic rings	Concentration(ng/g)	USEPA Categories of Carcinogenicity
Naphthalene	Nap	2	3060±59.9	C
Acenaphthylene	Acy	3	1300±82.4	ND
Acenaphthene	Ace	3	4410±69.7	D
Fluorene	Fl	3	2520±26.6	D
Phenanthrene	Phe	3	886±15.7	D
Anthracene	Ant	3	536±81.3	D
Fluoranthene	Flu	4	107000±1730	D
Pyrene	Pyr	4	78400±1550	D
Beno[a]anthracene	BaA	4	40600±253	B2
Chrysene	Chr	4	8700±1240	B2
Benzo[b+k]fluoranthene	B[b+k]F	5	177±0.02	B2
Benzo[a]pyrene	BaP	5	338±1.21	B2
Dibenz[ah]anthracene	DBA	5	162±0.10	B2

Compound	Abbreviation	Number of aromatic rings	Concentration(ng/g)	USEPA Categories of Carcinogenicity
Indeno[123cd]pyrene	Icdp	6	121±0.08	B2
Benzo[ghi]perylene	BghiP	6	45±0.05	D

All experiments were performedin triplicate, and results are presented as average±SD.

ND, not decided; D, substance with no evidence of being a human carcinogen; B2,possible human carcinogen; C, cannot be classified as a human carcinogen.

2.1.2. Reagents

A standard solution of 16PAHs (naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[123cd]pyrene, dibenz[ah]anthracene and benzo[ghi]perylene), standard solutions of naphthalene, phenanthrene, pyrene and benzo[a]pyrene, and naphthalene-d8, phenanthrene-d10, pyrene-d10, benzo[a]pyrene-d12, acenaphtylene-d10 and chrysene-d12, were purchased from Smart Solutions, Inc. (Madison, WI, USA). Cell culture medium and relevant reagents, including Dulbecco's Modified Eagle Medium (DMEM), antibiotic-antimycotic solution (AA), foetal bovine serum (FBS) and Hanks' balanced salt solution (HBSS), were purchased from Thermo Fisher Scientific Inc. (GIBCO, USA). A Transwell apparatus, cell culture plates and dishes were obtained from Corning Inc. (NY, USA). A normal human keratinocyte cell line (NHEK) was purchased from the Shanghai Guandao Biological Engineering Co., Ltd.; this product originated from the Global Bioresource Center (ATCC, USA). MTT and DMSO were obtained from Shanghai Macklin Biochemical Co., Ltd (China) and Sigma-Aldrich (USA), respectively. Organic solvents such as n-hexane and methanol were purchased from Thermo-Fisher Scientific (USA).

2.2. Synthetic sweat and sebum mixture

Human skin surface film liquid (SSFL) is a mixture of different proportions of sweat and sebum (Pawar et al., 2016). Based on previous research (Stefaniak and Harvey, 2008) (TableS1, Supplementary Material), artificial sweat and artificial sebum were

freshly prepared in ultrapure H_2O (18Ω) and n-hexane, respectively. The synthetic sweat and sebum (SSSM) were then mixed under different physiological conditions (see Section 2.3). The pH of SSFL was adjusted to 5.3±0.2 with 1M NaOH.

2.3. *Invitro* dermal bioaccessibility

Approximately 30mg of indoor dust was added to SSSM in order to investigate the effects of various incubation temperatures, incubation times, sweat/sebum ratios and solid/liquid ratios on dermal bioaccessibility.

Due to the limited quantity of dust sample collected (3–4g), only one variable was varied at a time during the dermal bioaccessibility test, and all the others were kept fixed. To study the effect of the solid/liquid ratio (1:50, 1:100 and 1:150 (w/v), based on previous work (Ertl and Butte, 2012)), the temperature, sweat/sebum ratio and incubation time were set to 36.3°C, 50:50 and 60min, respectively (Pawar et al., 2016). To study the effect of the sweat/sebum ratio(100:0, 70:30, 50:50, 30:70 and 0:100 v/v), the temperature, solid/liquid ratio and incubation time were set to 36.3°C, 1:100 (w/v) and 60min. To study the effect of temperature (33 and 36.3°C), the solid/liquid ratio, sweat/sebum ratio and incubation time were set to 1:100 (w/v), 50:50 and 60min, respectively. To study the effect of incubation time (0, 30, 60, 90, 180, 360 and 540min), the temperature, solid/liquid ratio and sweat/sebum ratio were set to 1:100 (w/v), 50:50 and 36.3°C, respectively. After incubation, the mixture of indoor dust and SSSM was centrifuged at 3000rpm for 10min, and the supernatant was collected for chemical analysis. All of the experiments were performed in triplicate. The dermal bioaccessibility was calculated by using the following equation (Eq. (1)):

$$\mathrm{f_{bioaccessible}}\ (\%) = \frac{\text{Concentration of a particular PAH in SSSM}}{\text{Concentration of that particular PAH in dust}} \times 100 \quad (1)$$

2.4. Absorption kinetics assay

The normal human keratinocyte cell line (NHEK) was cultivated in DMEM, which was supplemented with 10% fetal bovine serum (FBS) and 1% penicillin/streptomycin. All of the cultures were maintained in 25-cm^2 or 75-cm^2 tissue culture flasks (Costar) under standard conditions at 37°C in a humidified atmosphere containing 5% CO_2. The growth medium was replaced three times per week.

The absorption assay was performed by using a static configuration (Fig.S1, Supplementary Material). The NHEK cells were inoculated on Transwell inserts coated with Matrigel (BD Biosciences, USA), and then cultured in an incubator at 37 °C in an atmosphere of 5% CO_2 until the cells were fully grown. Naphthalene (a two-ring PAH), phenanthrene (a three-ring PAH), pyrene (a four-ring PAH) and benzo[*a*]pyrene (a five-ring PAH) were individually added to the upper media (5 and 10 μgL^{-1} for each PAH). Samples of the receptor fluid were collected at the following times: 30, 60, 90, 180, 360 and 540 min, and immediately replaced with fresh fluid. Finally, the upper exposure media were collected and retained for chemical analysis. The skin-cell surface was thoroughly washed with 1 mL methanol, twice. The washing solution and the skin cells were collected for chemical analysis. The cell viability was determined by (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide) (MTT) assay. All of the experiments were performed in triplicate. The dermal absorption efficiency was calculated by using the following equation (Eq. (2)):

$$\mathrm{Abs_{Dermal}}\ (\%) = \frac{\text{Concentration of a particular PAH in the receptor fluid}}{\text{Concentration of that particular PAH exposure to dermal}} \times 100 \tag{2}$$

2.5. Establishment of kinetics model

2.5.1. Kinetics of release of PAHs from dust by *invitro* extraction in SSSM

The time-course of PAH release from indoor dust obeys a first-order one-compartment model, as given by the following equations (Eq. (3) and (4)):

$$\frac{dC_{out}}{dt} = k_1 \cdot C_{in} - k_2 \cdot C_{out} \tag{3}$$

$$\frac{C_{out}}{C_{in}} = \frac{k_1}{k_2} \cdot \left(1 - e^{-k_2 t}\right) \tag{4}$$

where C_{out} is the concentration of target pollutants released into the SSSM; ng/g; C_{in} is the concentration of the pollutant contained in the indoor dust; ng/g; t is time, min; k_1 is the release rate, ng/min; and $k_2$is the adsorption rate, ng/min.

2.5.2. Dermal absorption model of PAHs

The time-course of absorption of PAHs by skin cells from the upper exposure medium to the receptor fluid also obeys a first-order one-compartment model, as given by the following equations (Eq. (5) and (6)):

$$\frac{dC_{exp}}{dt} = k_3 \cdot C_{der} - k_4 \cdot C_{exp} \quad (5)$$

$$\frac{C_{exp}}{C_{der}} = \frac{k_3}{k_4} \cdot \left(1 - e^{-k_4 t}\right) \quad (6)$$

where C_{exp} is the concentration of PAHs in the exposure medium, ng/g; C_{der} is the concentration of PAHs in the receptor fluid, ng/g; t is time, min; k_3 is the absorption rate, ng/min; and k_4 is the elimination rate, ng/min.

2.6. Chemical analysis

2.6.1. Determination of PAHs in SSSM

The supernatant (SSSM) was spiked with a known amount of surrogates (phenanthrene-d10 and chrysene-d12) and extracted three timeswith3 mL of *n*-hexane. The combined extracts were then concentrated to a volume of approximately 2mL on a rotary evaporator, and this mixture was loaded onto a Florisil column and then eluted with 10mL of *n*-hexane (U.S.EPA, 1996), thereby removing polar impurities. The eluate was concentrated to a volume of approximately 500μL, and the PAH internal standards were added (naphthalene-d8, acenaphtene-d10 and perylene-d12) to give a final concentration of 200$\mu g L^{-1}$ for each. The resulting mixture was stored at−20°C until analysed by gas chromatography-mass spectrometry (GC-MS).

2.6.2. Determination of PAHs from the original sample and solid residue

The original samples and residues were spiked with a known amount of surrogates (phenanthrene-d10 and chrysene-d12) and equilibrated at room temperature (25°C) for 6h. Target compounds were extracted on a BUCHI™ Speed Extractor E−916 (CH) system. After mixing the spiked sample with quartz sand (BUCHI ™), the mixture was transferred to a 40-mL stainless-steel extraction cell. The extraction conditions (temperature, pressure, extraction solvent, static time and cycle index) were optimized according to the instruction manual for the extractor. The extract was purified on a Florisil column (as before) and the eluate was evaporated to approximately 500μL on a rotary evaporator. Internal standards (naphthalene-d8,

acenaphthene-d10 and perylene-d12) were then added to the extract to give a final concentration of 200 μg L^{-1}, and the resulting mixtures were stored at −20 °C until GC-MS analysis was performed.

2.6.3. Determination of PAHs in the fluid of the absorption kinetics assay

The samples collected from the skin absorption assay were the receptor liquid, the upper exposure medium, the cell eluate and the cells. To determine the concentration of PAHs in cells requires three cycles of freezing and thawing to rupture the cells, thereby releasing the freezing and thawing solutions to be analysed.

The processed liquids to be tested were spiked with known amounts of surrogates (naphthalene-d8, phenanthrene-d10, pyrene-d10 and benzo[*a*]pyrene-d12) and extracted three times with 3 mL of *n*-hexane. The combined extracts were evaporated to approximately 2 mL on a rotary evaporator, and purified on a Florisil column as before. The eluate was evaporated to approximately 500 μL, and internal standards (acenaphthylene-d10 for naphthalene and phenanthrene, chrysene-d12 for pyrene and benzo[*a*]pyrene) were added to give a final concentration of 200 μg L^{-1} for each. The treated solution was stored at −20 °C before analysis by GC-MS.

2.7. GC–MS analysis

All of the processed extracts were analysed by GC-MS (Agilent Technologies 7890A gas chromatograph coupled with an Agilent Technologies 5975Cmass selective detector). The instrument was equipped with a fused-silica capillary column (HP-5MS, 30 m × 0.25 mm × 0.25 μm). The column oven temperature was initially set at 100 °C, and then ramped to 200 °C at 30 °C/min; then ramped to 250 °C at 3 °C/min and retained at this temperature for 2.5 min; then ramped to 270 °C at 40 °C/min and retained at this temperature for 2.0 min; and finally ramped to 320 °C at 80 °C/min and retained at this temperature for 5 min. The ion-source and injection port temperatures were set at 230 and 300 °C, respectively (Gimeno et al., 2014).

2.8. Quality assurance and quality control

A spiked blank and a procedural blank were processed with each batch of six to eight samples. The recoveries of surrogate standards in dust samples ranged from 50.4 to 101%. The recoveries of surrogate standards in most samples from the cell assay were 62.6–106% (naphthalene-d8), 65.4–99.7% (phenanthrene-d10), 62.8–88.8% (pyrene-d10) and 50.4–89.5%

(benzo[*a*]pyrene-d12). A few samples were below 50%. The measured experimental values were adjusted according to the recoveries of surrogate standards. The limit of detection (LOD) was determined to be three times the standard deviation of the blank. The LODs of PAHs ranged from 0.25 to 1 $ng\,mL^{-1}$.

2.9. Statistical analysis

All the statistical analyses were performed with SigmaPlot 13.0 and Microsoft Excel 2010 software. Nonlinear regression analysis was used to fit the kinetics models. A P valueis <0.05 was considered as indicating statistical significance.

3. Results and discussion

The percutaneous exposure of the human body to chemical pollutants from indoor dust consists of two steps: pollutant release from indoor dust into dermal fluid, and pollutant penetration into the skin. The first step relies on dermal bioaccessibility; that is, the pollutants contained in indoor dust must be released into the liquid on the skin surface and available for dermal absorption. The second step depends on the permeability of the contaminant to the skin, which represents the proportion of the pollutant absorbed by a skin cell from the SSSM.

3.1. PAHs in house dust samples

The concentrations of the 16PAHs in house dust are displayed in Table1. They were primarily three-ring PAHs (3.89%; Acy, Ace, Fl, Phe and Ant) and four-ring PAHs (94.5%; Flu, Pyr, BaA and Chr). Two-ring PAHs (Nap), five-ring PAHs (B[b+k]F, BaP and DBA) and six-ring PAHs (Icdp, BghiP) accounted for 1.23, 0.28 and 0.07%, respectively. The profile of PAHs in dust was similar to that found in other studies, with three- and four-ring PAHs being the dominant contaminants in settled dust (Ali, 2019; Maragkidou et al., 2017).

3.2. Dermal bioaccessibility of PAHs

3.2.1. The effect of temperature on bioaccessibility

The results showed that temperature had a significant effect on the release of PAHs from the environmental matrix (Table2). For all PAHs, the release was greater at 36.3°C than at 33.0°C. These results are consistent with those found by Bartsch et al. (2016), who reported that the release of PAHs from consumer products into simulated aqueous sweat or aqueous ethanol was enhanced with an increase in temperature. Thus, the dermal bioaccessibility of PAHs in indoor dust would increase on summer days, resulting in a higher risk of exposure.

Table2. Effect of exposure temperature on the bioaccessibility ($f_{bioaccessible}$) of PAHs.

Compound	**$f_{bioaccessible}$ (%) for different exposure temperatures**	
	33.0°C	**36.3°C**
Naphthalene	36.7±1.30	60.5±20.5
Acenaphthylene	9.09±1.00	22.4±13.4
Acenaphthene	9.13±0.20	40.9±8.67
Fluorene	10.5±0.08	50.0±9.96
Phenanthrene	9.85±0.61	37.2±9.87
Anthracene	33.7±1.87	89.6±8.77
Fluoranthene	0.11±0.01	0.45±0.30
Pyrene	0.12±0.01	0.72±0.55
Beno[a]anthracene	0.23±0.02	0.54±0.39
Chrysene	0.27±0.01	0.45±0.28
Benzo[b+k]fluoranthene	11.0±0.44	17.4±5.18
Benzo[a]pyrene	8.55±1.82	9.37±0.49
Dibenz[ah]anthracene	17.8±2.11	23.2±7.72

Compound	$f_{bioaccessible}$ (%) for different exposure temperatures	
	33.0°C	36.3°C
Indeno[123cd]pyrene	10.6±1.72	15.2±4.13
Benzo[ghi]perylene	29.6±5.24	37.0±7.41

All experiments were performedin triplicate, and results are presented as average±SD.

3.2.2. The effect of sweat/sebum ratio on bioaccessibility

The results showed that the dermal bioaccessibilities of most PAHs increased as the sebum content in SSSM increased from 0 to 50%, and then decreased as the sebum content in SSSM increased from 50 to 100% (Table3). In contrast, the dermal bioaccessibilities of Nap and Chr increased as the sebum content in SSSM increased from 0 to 30%, and, in general, then decreased as the sebum content in SSSM increased from 30 to 100%. The dermal bioaccessibilities of BaA, DBA, Icdp and BghiP were greatest when sebum comprised 70% of SSSM.

Table3. Effect of the sweat/sebum ratio on the bioaccessibility ($f_{bioaccessible}$) of PAHs.

Compound	$f_{bioaccessible}$ (%) for different sweat/sebum ratio				
	100% sweat	70:30 sweat/sebum	50:50 sweat/sebum	30:70 sweat/sebum	100% sebum
Naphthalene	82.3±6.60	87.0±3.05	60.5±20.5	54.2±7.48	19.4±0.74
Acenaphthylene	11.1±11.8	19.6±12.0	22.4±13.4	11.7±17.8	11.9±0.72
Acenaphthene	20.5±0.69	25.6±22.0	40.9±8.67	21.6±10.2	0.89±0.06
Fluorene	19.8±0.84	29.1±0.41	50.0±9.96	19.1±16.0	1.56±0.17
Phenanthrene	16.9±0.38	15.5±5.75	37.2±9.87	10.5±3.90	0.12±0.05

Compound	$f_{bioaccessible}$ (%) for different sweat/sebum ratio				
	100% sweat	70:30 sweat/sebum	50:50 sweat/sebum	30:70 sweat/sebum	100% sebum
Anthracene	42.2±2.79	51.9±8.20	89.6±8.77	59.0±7.72	6.22±1.78
Fluoranthene	0.07±0.05	0.22±0.27	0.45±0.30	0.44±0.53	0.02±0.01
Pyrene	0.10±0.03	0.14±0.57	0.72±0.55	0.11±0.06	0.02±0.01
Beno[a]anthracene	0.05±0.01	0.23±0.35	0.54±0.39	0.72±0.67	0.04±0.01
Chrysene	0.10±0.04	1.84±0.56	0.45±0.28	0.72±0.87	0.08±0.02
Benzo[b+k]fluoranthene	11.3±4.80	12.2±0.00	17.4±5.18	14.8±7.55	10.1±2.91
Benzo[a]pyrene	7.73±3.52	8.88±0.49	9.37±0.49	8.05±0.61	8.81±3.58
Dibenz[ah]anthracene	28.1±2.57	22.6±1.03	23.2±7.72	28.8±6.56	25.9±27.0
Indeno[123cd]pyrene	12.4±2.25	11.5±2.75	15.2±4.13	16.5±2.34	14.4±15.4
Benzo[ghi]perylene	27.2±6.98	33.3±5.56	37.0±7.41	39.5±1.75	22.2±3.02

All experiments were performedin triplicate, and results are presented as average±SD.

Previous studies have shown that the bioaccessibility of flame retardants and phthalates in indoor dust attains its highest value in SSSM comprising 100% sebum and 70% sebum, respectively (Pawar et al., 2016; Zeng et al., 2019). These different results may be attributable to the different chemical behaviour of flame retardants and phthalates, due to their partition coefficient between octanol and water, K_{ow} (Table S2, Supplementary Material), i.e., the K_{ow} values of the pollutants influence the extent of their passage from an environmental matrix into SSSM. The solubility effect could partially explain the release of PAHs from indoor dust to SSFL. The sorption mechanism between organic matter in indoor dust and PAHs would also influence the release of PAHs. Therefore, the actual mechanism of this process needs to be determined by further research.

3.2.3. The effect of solid/liquid ratio on bioaccessibility

Table4 shows the influence of the solid-liquid ratio on dermal bioaccessibility. The dermal bioaccessibility of PAHs increased with a decrease in the solid-liquid ratio (aside from DBA), and generally peaked at 1:150 (w/v) (Table4). A previous study has also shown that the release of PAHs into lung fluid increases significantly at a solid-liquid ratio range of 1/30 to 1/500 (Julien et al., 2011). Thus, it can be seen that a certain increase in the volume of the liquid leads to an increase in the efficiency of the extraction, indicating that a significant amount of the contaminant is sorbed on the residues of indoor dust and is easily released (Yu et al., 2009). An increased liquid volume will reduce the concentration of PAHs in the skin fluid, resulting in a change in the distribution of PAHs in the aqueous phase, in turn enhancing the desorption of PAHs from residues.

Table4. Effect of solid/liquid ratio on the bioaccessibility ($f_{bioaccessible}$) of PAHs.

Compound	**$f_{bioaccessible}$ (%) for different solid/liquid ratios**		
	1/50	**1/100**	**1/150**
Naphthalene	50.8±14.0	60.5±20.5	60.7±2.39
Acenaphthylene	9.52±0.26	22.4±13.4	26.9±8.47
Acenaphthene	14.9±0.83	40.9±8.67	41.3±2.71
Fluorene	5.69±0.17	50.0±9.96	50.9±15.3
Phenanthrene	7.94±0.83	37.2±9.87	39.6±4.14
Anthracene	12.2±0.25	89.6±8.77	91.5±8.51
Fluoranthene	0.18±0.02	0.45±0.30	0.47±0.00
Pyrene	0.18±0.03	0.72±0.55	0.81±0.13
Beno[a]anthracene	0.17±0.01	0.54±0.39	0.55±0.32
Chrysene	0.13±0.02	0.45±0.28	0.47±0.10

Compound	$f_{bioaccessible}$ (%) for different solid/liquid ratios		
	1/50	1/100	1/150
Benzo[b+k]fluoranthene	9.10±2.47	17.4±5.18	18.2±6.40
Benzo[a]pyrene	8.22±1.61	9.37±0.49	9.86±1.75
Dibenz[ah]anthracene	17.8±3.39	23.2±7.72	22.6±0.84
Indeno[123cd]pyrene	12.4±2.34	15.2±4.13	16.1±3.44
Benzo[ghi]perylene	34.6±1.75	37.0±7.41	44.4±10.9

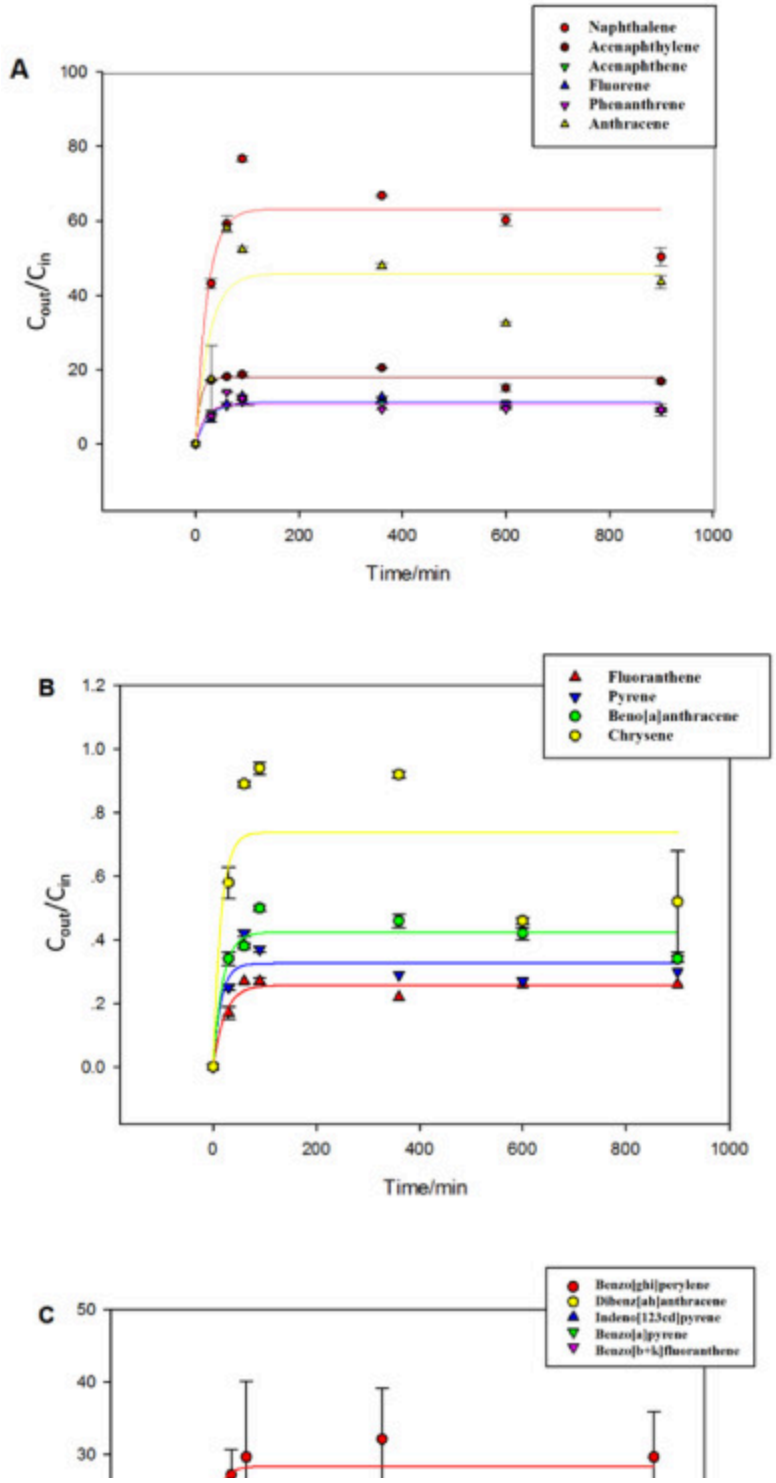
All experiments were performedin triplicate, and results are presented as average±SD.

3.2.4. The effect of incubation time on the dermal bioaccessibility model of PAHs from dust

The results showed the time-dependent profile of the release of PAHs from SSSM. More detailed values of dermal bioaccessibility on incubation time are shown in TableS3. Most of PAHs showed two release phases. A fast phase occurred within the first 60min (Phe, Ant, Pyr and Icdp), 90min (Nap, Ace, Fl, Flu, BaA, Chr, BaP and DBA) or 180min (Acy, B[b+k]F and BghiP). During this time, the dermal bioaccessibility rapidly increased from 0.27±0.01% to76.7±0.60%, and then reached an equilibrium value and showed no apparent change during the 60–540min, 90–540min or 180–540min incubation periods, respectively.

Fig.1 shows that the time-course of PAH release from indoor dust could be well explained by a first-order one-compartment model (r^2 ranged from 0.72 to 0.99). Most C_{out}/C_{in} of PAHs reached an equilibrium after 60–180min, which was consistent with the trend of bioaccessibility. The dermal bioaccessibility of two- and three-ring PAHs in indoor dust, including Nap, Acy, Ace, Fl, Phe and Ant, ranged from 43.2±1.33% to 76.7±0.60%, 12.6±0.37% to 20.4±0.06%, 8.46±0.32% to 11.3±0.48%, 8.33±0.09% to 13.0±0.35%, 4.73±0.07% to 13.9±0.28% and 17.4±9.10% to 52.2±0.67%, which were lower than the reported dermal bioaccessibility of phthalates (PAEs) in indoor dust, including diethyl phthalate (DEP), dibutylphthalate (DBP) and diethylhexyl phthalate (DEHP), which were 49.2–66.2%, 73.8–94.3%, and 70.2–92.5%, respectively (Zeng etal., 2019). The

dermal bioaccessibility of four- and five-ring PAHs in indoor dust, including Flu, Pyr, BaA, Chr, B[b+k]F, BaP, Icdp and DBA, ranged from 0.17±0.00% to 0.27±0.01%, 0.25±0.00% to 0.42±0.01%, 0.20±0.01% to 0.50±0.01%, 0.32±1.76% to 0.94±0.02%, 2.51±0.89% to 9.42±5.33%, 3.78±0.93% to 7.23±0.93%, 7.35±3.44% to 9.18±2.43% and 11.0±4.31% to 13.0±3.88%, respectively, which was similar to the reported oral bioaccessibility for PAHs in indoor dust, which ranged from 3.5%±0.9%–9.8%±2.3% (Kang et al., 2011).


A
Naphthalene
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Acenaphthene
Fluorene
Phenanthrene
Anthracene
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Pyrene
Beno[a]anthracene
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Indeno[123cd]pyrene
Benzo[a]pyrene
Benzo[b+k]fluoranthene

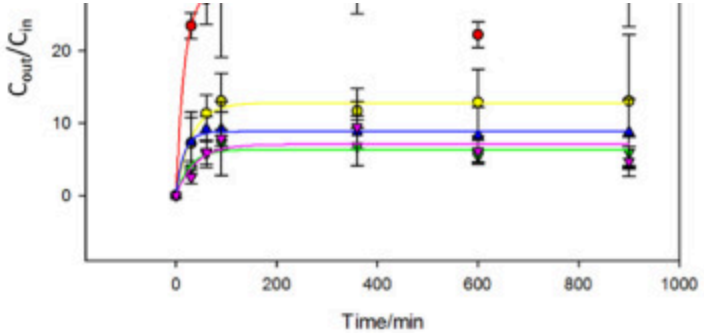

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Fig. 1. The change of C_{out}/C_{in} of target PAHs over time in indoor dust. The curves were fitted according to Eq. (4). (A):2–3 ring-PAHs; (B):4 ring-PAHs; (C):5–6 ring-PAHs.

The release rate (k_1) and adsorption rate (k_2) of the 16PAHs were calculated and are shown in TableS4. In summary, Nap and Acy (two- and three-ring PAHs), Chr (a four-ring PAH) and B[b+k]F (five- and six-ring PAHs) exhibited the highest release rates in indoor dust. Naphthalene had the highest release rate of all, which indicated that naphthalene migrates much more easily into the SSSM and, thus, hasthe highest bioaccessibility.

3.2.5. Relationship between dermal bioaccessibility of PAHs in indoor dust and their K_{ow} and water solubility

Compounds with different K_{ow} values may alter the polarity of the skin surface membrane fluid or the digestive fluid. It has been suggested that the difference in K_{ow} among the 16 PAHs may explain their different dermal bioaccessibilities. The K_{ow} values of the 16 PAHs range from 3.3 to 7.1 (Table S2) and, as can be concluded from Figs. S2–A, the dermal bioaccessibility of PAHs (aside from Ant) decreased as the value of K_{ow} increased from 3.3 to 5.2, and then increased as K_{ow} increased from 5.2 to 7.1. In addition, the water solubility of the 16 PAHs range from 0.0003 to 31.5 mgL^{-1}, which is inversely proportional to the K_{ow} value (Table S2). As can be concluded from Figs. S2–B, aside from Ant, the dermal bioaccessibility of PAHs decreased as the water solubility increased from 0.0003 to 0.26 mgL^{-1}, then increased according to the increase of water solubility from 1.2 to 31.5 mgL^{-1}. Both Phe and Ant have a K_{ow} of 4.50, but their water solubilities are 1.20 mgL^{-1} and 0.05 mgL^{-1}, respectively. Therefore, the high dermal bioaccessibility of Ant may be related to its low water solubility.

Conversely, the oral bioaccessibility of PAHs in indoor dust has been shown to be negatively correlated with their respective K_{ow} values (Kang et al., 2011). Thus, the specific mechanism causing the association between the K_{ow} and dermal bioaccessibility of PAHs in indoor dust should be further investigated.

3.3. Dermal absorption of PAHs from indoor dust

3.3.1. Distribution of PAHs in different compartments

The 9-h skin absorption of PAHs is summarised in Fig. 2. More detailed skin absorption data are shown in Table S5. The data show that the dermal permeability of PAHs with fewer rings, such as Nap and Phe, is much greater than that of PAHs with more rings (Pyr and BaP). The mass-balance assay showed that the loss ratio of Nap and Phe was less than 10%. In contrast, the loss ratio of Pyr for low-concentration and high-concentration exposure was 16.2 and 46.4%, respectively, and that of BaP for low-concentration and high-concentration exposure was 86.7 and 88.9%, respectively.

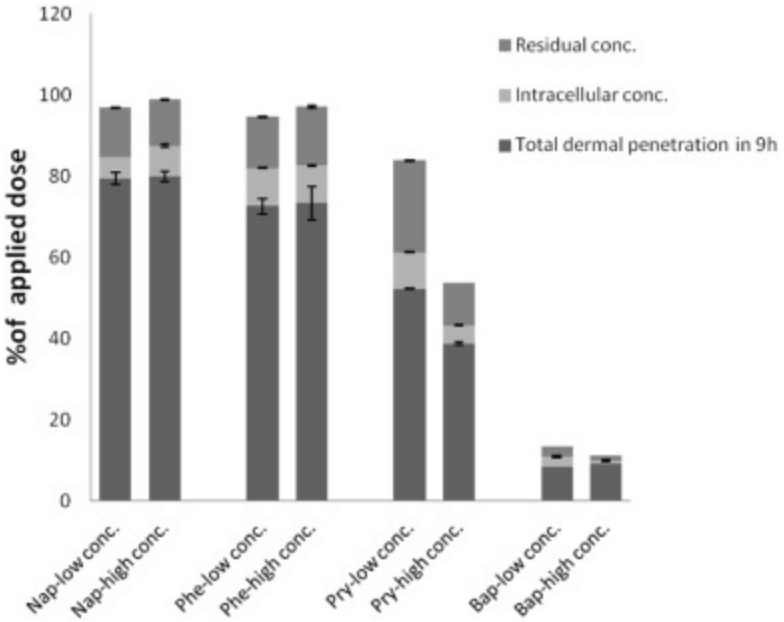

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Fig.2. Dermal penetration for four PAH compounds (after a 9-h exposure), as well as intracellular and residual concentrations after exposure.

These results may be attributable to Pyr and BaP being metabolized differently in skin cells. Recent studies have shown that exposure concentration, exposure duration and age of skin all have significant effects on the metabolism of BaP (Bourgart et al., 2019). BaP metabolism has been shown to be related to the activity of cytochrome P450 mono-oxygenase (CYP450) and epoxidehydrolase, and the metabolic products of PAHs have been found to be responsible for the mutagenicity and carcinogenicity of PAHs (Shimada, 2006). Therefore, the metabolic form of PAHs could be considered as the bioavailable form of PAHs. Thus, the specific metabolic products of PAHs, such as for Pyr and BaP, must be identified in future work.

3.3.2. Absorption kinetics of PAHs by skin cells

According to the National Institute of Occupational Safety and Health's allowable concentrations of pollutant exposure, combined with the results of an MTT toxicity test (<10% of cell mortality), two concentrations (5 $\mu g L^{-1}$ for low concentration exposure and 10 $\mu g L^{-1}$ for high concentration exposure) were selected for use in the cell penetration assay. As can be seen from Fig. 3, the permeability of the four PAHs began to reach an equilibrium within approximately 3–6 h. As none of the four PAHs were 100% absorbed during the entire 9-h measurement, the peak absorption rate cannot be attributed to the depletion of the dose used. In contrast, the decrease in penetration rate was more likely to be the result of liquid-spray dilution, as this causes the absorption of pollutants to slow down considerably over time (Clarke et al., 2018). That is, PAHs in indoor dust need to re-dissolve in a limited amount of surface moisture before they can diffuse into the skin. Therefore, it is necessary to pay more attention to highly water soluble PAHs like Nap.

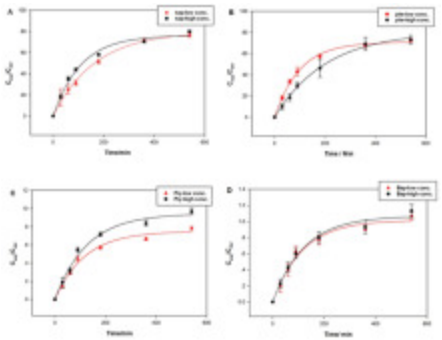

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Fig. 3. The change of C_{exp}/C_{der} of target PAHs over time in indoor dust. The curves were fitted according to Eq. (6). A: Nap; B: Phe; C: Pyr; D: BaP.

As shown in Table S6, the kinetics of dermal penetration of PAHs from the upper medium to the receptor fluid could be well explained by the first-order one-chamber model (r^2 ranged from 0.98 to 1.00). The absorption rates (k_3) of Nap, Phe, Pyr and BaP were calculated as 0.479 ng/min (low concentration), 0.696 ng/min (high concentration.), 0.396 ng/min (low concentration),0.716 ng/min (high concentration), 0.0637 ng/min (low concentration), 0.0746 ng/min (high concentration), 0.0088 ng/min (low concentration) and 0.0088 ng/min (high concentration), respectively. The elimination rates (k_4) of target PAHs were 0.0060 ng/min (Nap exposure in low concentration), 0.0091 ng/min (Nap exposure in high concentration),

0.0049 ng/min (Phe exposure in low concentration), 0.0101 ng/min (Phe exposure in high concentration), 0.0085 ng/min (Pyr exposure in low concentration), 0.0079 ng/min (Pyr exposure in high concentration), 0.0087 ng/min (BaP exposure in low concentration), and 0.0082 ng/min (BaP exposure in high concentration) (Table S6).

The multicellular 3D skin model is the ideal alternative to investigate the penetration ability, toxicological effects and metabolism of xenobiotics due to the model has both similar metabolic behaviour and cell layers as human skin (Hu et al., 2009). Those reconstructed models such as EpiSkin?R¡ðRand EpiDerm™ are derived from human keratinocytes differentiated into multi-layer cell layers (Hu et al., 2009). For testing the penetration ability of xenobiotics across the skin, the keratinocytes would show similar results as the 3D skin model (Christensen et al., 2011). However, the metabolic ability of keratinocytes on xenobiotics such as BaP is much lower than that of 3D skin models, which may subsequently result in lower estimation of chemical mass transfer (Brinkmann et al., 2012). Overall, the absorption rates of low molecular weight PAHs (Nap and Phe) were greater than those of high molecular weight PAHs (Pyr and BaP). In addition, the absorption rate of high concentrations of PAHs was greater than that of low concentrations of PAHs (Table S6). However, it could not be concluded that the absorption rate increased with an increase in exposure concentration, as this would mean that when the concentration reached a certain value, the cell absorption element (such as a transporter) would be saturated, and thus the absorption rate should decrease. However, the high concentration group and low concentration group had similar total dermal absorption ratios (%) for PAHs as calculated at the 9 h point (Table S5), which was consistent with previous reports (Bourgart et al., 2019). The passive sampler model is commonly used to quantify personal exposure to gaseous PAHs. Comparing the absolute absorption efficiency of PAHs between passive samplers and skin cells is difficult, due to differences in exposures, but similar absorption patterns have been observed. Previous studies indicated that low molecular weight PAHs (2–3 rings) were much more easily absorbed than the high molecular weight PAHs (4–5 rings) by passive samplers (Fan et al., 2006; Sjöström et al., 2019), which was consistent with the present results. In short, these results showed that low molecular weight PAHs were much more easily absorbed by skin cells.

It should be noted that human exposure to PAHs typically occurs as mixtures. Individual PAHs were selected for the cell absorption assays, which cannot account for interactive effects of different PAHs. The PAHs may compete with each other for the transporter elements in skin cells and the active sites of the metabolizing enzymes such as cytochrome P450-dependent monooxygenase family 1 and microsomal epoxide hydrolase (Brinkmann et al., 2012). Therefore, individual exposure may result in over estimation of the penetration ability.

3.4. Implications for risk assessment

3.4.1. The dermal bioavailability

The dermal bioavailability can be obtained by combining the bioaccessibility of PAHs in SSSM with their dermal absorption ratio by skin cells. Dermal bioavailability was calculated by using the following equation (Eq. (7)):

$$\mathbf{Bio_{Der}}\ (\%) = \mathbf{Abs_{Dermal}}\ (\%) \times \mathbf{f_{bioaccessible}}\ (\%) \tag{7}$$

The metabolic part of PAHs was quantified as the absorption measurements (Abs_{Dermal}). Table 5 shows the dermal bioavailabilities after a 9-h exposure. The results show that the dermal bioavailability of highly water-soluble PAHs (Nap) is greater than that of relatively high molecular weight PAHs (>two rings). The dermal bioavailability of Pyr was the lowest, possibly due to the fact that the extremely high concentration of Pyr in indoor dust exceeded the amount able to be dissolved in SSSM resulting in low bioaccessibility. In addition, after considering metabolism, the dermal bioavailability of BaP was close to that of Phe, which needs to be examined further.

Table 5. Values of dermal bioavailability.

	Naphthalene		**Phenanthrene**		**Pyrene**		**Benzo[a]pyrene**	
	Low conc.	High conc.	Low conc.	High conc.	Low conc.	High conc.	Low conc.	High conc.
Bio_{Der} (%)	49.3±3.95	51.0±2.91	5.82±1.48	5.86±1.65	0.17±0.001	0.12±0.001	5.78±0.25	5.85±0.22

3.4.2. Non-carcinogenic and carcinogenic risk of PAHs

The hazard index (HI) method can be used for evaluate the risk assessment of non-carcinogenic PAHs. The average daily exposure dose (ADD) for the dermal exposure pathways were calculated according to Eq. (8) (US EPA, 2009), while the HI were calculated according to Eq. (9):

$$\mathbf{ADD} = \frac{\mathbf{C_{PAH} \times SA \times SAF \times ABS \times EF \times ED}}{\mathbf{BW \times AT}} \times \mathbf{CF} \tag{8}$$

$$HI = \frac{ADD}{RfD} \quad (9)$$

The EPA recommended lifetime carcinogenic risk (ILCR) model is normally used to calculate the carcinogenic risk of PAHs in dust via dermal contact (Ali, 2019; EPA, 2011). The BaP_{eq}-TEQ for individual carcinogenic PAHs was calculated by using Eq. (10) and the ILCR was calculated according to Eq. (11):

$$\mathbf{BaP_{eq} - TEQ} = \sum (\mathbf{C_{PAH}} \times \mathbf{TEF}) \quad (10)$$

$$\mathbf{ILCRs_{Dermal}} = \frac{\mathbf{CS} \times (\mathbf{CSF_{Dermal}} \times \sqrt[3]{\mathbf{BW}/70}) \times \mathbf{SA} \times \mathbf{SAF} \times \mathbf{ABS} \times \mathbf{EF} \times \mathbf{ED}}{\mathbf{BW} \times \mathbf{AT} \times 10^6} \quad (11)$$

where ADD is the average daily exposure dose (ng/kg-bw/day); CPAH is the concentration of PAH in dust (ng/g) (Table 1); SA is the skin surface area (4615 cm^2, including hands, legs, and arms accounting for 25% of the total skin area); SAF is the skin adherence factor for dust (0.096 mg/cm^2); ABS is the dermal absorbed factor (unitless, 0.13); EF is the exposure frequency (350 days/year); ED is the exposure duration (24 years for adults); BW is the body weight (70 kg for adults); AT is the average life expectancy (carcinogens, AT=70×365=25,550days); CF is the conversion factor (1×10−6 kg/mg); and RfD is the reference does of non-carcinogenic PAHs (mg/kg/day) (Table S6). TEF is the toxic equivalent of PAH monomer (unitless); CS is BaP_{eq}-TEQ value of PAHs in the dust (mg/kg) (Table S7), and CSF is carcinogenic slope factor for the BaP via dermal contact (25 $(mg/kg/day)^{-1}$) (Ali, 2019; U.S.EPA, 2009).

The parameter ABS in Eq. (8) and Eq. (11) has previously been given a default value, thus leading to inaccurate risk assessment. Herein, the ABS of PAHs could be replaced with our established dermal bioavailabilities of PAHs (Bio_{Der}), thereby improving the accuracy of the assessment of risk to humans of exposure to PAHs via indoor dust. In light of their convenient use and facilitation of a conservative risk assessment, the agreed values of Bio_{Der} for Nap and other PAHs are 50% and 6%, respectively. For non-carcinogenic risk assessment, HI values ranged from 2.29E-13 to 3.64E-10 when the established ABS were used, which were lower than the HI values from 4.97E−13 to 7.89E−10 calculated by the default ABS values (Table S7). For cancer risk assessment, except for Nap, ILCR values ranged from 5.31E-08 to 1.33E-05 when the established ABS values were employed, which were also lower than that (1.15E-07 to 2.88E−05) calculated by default ABS values (Table S8). The ILCR values of Nap was 8.36E−08 calculated by established ABS, which was higher than that (2.17E-08) calculated by default ABS values (Table S8). Those indicated that the employment of ABS value should be paid more attention when performing risk

assessment, and our established ABS values would improve the accuracy of risk assessment. It should be noted that these may cause overestimation of BaP risk, as the loss of BaP was considered to always result in a metabolic product of BaP. The mechanisms of the metabolism of BaP by skin cells should be explored, and its metabolic products identified, in future work.

4. Conclusion

The results of this study showed that PAHs in indoor dust samples were predominantly three- and four-ring PAHs. The effects of temperature, solid-liquid ratio, sweat-sebum ratio and incubation time on the dermal bioaccessibility of PAHs in indoor dust were studied. The dermal bioaccessibility of PAHs increased following an increase in temperature. In addition, PAHs showed the highest dermal bioaccessibility when the solid/liquid ratio was 1:150 and the sweat/sebum ratio was 50/50. The release profile of PAHs from indoor dust was fitted to a first-order one-compartment model. According to the model calculation, the release rate of naphthalene (k_1) was the highest, consistent with the results of our bioaccessibility assay. In addition, the absorption rate of naphthalene and phenanthrene (k_3) by skin cells in a cell absorption assay was also higher than those of pyrene and benzo[*a*]pyrene, which was attributed to the latter compounds' high molecular weight. This indicates that the low molecular weight PAHs were much more easily absorbed by skin cells than the high molecular weight PAHs. Thus, by combining the bioaccessibility of PAHs in indoor dust with their dermal absorption ratio by skin cells, the dermal bioavailability of PAHs in indoor dust was estimated to range from 0.12 to 51.0%. This finding could be used in assessments of the risk of exposure to these pollutants.

Author contribution

Kesong Luo: Conceptualization, Methodology, Software, Yuan Kang: Conceptualization, Methodology, Software, Kesong Luo: Data curation, Writing - original draft, Diya Zeng: Data curation, Writing - original draft, Yuan Kang: Data curation, Writing - original draft, Hui Li: Data curation, Writing - original draft, Kesong Luo, Diya Zeng. Xunyang Lin, Na Sun, Cheng, Li: Investigation., Yuan Kang: Supervision, Project administration. Xunyang Lin, Na Sun, Cheng, Li, Menqi Zhu, Zhenwen Chen: Software, Validation. Kesong Luo, Yuan Kang, Yubon Man: Writing- Reviewing and Editing

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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Further information on research data

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2022, Environmental Research

> *Citation Excerpt :*
>
> …Hence, indoor dust is an increasingly serious public health problem, encouraging various researchers to study exposure of different people especially senior citizens, infants, and vulnerable groups such as pregnant women and patients with cardiovascular disease to this mixture. As mentioned earlier, indoor dust is a mixture and heterogeneous composition of organic and inorganic particles that can absorb and accumulate various contaminants such as polycyclic aromatic hydrocarbons (PAHs) (Luo et al., 2020). PAHs are a group of pollutants that have attracted extensive attention from academia, research centers, governmental organizations, and others because of the risks they have for the public health (Yang et al., 2020; Al-Harbi et al., 2020)….

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> ...Therefore, the future development of bioavailability measurement methods should provide adequate sensitivity to allow for the characterization of the bioavaliability at environmentally relevant doses so that the PAH-environmental matrix interactions will accurately reflect the factors operating in the PAHs concentration range relevant to the remediation of contaminated sites. Research on the in vitro bioaccessibility of PAHs has been carried out at multi-dimensional level, including human in vitro gastrointestinal simulations (Zhang et al., 2018; Zhang et al., 2015), human epithelial lung lining fluid simulations (Liu et al., 2019b; Liu et al., 2019c), and body fluid simulations of the surface layer of human skin (Luo et al., 2020). The development of in vitro digestion methods indicates that people are more comprehensive in considering the pathways of the exposure of humans to PAHs....

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> ...As can be seen from Table S5 (Supplementary material), for total dermal absorption ratios (%) at the 9 h point, no significant difference ($P > 0.5$) were observed between the high exposure concentration group and low exposure concentration group of four selected PAHs. Similar phenomenon was also observed in the studies of PAHs absorption by skin cells (Bourgart et al., 2019; Luo et al., 2020), which might be due to that the cell absorption element (such as a transporter) would not be saturated, and thus the absorption ratio did not show significant difference between the high and low concentration group. As shown in Fig. 3, the cumulative absorption efficiency of PAHs by lung cell was gradually increased with time and reached the highest point at 96 h, but did not reach a complete equilibrium....

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☆ This paper has been recommended for acceptance by Charles Wong.

1 These authors contributed equally to this work.

View Abstract

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Background concentration, risk assessment and regulatory threshold development: Polycyclic aromatic hydrocarbons (PAH) in Milwaukee, Wisconsin surface soils☆

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ABSTRACT

Inputs of polycyclic aromatic hydrocarbons (PAHs) of regulatory interest from diffuse atmospheric sources within urban areas frequently elevate local soil concentrations to levels requiring remediation despite the lack of in-situ contamination. This research sought to determine the distribution and potential health effects of aerially deposited PAHs in soil within the urban core of metropolitan Milwaukee, Wisconsin, U.S.A. as part of a soil regulatory standards reevaluation. Park areas (n = 27) identified as undisturbed for 80+ years, containing no fill material, and receiving only atmospheric deposition were selected for composite surface and 92 cm core soil sample collection (n = 295). Samples were analyzed for the 16 USEPA priority PAHs, 1- and 2- methylnapthalene and ancillary soil properties. Soil core and ancillary data confirm lack of site disturbance. PAH diagnostic ratios and homologue summations indicate that diffuse multiple point source emissions contribute equally to PAH deposition throughout the area. Benzo(a)pyrene (BaP) and dibenz(a,h)anthracene mean concentrations exceed health-based clean up levels. Risk assessment shows only a worst-case exposure scenario (BaP at the 95% upper confidence limit) increasing cancer risk (1.67×10^{-6}) over current regulatory thresholds (1.0×10^{-6}). Health quotients show potential health risks from fluoranthene and pyrene for daily park users and from BaP for all others. Mean soil PAH values are similar to New Orleans, but lower than Chicago, Boston, and London reflecting industrial history and site selection protocols. The soil PAH results presented here for sites selected for non-manipulated soils combined with an almost 100-year uninterrupted atmospheric exposure effectively show the maximum potential PAH values that can be found at any given undisturbed location within the Milwaukee urban core due solely to atmospheric deposition.

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1. Introduction

Polycyclic aromatic hydrocarbons (PAHs) are a group of hundreds of chemical compounds produced through both natural sources and human (anthropogenic) activities. PAHs are largely formed through thermal decomposition (pyrolosis) of organic materials and recombination (pyrosynthesis) of organic molecules (Kamal et al., 2014). PAH chemistries vary, and many are known to be toxic to humans as well as other mammals and aquatic life (International Agency for Research on Cancer (IARC), 2012; Nielsen et al., 1996). Common anthropogenic sources include the burning of fossil fuels (oil, gasoline, and coal), disposal of coal ash, use of coal tar pavement sealants, and waste incinerators (Nikolaou et al., 1984). It is these anthropogenic sources which generate the PAHs of highest toxicity and environmental impact. Natural sources can include hydrocarbon bearing rock formations and the burning of organic materials (forest fires, fire pits, peat fires) (Harvey, 1991).

The goal of this research was to determine the distribution and potential health effects of PAHs in soil within the urban core of metropolitan Milwaukee, Wisconsin, U.S.A. derived solely through aerial deposition from natural and anthropogenic sources. Milwaukee is the historic and present manufacturing and population center of Wisconsin. Its industrial heyday lasted from the

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1880s–1960s and was known in the early 1900s as the "machine shop to the world" (Fehring, 2017). Its peak population in 1960 was 741,000 comprising ≈25% of the total state population and was the 11th largest city in the United States (WPR, 2020). The PAH values found in this region's soils are assumed the highest within the state and therefore appropriate to inform a reevaluation of PAH soil regulations by the Wisconsin Department of Natural Resources (WDNR).

Determination of background values for PAHs and other anthropogenically introduced chemicals is a challenge worldwide. Using natural or geologic background as a remediation threshold requires the removal of anthropogenically introduced compounds at any soil concentration. However, human activity has spread PAHs to the most remote parts of the world (Nam et al., 2009; Bi et al., 2016; Kukučka et al., 2010) and regulatory systems have to adapt to the ubiquity of PAHs in soil with no specific source. When human health protection is the regulatory standard, acceptable risk levels are determined, clean up thresholds calculated, and remediation required above those thresholds. Determining acceptable risk levels always involves value judgements by the stakeholders and are not exclusively data driven (Kelly, 1991). PAH regulatory clean up thresholds (Table 1) in the U.S. are commonly based on human health risk assessments from the United States Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS) database (USEPA, 2020). These assessments evaluate toxicology study impacts on animals and humans from specific chemicals. The regulatory thresholds for cancer causing compounds are currently calculated to protect against an increased lifetime chance of 1×10^{-6} (1:1,000,000) of developing cancer due to lifetime exposure to a chemical. One in a million is considered to be the point at which risk is *de minimis* and not of regulatory concern (USFDA, 1973, 1979), but it is not a scientifically derived value and acceptable risk within regulatory systems overall typically range from 1:10,000 to 1:1,000,000 (Travis et al., 1987; WHO, 2001).

A background study requires careful design to maintain scientific rigor and meet legal requirements. Government agencies typically prefer data from undisturbed sites with no site-specific discharges. It is very challenging to find such sites within urban areas and U.S. property owners cannot be easily compelled to grant site access. Public institutions with long ownership and limited site disturbance (e.g. cemeteries, grounds of historic buildings, and public green spaces) are often good options. Alternatively, background studies can select sites regardless of contaminant inputs (Ander et al., 2013; Cave et al., 2012) but not excluding site-specific impacts may skew contaminant concentrations higher resulting in increased health risks if used for regulatory development. For this study, the Wisconsin regulated community advocated for inclusion of sites containing foundry sand, a common fill material often PAH contaminated (Dungan, 2006), but these were excluded. This study sought to develop a site screening criteria and sample analysis protocol to that would eliminate all but atmospheric sources allowing the data to be used as PAH soil background values for the entire metropolitan area.

This study used the term 'area background' derived from the USEPA (2002) anthropogenic background definition with modification, "Natural and human-made substances present in the *soil* environment *via aerial deposition* as a result of human activities *and natural sources*" (changes in italics). The hypothesis was that PAHs of high regulatory interest would be found at measurable levels but below regulatory action levels. This work focused on the 18 PAHs typically assessed in Wisconsin (Table 1), including the USEPA16 priority PAHs as well as 1- and 2-methyl naphthalene. While this work was planned in cooperation with regulatory agency staff, the authors had no input into how the agency ultimately used project data.

2. Materials and methods

2.1. Site selection

A robust site screening process was developed to eliminate locations with possible past PAH discharges. Site selection criteria were designed to: 1) eliminate sources of direct PAH discharge to sampling locations and 2) eliminate sampler bias within proscribed sampling areas. It was determined that within the region, long-established Milwaukee County parks were the least likely to be disturbed. County staff suggested specific park regions of no likely soil disturbance based on internal historic records which were cross checked using the Milwaukee County GIS and Land Use Interactive Database containing property data and aerial photos starting in 1937 (Milwaukee County, 2020). Although park topography may have been altered from its natural state prior to 1937, it was assumed that the park space would never have been industrial, commercial or residential as the parks were established as city expansion occurred and not reclaimed from previously developed

Table 1
PAHs typically assessed for Wisconsin site investigations.

PAH Compound	Abbreviation	Molecular weight (g/mol)	CAS#	# rings	Descriptor	WNDR non-industrial RCL[a] (mg/kg)
Naphthalene	Nap	128.17	91-20-3	2	Semi-volatile	5.52
1-Methylnaphthalene	1-Mn	142.20	90-12-0	2	Semi-volatile	17.6
2-Methylnaphthalene	2-Mn	142.20	91-57-6	2	Semi-volatile	239
Acenaphthylene	Acy	152.19	208-96-8	3	Semi-volatile	NA
Acenaphthene	Ace	154.20	83-32-9	3	Semi-volatile	3590
Fluorene	Fle	166.22	86-73-7	3	Semi-volatile	2390
Anthracene	Ant	178.23	120-12-7	3	Relatively water soluble	17,900
Phenanthrene	Phe	178.23	85-01-8	3	Relatively water soluble	NA
Fluoranthene	Fla	202.26	206-44-0	4	Hydrophobic, less volatile	2390
Pyrene	Pyr	202.26	129-00-0	4	Hydrophobic, less volatile	1790
Benz[*a*]anthracene	BaA	228.29	56-55-3	4	Highly hydrophobic, non-volatile	1.14
Chrysene	Chr	228.30	218-01-9	4	Hydrophobic, less volatile	115
Benzo[*b*]fluoranthene	BbF	252.30	205-99-2	5	Highly hydrophobic, non-volatile	1.15
Benzo[*k*]fluoranthene	BkF	252.30	207-08-9	5	Highly hydrophobic, non-volatile	11.5
Benzo[*a*]pyrene	BaP	252.31	50-32-8	5	Highly hydrophobic, non-volatile	0.115
Indeno[*1,2,3-c,d*]pyrene	IcdP	276.33	193-39-5	6	Highly hydrophobic, non-volatile	1.15
Benzo[*g,h,i*]perylene	BghiP	276.33	191-24-2	6	Highly hydrophobic, non-volatile	NA
Dibenz[*a,h*]anthracene	DahA	278.35	53-70-3	5	Highly hydrophobic, non-volatile	0.115

[a] RCL = Residual Contaminant Level, carcinogen in **bold**.

land. To facilitate park system cooperation, WDNR formally waived enforcement action options related to data collected or contaminants discovered as part of this research. This waiver was critical to project success as Wisconsin does not have an 'innocent landowner' law and contaminant discovery could incur regulatory penalty. Soil sampling was ultimately targeted at 30 Milwaukee County parks throughout the urban core of metropolitan Milwaukee. Park maps, sample allocations, sample locations, soil type descriptions, and additional site information is detailed in Lierl and Siemering (2018) and the supplementary material. Proximity to atmospheric deposition sources (current or historic) were not considered, since these represent many sources that would have come and gone over the past 150 years of industrial activity in the Milwaukee core and of which no readily available records exist.

Within suitable park areas, sampling locations were screened with reference to the following criteria: > 6 m from roadways and any parking lots, > 6 m from other asphalt surfaces (i.e., bike/walk paths potentially coal tar sealant coated), >1.5 m from any concrete sidewalks or any other structures, exclude athletic fields (if necessary, only along edges thereof), exclude areas that suggest overland soil runoff/deposition from rainwater, exclude areas where street-cleared snow is piled. These criteria ultimately focused sampling on areas within parks close to mature trees. Historic aerial photos confirmed the presence of trees in these areas since at least 1937. Often the trees visible in 1937 photos are still present today. Asphalt surfaces were given a wide buffer as until recently coal-tar based asphalt sealants were regularly used in this region and are the likely source of area waterbody sediment PAH contamination (Baldwin et al., 2017).

Based on available budget, a total sample count of 310 (~1 sample/460 m^2 of park area) was allocated between parks. A minimum of three samples were collected from each park or park-subregion with additional samples allocated based on park total size. The sampling design tool within ArcGIS was used to generate random latitude and longitude coordinates within individual parks until a sufficient number of sites had been selected from the identified sampling areas. Field duplicate samples (1 per each 10 sites sampled) were collected to assess the precision of the sampling process.

2.2. Sample collection

At each discrete sampling location, the following procedure was performed:

1. A soil core 92 cm in length (3 cm diameter) was hand collected to confirm the presence of a mature or undisturbed soil profile using a JMC PN150 ESP Plus subsurface probe (Clements Associates Inc., Newton, Iowa) with PETG copolyester liners. The soil column was inspected for soil horizon layer development and debris presence. If the column lacked distinct soil layers or contained debris, the sampling site was moved 3 m towards the nearest large trees and resampled. Resampling occurred as often as needed to obtain a sample meeting the criteria while staying within the park sampling area. Core sampling is not typically conducted at each location for surface soil contaminant investigations because of the effort and expense but is crucial for confirmation of undisturbed soil.
2. Surface soil samples from 0 to 7 cm below ground surface (BGS) (i.e. beginning at base of thatch/turf/leaf debris zones) were collected using a stainless-steel soil push probe. Sufficient samples were collected to obtain 350 ml of screened soil material (typically 15 probe cores). The soil samples were collected within a 61 cm radius of the deep soil core sampling location.
3. The surface soil was collected into lidded disposable aluminum pans, roughly deaggregated by hand, and stored in a cooler on ice prior to transport to the laboratory.
4. Beginning in the final month of sampling and due to elevated PAH values found in early surface soils, additional discrete soil samples were collected from 15 to 30 cm BGS using the stainless-steel push probe.

Typical PAH sampling procedures at sites where discharges or spills are suspected to have occurred require immediate sample storage on ice, storage at −80 °C and analysis within 24–48 h of receipt to facilitate detection of volatile and semi-volatile compounds. Similar to Wang et al. (2004) this sampling focused on undisturbed soil samples exposed to long term aerial PAH deposition, volatile and semi-volatile compounds were assumed lost due to environmental conditions (i.e. exposure to solar heating, precipitation, and oxidation) and standard PAH hold times were not relevant. Once collected, the soil samples were kept out of direct sunlight and at or below ambient air temperature, conditions less likely to cause volatilization than their in-situ condition.

Surface samples 0–7 cm BGS were ultimately collected at 295 locations allocated between 27 parks from June–August 2017. Samples were not collected from three parks due to lack of undisturbed soil evidenced from the 92 cm core sampling. A total of 26 samples from 15 to 30 cm BGS were collected. Soil samples were air dried in an air-conditioned 24 °C room. Container lids were loosened to allow drying, but still prevent contamination in the lab. Surface composite samples were hand ground in a ceramic mortar and pestle to deaggregated the soil without altering grain size, sieved to <2 mm (#10 sieve), organic material removed as practical and stored in glass jars with Teflon lined lids.

Soil core samples were removed from PETG sleeves into PVC drying racks and allowed to air dry in an air-conditioned 24 °C room. The core sample soil horizons were documented, the core photographed, split into 10 cm sections, placed in plastic storage bags and archived.

2.3. Laboratory and statistical analysis

Each sieved sample was analyzed by a U.S. state and federally accredited contract lab (Pace Analytical, Green Bay, WI) for total organic carbon (TOC) using USEPA Method 9060 (USEPA, 2004) and for the 18 PAHs of interest using either USEPA 3550c (ultrasonic) or 3546 (microwave) extraction methods (USEPA, 2007) and Method 8270 E with SIM (USEPA, 2017a). Two extraction methods were used because analytical equipment breakdown required samples to be sent to an alternate company facility where a different extraction method was utilized. A methods comparison was not conducted due to sample disposal prior to discrepancy discovery. While not preferable, both methods are USEPA (2007) approved and equally valid for regulatory purposes. Extraction methods by park have been noted on Fig. 1 and detection rate information is available in the supplementary material. Song et al. (2002) found no difference in extraction efficiencies for less polluted soil, but some difference based on benzene ring number regardless of method. Lau et al. (2010) acknowledged differences but did not conclude in the superiority of one extraction method over another. All contract labs that submitted bids offered only Method 3550c and 3546 as options.

Extraction batches consist of up to 20 samples, a method blank, laboratory control spike, matrix spike and matrix spike duplicate. All samples and quality control standards are surrogated with 2-fluorobiphenyl (23–106% recovery) and p-terphenyl-d14 (29–106% recovery) to determine extraction efficiency. The laboratory control spike (LCS) consists of an Ottawa sand/sodium sulfate

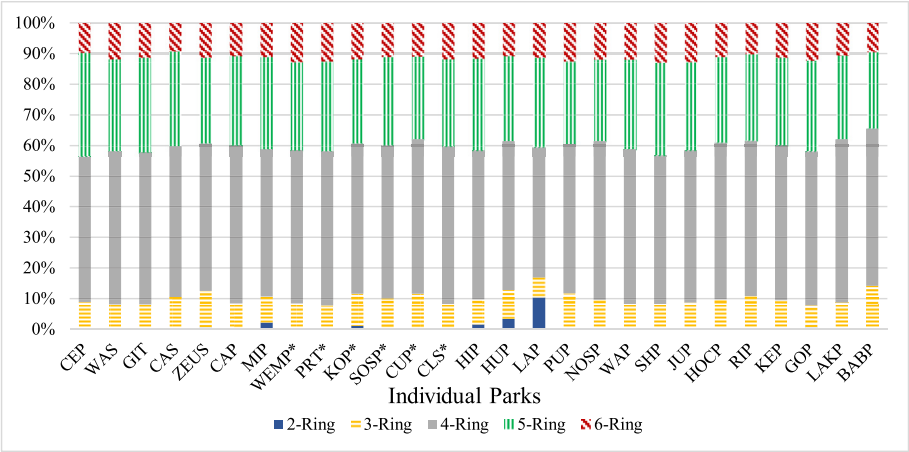


Fig. 1. Composition of PAH homologues from Milwaukee park surface soil samples.

blank matrix spiked with US National Institute of Standards and Technology (NIST) certified PAH standard at a concentration near the midpoint of the instrument's calibration curve. The laboratory control spike recovery limits were within 70–130%. The matrix spike (MS) and matrix spike duplicate (MSD) consist of the client sample in which two aliquots are spiked with the same standard and concentration as the LCS. The recovery limits of the MS/MSD were within 70–130%. The relative percent difference limit was 20%. Prior to sample analysis internal standards (napthalene-d8, acenaphthene-d10, phenanthrene-d10, chrysene-d12, perylene-d10) are added to each sample and quality control sample for internal standard quantitation. The detection limits are determined following EPA 40CFR Part 136. The practical quantitation limit was calculated based on the lowest calibration standard used for the analysis (practical quantitation limit ¼ [lowest initial calibration standard concentration] [final extract volume]/[sample mass extracted, dry wt.]). Particle size analysis (PSA) was conducted in house using standard hydrometer methods (Gee and Or, 2002) with pre-oxidation of organic matter. PSA was conducted on 42 composite samples from each park and sub-park region and an additional 14 samples where the core sample showed variation from park or park sub-region co-located cores.

All summary statistics were generated with the USEPA ProUCL statistics package (USEPA, 2018). Sample results below the level of detection, level of qualification, and where surrogate recovery exceeded 106% were removed from the dataset prior to statistical analysis following ProUCL protocols. QQ plots were created for each PAH lognormal dataset to test for normality and visually identify possible outliers. For duplicate pair samples, the highest value was used for statistical analysis to bias towards health protection. Outlier tests within ProUCL (either Rosner's ($N > 25$) or Dixon's ($N < 25$) test) were used to determine if the outliers were significant. Average percent difference and Bland-Altman plots were used to compare duplicate sample pairs. The nonparametric Spearman correlation analysis (alpha = 0.05, two-tailed) was used to determine whether there was a good correlation between the PAHs themselves, TOC and ∑PAH. Spearman analysis was conducted using Microsoft Excel with the Real Statistics plug-in (http://www.real-statistics.com/).

2.4. Risk assessment

Risk assessment was conducted as both an area background assessment was well as a site-specific assessment for daily, weekly and monthly park users. The risk for daily park users to park soil is equivalent to Milwaukee resident exposure to area background PAH values. The assessment utilized modified exposure (EF) to account for different user groups (Cohen et al., 2006, 2016) and soil accessibility (SF) for multiple months of frozen soil (NWS, 2020). While these modified inputs quantify reduced park soil exposure, the entire risk assessment remains protective as the process cannot account for the turfgrass layer that isolates contaminated soil, outdoor recreation occurring primarily on paved or gravel paths (Cohen et al., 2016) and regional inclement late fall/early spring weather reducing outdoor activities in general.

Total cancer risk (Equation (1)) was calculated for median and 95% of the upper confidence limit (UCL) PAH concentrations using the incremental lifetime cancer risk (ILCR) equation for ingestion (Equation (2)) (USEPA, 1991). Lifetime hazard quotients (HQ) (Equation (3)) were calculated using the HQ equation (Equation (4)). Total cancer risk was calculated for PAHs with cancer slope factors (CSF) and HQs for those PAHs with reference dose data (RfD). For aged PAHs in a soil matrix, ingestion is considered the only relevant human exposure pathway (Ruby et al., 2016). To ascertain population level risk from the park soil, composite risk was determined (Equation (5)).

$$Total\ Cancer\ Risk_{Ingestion} = ILCR_{child} + ILCR_{adult} \quad (1)$$

$$ILCRIngestion = \frac{CS \times \left(CSF_{Ingestion} \times \sqrt[3]{(BW/70)}\right) \times IR \times EF \times ED \times SBF}{BW \times AT \times 10^{6}} \quad (2)$$

$$HQ_{lifetime} = HQ_{adult} + HQ_{child} \quad (3)$$

$$Hazard\ Quotient(HQ) = \frac{CS \times IR \times \left(kg\ soil \Big/ 10^6 mg\ soil\right) \times (1/BW) \times EF \times ED \times SF}{RfD} \quad (4)$$

$$Park\ User\ Population\ Risk_{mean\ or\ 95\%\ UCL} = \left(EF_{daily} \times daily\ composite\ risk\right) + \left(EF_{weekly} \times weekly\ composite\ risk\right) + \left(EF_{monthly} \times monthly\ composite\ risk\right) \quad (5)$$

where:

CS = concentration in soil; soil contaminant mean or 95% UCL PAH concentration in mg PAH/kg soil.

$CSF_{Ingestion}$ = cancer slope factor; chemical specific cancer cases per million, per mg/kg BW-day.

BW = body weight; adult = 70 kg, child = 15 kg.

IR = oral soil ingestion rate; adult = 100 mg per day, child = 200 mg per day.

EF = exposure frequency; 9% daily use, 38% weekly use, 18% monthly use (Cohen et al., 2006).

ED = exposure duration; adult = 24 years, child = 6 years.

SF = soil accessibility factor; average region thawed soil days, 251 days/365 = 0.69 (NWS, 2020).

AT = averaging time in days; 70-year lifespan x 365 days/year = 25,550 days.

Rfd = EPA Reference dose, in mg PAH/kg body weight/day.

3. Results

All 18 PAHs analyzed were found in at least some subset of the surface samples collected (Table 2), although the total number of valid PAH measurements varied by compound. In surface soils (0–7 cm BGS), the mean concentrations of BaA, BbF, BaP, DahA, and IcdP (see Table 1 for abbreviations) had individual soil concentration values exceeding single compound WDNR residual contaminant limits (RCLs). Mean BaP (600 μg/kg) and DahA (144 μg/kg) surface soil concentrations both exceed single compound WDNR RCLs. PAH values collected 15–30 cm BGS did not exceed regulatory values and were far below surface sample concentrations indicating atmospheric deposition as the PAH source.

Of the surface samples (0–7 cm BGS), only the Acy dataset was determined to have a single outlier that exceeded the 5% significance level according to Rosner's test. The BkF surface sample data set was determined to have two potential outliers and all other PAH surface soil datasets had one possible outlier all within the 1–5% significance level. For the 15–30 cm BGS sample set, Ant had a single outlier that passed the 10% significance level. No other PAH 15–30 cm BGS data set had outliers.

Summary statistics for all valid measurements were calculated for each PAH dataset (Table 2). Summary statistics were not generated for ∑PAH data due to lack of regulatory applicability. Potential outliers were included in the summary statistics calculations as ancillary data indicated sample locations were undisturbed and received only atmospheric deposition. Full statistics tables showing data with and without potential outliers are available in the supplementary material.

For duplicate sample pairs, average percent difference calculations showed the average precision percentages between pairs ranged 14–31% and Bland-Altman plots confirmed low precision. This range was expected given the inherent heterogeneity of soil and does not confound the calculation of summary statistics. Sample heterogeneity is a known issue at both the field scale as well as within a single sample (ITRC, 2012).

Table 2
Statistical summary of PAHs from 0 to 7 cm BGS and 15–30 cm BGS soil samples from Milwaukee, Wisconsin. (μg/kg).

	Nap	1-Mn	2-Mn	Acy	Ace	Fle	Ant	Phe	Fla	Pyr	BaA	Chr	BbF	BkF	BaP	IcdP	BghiP	DahA	TOC (%)
0–7 cm BGS																			
# Valid Detections	14	32	38	109	75	75	207	295	295	295	295	295	295	295	295	295	295	287	295
Min.	20.6	2.7	2.3	3.7	3.7	4.6	11	54.2	84	75.9	34.1	55.2	57.3	63	49.8	23.7	22.1	9.7	1.98
Max	190	233	281	812	280	327	1110	3840	10,600	9010	6600	6380	5430	3940	6530	3530	3430	1270	8.89
Mean	69	37.3	39.7	35.2	50	52.1	118	558	1360	1160	600	764	878	514	680	422	465	144	4.01
95% UCL	173	82.9	103	70	102	98.2	321	1650	4220	3590	1860	2360	2860	1340	2060	1270	1440	411	5.92
Median or GeoMean[a]	51	19.7	23.5	17.9	29.5	27.9	62.5	339	956	820	407	545	615.2	372	484	297	324	101	3.90
Standard Deviation	46.4	46.9	53	78.5	54.3	61	144	597	1380	1160	662	766	860	502	700	429	466	150	1.02
15–30 cm BGS																			
# Valid Detections	0	4	3	5	3	3	12	18	22	22	22	22	22	22	22	22	22	22	22
Min.		14.5	17.3	11.7	15.2	14.6	20.1	1.72	61.8	55.7	24.8	37.6	31.3	35.7	32	22.1	24.5	8.3	0.55
Max		22.4	24.9	17.9	17.7	17.7	179	2.84	1330	1370	572	691	834	361	558	346	387	105	2.44
Mean		18.6	21.8	15.2	16.2	16	60	2.28	459	425	198	249	293	151	203	116	120	37.6	1.41
Median or GeoMean[a]		18.7	23.3	16.5	15.8	15.7	42.3	2.31	299	283	129	171	183	115	141	78.3	80.5	26.9	1.31
Standard Deviation		46.9	53	78.5	54.3	61	144	597	1380	1160	662	766	860	502	700	429	466	150	0.53

[a] ProUCL calculates median (M) values for censured datasets (i.e. with nondetects) and geometric mean (GM) for noncensured datasets. M shown for Nap, 1-Mn, 2-Mn, Acy, Ace, Fle, Ant, Phe, DahA. GM shown for Fla, Pyr, BaA, Chr, BbF, BkF, BaP, IcdP, BghiP, and TOC.

Table 3
Spearman correlations between 18 individual PAHs, ∑PAH and TOC.

Nap	1.0																		
1-Mn	0.27	**1.0**																	
2-Mn	0.44	.092	**1.0**																
Acy	−0.02	0.23	*0.47*	**1.0**															
Ace	0.43	0.00	**0.60**	**0.87**	**1.0**														
Fle	0.35	−0.12	*0.46*	**0.89**	**0.98**	**1.0**													
Ant	0.25	0.13	0.34	**0.93**	**0.95**	**0.98**	**1.0**												
Phe	0.16	0.23	0.30	**0.89**	**0.94**	**0.97**	**0.97**	**1.0**											
Fla	0.20	0.11	0.18	**0.88**	**0.87**	**0.87**	**0.94**	**0.97**	**1.0**										
Pyr	0.22	0.09	0.16	**0.90**	**0.91**	**0.91**	**0.96**	**0.97**	**0.98**	**1.0**									
BaA	0.14	0.15	0.22	**0.92**	**0.90**	**0.91**	**0.97**	**0.97**	**0.98**	**0.99**	**1.0**								
Chr	0.21	0.18	0.25	**0.92**	**0.90**	**0.91**	**0.96**	**0.97**	**0.98**	**0.99**	**0.99**	**1.0**							
BbF	−0.01	0.15	0.19	**0.87**	**0.85**	**0.85**	**0.89**	**0.93**	**0.95**	**0.95**	**0.97**	**0.95**	**1.0**						
BkF	0.34	0.14	0.27	**0.73**	**0.82**	**0.84**	**0.82**	**0.83**	**0.85**	**0.88**	**0.85**	**0.88**	**0.72**	**1.0**					
BaP	0.15	0.13	0.23	**0.91**	**0.89**	**0.89**	**0.96**	**0.96**	**0.98**	**0.99**	**0.99**	**0.98**	**0.96**	**0.87**	**1.0**				
IcdP	0.28	0.21	0.24	**0.88**	**0.88**	**0.89**	**0.92**	**0.95**	**0.97**	**0.98**	**0.97**	**0.98**	**0.92**	**0.89**	**0.98**	**1.0**			
BghiP	0.35	0.20	0.23	**0.86**	**0.87**	**0.88**	**0.90**	**0.94**	**0.96**	**0.96**	**0.96**	**0.97**	**0.90**	**0.87**	**0.97**	**1.0**	**1.0**		
DahA	0.34	0.10	0.19	**0.86**	**0.87**	**0.87**	**0.91**	**0.88**	**0.94**	**0.99**	**0.95**	**0.96**	**0.86**	**0.94**	**0.96**	**0.98**	**0.98**	**1.0**	
∑PAH	**0.00**	0.16	0.24	**0.91**	**0.90**	**0.90**	**0.96**	**0.97**	**0.98**	**0.99**	**0.99**	**0.98**	**0.95**	**0.88**	**1.0**	**0.99**	**0.98**	**0.97**	**1.0**
TOC	-.028	*0.40*	**0.56**	**0.40**	**0.47**	**0.46**	**0.32**	**0.29**	**0.28**	**0.27**	**0.29**	**0.31**	**0.31**	**0.24**	**0.29**	**0.26**	**0.26**	**0.22**	**0.29**	**1.0**
	Nap	1-Mn	2-Mn	Acy	Ace	Fle	Ant	Phe	Fla	Pyr	BaA	Chr	BbF	BkF	BaP	IcdP	BghiP	DahA	∑PAH	TOC

Note: Values shown in bold have P=<0.01. Values shown in italics have 0.05 > P > 0.01.

3.1. Area background confirmation

Collected soil cores match park soil descriptions from the era of park establishment (WGNHS, 1919) showing lack of fill material. A complete catalog of soil core photos and descriptions as well as comparison to 1919 soil survey information can be found in Lierl and Siemering (2018). Particle size analysis showed clay content with less than a 5% variation between park sub-regions within a single park and between parks with a single sample area and other parks with the same soil type. Total organic carbon (TOC) values indicate no surface soil disturbance on the decade scale. TOC measurements were converted to soil organic matter (SOM) using TOC*1.72 = SOM (Pribyl, 2010) with sample SOM ranging from 3.5 to 10%. Wisconsin topsoil is typically 2–4% SOM (Schulte et al., 2005).

3.2. Spatial variability and source apportionment

Despite wide variation in individual PAH sample concentrations throughout the city, there was no discernible spatial gradient or clustering of PAH values among the parks. Fig. 1 shows PAH homologues (2-,3-,4-,5- and 6-ring compounds summed) by park with the 4-ring PAHs (BaA, Chr, Fla, and Pyr) constituting the greatest percentage in the soil followed by the 5-ring (BaP, BbF, BkF, and DahA) and 6-ring PAHs (BghiP and IcdP).

Virtually all 3-6-ring PAH combinations showed significant very strong Spearman correlation (>0.8, p=<0.01) with other 3-6-ring PAHs as well as the ∑PAH values (Table 3). BkF showed significant strong correlations (0.6 < x < 0.79, p=<0.01) with BbF (0.72) and Acy (0.73). 2-Mn showed moderate significant correlation with Ace (0.60) and ∑PAH (0.56) with all other 2-ring PAHs having weak correlation to other PAHs, TOC or ∑PAH. The result suggests that the 3-6-ring PAHs originated from similar sources (Chung et al., 2007; Li et al., 2010) and given the site selection process and ancillary data can be assumed to be local atmospheric deposition sources. The 2-ring PAHs (Nap, 1-Mn, and 2-Mn) are more likely to be a combination of local and long-distance sources.

PAH concentration showed no correlation to soil properties. Comparisons of ∑PAH versus % clay ($R^2 = 0.012$), ∑PAH versus TOC ($R^2 = 0.11$) were plotted but no trends were observed (see supplementary material). Spearman's coefficient calculations also show no correlation between individual PAH data and TOC (Table 3). Weak correlations between TOC and PAH concentrations in soils have been previously observed (Buchelli et al., 2004; Heywood et al., 2006; Bi et al., 2016). Correlations were observed by Chiou et al. (1998) between SOM and low molecular weight PAHs and by Tang et al. (2005) for mixtures with high percentages of low weight PAHs.

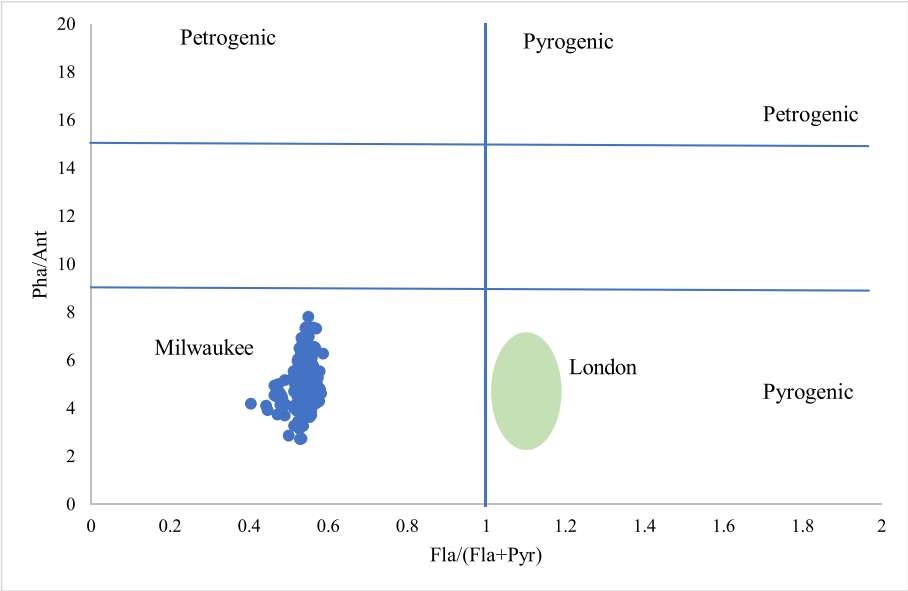
To broadly characterize PAH sources (petrogenic vs pyrogenic) and further confirm the uniformity of PAH distribution, PAH diagnostic ratios phenanthrene/anthracene (Phe/Ant) versus fluoranthene/fluoranthene + pyrene (Fla/(Fla + Pyr) and benzo(a) anthracene/(benzo(a)anthracene + chrysene) (BaA/(BaA + Chr)) versus fluoranthene/pyrene (Fla/Pyr) were plotted in Figs. 2 and 3 following Vane et al. (2014). Both figures show a tight clustering of data points indicating homogenous inputs. Fig. 2 indicates mixed petrogenic and pyrogenic sources and Fig. 3 narrows the sources to a mixture of petroleum combustion and grass/wood/coal combustion.

3.3. Risk assessment

Total cancer risk results indicate that only Milwaukee residents exposed to BaP values at the 95% UCL for the default 30-year exposure would see an increased cancer risk (1.67×10^{-6}) above the current individual compound regulatory threshold (1.0×10^{-6}). Cumulative risk calculations at the 95% UCL do not indicate increased cancer risk (2.53×10^{-6}) over proposed cumulative PAH regulatory thresholds (1.0×10^{-5}).

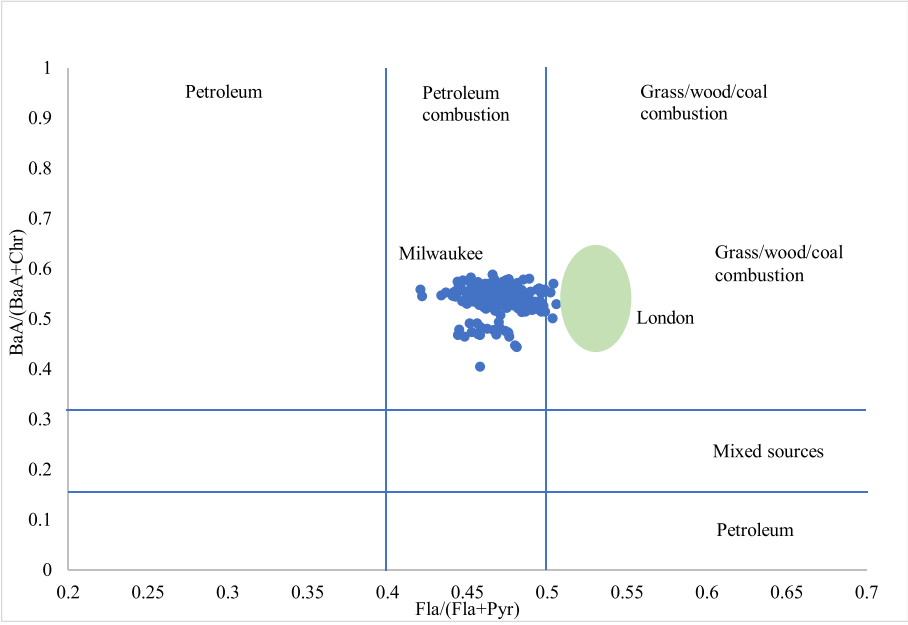
As a site-specific risk assessment, only daily park users see the potential increased risk from BaP exposure at the 95% UCL. All other exposure and PAHs combinations indicate no increased cancer risk from park soil exposure. For the park user population (65% of total population) (Cohen et al., 2016), the composite risk of exposure to mean PAH concentrations is 1.33×10^{-7} and to 95% UCL PAH concentrations is 3.8×10^{-7} indicating no increased cancer risk over the 1.0×10^{-6} threshold.

Hazard quotient calculations show potential adverse health effects (HQ > 1) at the mean and 95% UCL values for both the Milwaukee area/daily user scenario (HQ_{daily} 65.3/197 respectively) and weekly and monthly user scenarios for BaP (HQ_{weekly} 9.3/28.1; $HQ_{monthly}$ 2.15/6.49). HQ_{daily} for mean and 95% UCL Pyr concentrations (1.12 and 3.45) and 95% UCL Fla (HQ = 3.03) indicates a small increased health risk from daily lifetime exposure. Full cancer



Note: London data from Vane et al. (2014) for comparison only.

Fig. 2. Isomeric ratio plot of Pha/Ant and Fla/(Fla + Pyr).



Note: London data from Vane et al. (2014) for comparison only.

Fig. 3. Isomeric ratio plot of BaA/(BaA + Chr) and Fla/(Fla + Pyr).

risk and HQ tables are shown in the supplementary material.

4. Discussion

The homologue distribution and diagnostic ratios (Figs. 1–3) indicate soil PAHs are due to city-wide deposition of atmospherically homogenous PAH inputs. Spearman coefficient analysis (Table 3) further confirms homogenous local PAH inputs for 3-6-ring PAHs. Collected soil core match to historic records and high soil TOC values confirm the sampling method successfully identified sites lacking prior disturbances, fill, or contaminant releases.

While the mean PAH concentrations measured in this study are well above PAH values from remote forest areas (Aichner et al., 2015; Syed et al., 2017; Nam et al., 2008), Beijing (Peng et al., 2015), Nanjing (Wang et al., 2015), Istanbul (Yukhimets et al., 2019), and southern Italy (Thiombane et al., 2019), they are similar to those of New Orleans (Wang et al., 2004) and small cities in eastern Pennsylvania, USA (EPRI, 2008) (see Table 4). The PAH levels found in Chicago (Kay et al., 2008), New England cities (Bradley et al., 1994) and London, UK (Vane et al., 2014) are 2–3X higher than those found in Milwaukee. This variation is likely due to the length and type of area industrial activity as well as site selection and sampling protocols. The sample location methods for Chicago, New England and London were not screened for PAH site

Table 4
Comparison of PAH background studies. (mean μg/kg).

Geographic location	Reference	BaA	BbF	BaP	IcdP	DahA	Sample #	Site selection method
Milwaukee, USA	Current Study	600	881	680	423	140	295	Random in areas only receiving atmospheric deposition
Chicago, USA	Kay et al. (2008)	2060	2620	2307	1459	283	57	Random on city and utility owned land
London, England	Vane et al. (2014)	1967	1289	1896	1568	210	76	"Selected" within city subarea, 4 per km^2
New England cities, USA	Bradley et al. (1994)	1319	1433	1323	987	388	60	"Not industrial impacted"
New Orleans, USA	Wang et al. (2004)	797	852	749	343	405	36	Not disclosed
Illinois, USA small city	EPRI (2004, 2015)	102	120	131	93.4	38.6	50	Pseudo-random
Beijing, China	Peng et al. (2015)	83.9	123.7	93.6	92.4	21.2	68	Housing block yards
Nanjing, China urban	Wang et al. (2015)	287	443	278	212	52.3	129	Not disclosed
Istanbul, Turkey	Yukhimets et al. (2019)	1.56	1.14	2.12	1.1	0.33	35	Not disclosed
S. Italy urban	Thiombane et al. (2019)	7.27	15.05	10.47	2.64	0.50	40	"Representative" urban and rural
S. Italy rural	Thiombane et al. (2019)	26.86	86.58	70.14	7.91	1.45	40	
Eastern Pennsylvania, USA	EPRI (2008)	765	680	703	420	169	71	Pseudo-random
UK, Norway	Nam et al. (2008)	44	78	46	NA	6	53	Woodland/grassland transect
Germany (all)	Aichner et al. (2015)	18	88	24	46	9	474	Random per 256 km^2 excluding non-forest areas
Chinese mtn. forest	Syed et al. (2017)	12.7	17.8	10.5	12	8.7	143	Not disclosed
Nanjing, China rural	Wang et al. (2015)	85.3	153	77.5	72	14.3	10	Not disclosed

releases or for site disturbance. Many studies did not provide details on site selection.

The dominance of chemically stable 4-6-ring compounds shown in Fig. 1 is indicative of PAH contributions primarily from coal and petroleum combustion (Vane et al., 2007, 2014). Except for one park (LAP, see supplementary material for park abbreviations), the lack of spatial variability indicates homogenous PAH deposition among parks, and correspondingly uniform risk to park users exposed to soil. At LAP the comparatively larger percentage of 2-ring compounds is due to overall lower PAH soil values and proportionally fewer 4-ring compounds, but not a localized release of 2-ring PAHs. Compared to urban parks in Hong Kong (Chung et al., 2007) Milwaukee park soils contain approximately 10% fewer 2–3 ring PAHs and 10% greater 5-ring PAHs.

The PAH diagnostic ratios shown in Figs. 2 and 3 indicate mixed petrogenic and pyrogenic PAH sources. The tight data clustering indicates that all sampling locations were receiving PAH inputs from similar sources regardless of location within the city. Milwaukee PAH sources show a greater petrogenic source contribution compared with data from London, GB (Vane et al., 2014). This is likely due to London's long history of coal and wood home heating as well as industrial coal usage compared with Milwaukee's greater reliance on petroleum-fueled transportation, home heating with fuel oil, and the use of electric metal furnaces at the time of local industrial development.

The presence of semi-volatile, 2-3-ring PAHs (Nap, 1-Mn, 2-Mn, Acy, Ace and Fle) in both 0–7 cm BGS and 15–30 cm BGS samples was unexpected. Semi-volatile PAHs are commonly assumed to be found only at sites with recent spills. However, the sampling protocol eliminated that possibility. The low concentrations of alkylated PAHs (1-Mn and 2-Mn) compared to other PAHs indicate that fugitive diesel spills are not significant contributors to overall PAH soil burden (Vane et al., 2014). Low Spearman coefficients both between the individual 2-ring PAHs (Nap, 1-Mn, 2-Mn) and the 2-ring and 3-6-ring PAHs are evidence that the 2-ring compounds are being transported via atmospheric deposition from distant disparate sources.

Site specific risk assessment indicates that there is a slight increase in lifetime cancer risk from BaP only at the 95% UCL. For non-cancer endpoints, risk assessment refinement is indicated by elevated hazard quotients for BaP, Pyr, and Fla. Hazard quotients only indicate the potential for adverse health effects and the need for additional study. Lack of increased cancer risk due to BaP exposure despite elevated HQ ($HQ_{max} = 197$) show the need for caution in the use of HQs in regulatory development. Because the USEPA reference dose (RfD) values are intended to be protective against lifetime daily exposure but are typically limited to animal studies, they include safety factors which may overestimate human health risk (USEPA, 2017b) both in terms of toxicity and realistic exposure scenarios. Where PAHs in park soils exceed health-based screening levels, the PAHs are present at problematic concentrations only in the uppermost soil layer. This was expected due to the prediction of atmospheric deposition as well as PAH hydrophobic properties that resist percolation and matches the findings of Gateuille et al. (2014) for undisturbed areas.

The park soil PAH results presented here, where sample sites were chosen based on best available historical knowledge of non-manipulated soils, combined with the almost 100-year uninterrupted atmospheric exposure of the sampling areas, effectively show the maximum potential PAH values that can be found at any given undisturbed location within the Milwaukee urban core due solely to atmospheric deposition. Sampling within the same parks following different site selection criteria (e.g. random selection within the entire park) are likely to give different results. Samples from elsewhere within the metropolitan area with PAH levels above those shown here can be assumed to have received site specific discharges. If a PAH site release is suspected, but soil PAH concentrations do not exceed these established background values, PAH diagnostic ratio data could be used to determine a match with background PAH ratios. Additional techniques such as principle components analysis are available to yield PAH source identification, but specific PAH source was irrelevant for this research.

Study results show the utility of conducting an area-wide background study to aid in allocating resources to the many sites within this urban area where remediation is truly needed and avoid the futility of requiring PAH remediation at sites where the sole PAH source is atmospheric deposition and the levels found do not impact human health. Prior to this study data becoming available, remediations were required in Milwaukee at sites with lower levels of PAH soil contamination than found in the undisturbed areas of local parks. WDNR has included the study results in a multiyear reassessment of soil regulations where one goal is to facilitate urban economic development without compromising public health.

Given the disparities in PAH sources between urban areas, results from this study may not be readily applicable to results from other cities. However, from a cost benefit viewpoint, conducting similar area background studies elsewhere would be roughly equal in cost to a single moderately sized site remediation.

5. Conclusions

We conclude that PAHs in undisturbed Milwaukee park soils are

exclusively the result of diffuse non-point-source atmospheric deposition and confirmed that sampling locations did not contain fill material or PAH discharges. The PAH concentrations found in these samples are not representative of all soil found within the parks or Milwaukee County. A clear concentration gradient was not seen between parks or within individual parks. The total number of valid PAH detections in each sample varied by compound, but all 18 PAHs were measured in some portion of the samples collected. Individual BaA, BbF, BaP, IcdP, and DahA and mean BaP and DahA sample concentrations exceeding health-based regulatory limits. Risk assessment showed a worst-case scenario (30 years of seasonal daily incidental ingestion of surface soils containing BaP at the 95% UCL) causing a slightly increased cancer risk (1.67×10^{-6}) over current regulatory thresholds (1.0×10^{-6}). Other PAH exposure scenarios did not result in increased cancer risk. Hazard quotients (HQ > 1) indicated potential increased non-cancer health risks for lifetime daily exposure for all BaP exposure scenarios, for resident/daily park user mean and 95% UCL exposure to Pyr, and for resident/daily 95% UCL exposure to Fla. Due to uncertainty factors build into HQ calculations, this does not indicate the certainty of health impacts, but indicates the need for more robust exposure pathways evaluation to ensure public safety. Conducting area background studies can be an important tool in focusing scarce remediation resources to locations where the greatest health risk reductions can be realized. However, regulator and researcher collaboration are critical so the data generated can directly inform regulation development while remaining scientifically robust.

Author statement

Geoffrey Siemering: Conceptualization, Methodology, Investigation, Formal Analysis, Writing-Original analysis, Supervision. Robert Thiboldeaux: Formal analysis, Writing-Editing and review.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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Aquifer Drawdown and Recovery in the Northeast Groundwater Management Area, Wisconsin, USA: A Century of Groundwater Use

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Abstract: The Northeast Groundwater Management Area of Wisconsin, USA contains two major cones of depression in a confined sandstone aquifer. Each cone is centered near cities that have used groundwater for over 100 years. Near one of these cities (Green Bay), episodic changes in the development of groundwater and surface water resources during this period have resulted in major changes to the potentiometric surface. On two occasions, roughly 50 years apart, reductions in groundwater withdrawals have resulted from the construction of pipelines drawing surface water from Lake Michigan. In each case, rapid recovery of the potentiometric surface by as much as 70 m has occurred in the northern of the two pumping cones. The most recent switch occurred during 2006 and 2007 when eight communities stopped pumping groundwater, reducing daily withdrawals by approximately 46.37 million liters. The rate of water level recovery has diminished in some areas, with a return to a flowing artesian state for some municipal and residential wells. Although the northern portion of the groundwater management area has returned to a sustainable condition in the confined aquifer, the portion with the southern cone of depression remains in a state of prolonged drawdown.

Keywords: Wisconsin; groundwater management; recovery; potentiometric surface; drawdown; Cambrian; sandstone

1. Introduction

Aquifer depletion from extensive groundwater withdrawal is a widespread problem affecting broad regions of the world [1,2]. Adequate long-term monitoring of aquifer water levels is a critical component necessary for risk management of water resources [2]. While many aquifers show accelerating rates of depletion [1], few aquifers have shown large-scale water level recovery due to improved management changes or alternative water supplies (e.g., [3,4]).

Aquifer drawdown and recovery are a function of the interplay between a society's use of groundwater and its responses to resource sustainability issues. As such, drawdown and recovery are not the whole story by themselves. In the United States, while hydrogeologists and engineers play an important role in making recommendations, they do not make short-term or long-term decisions or implement resource use strategies. In most cases, local democratically elected officials are responsible for such decisions. When disputes arise, resolutions are often made in courts of law.

1.1. Water Resources in Wisconsin

The state of Wisconsin, USA, is located in the western Great Lakes region of North America (Figure 1) and has abundant supplies of surface water and fresh groundwater [5]. Few areas have faced water quantity limitations, but expanding water use, coupled with long-term aquifer drawdown, has resulted in noteworthy water supply challenges.

About 88% of water withdrawal in Wisconsin is from surface water supplies, with the remaining 12% from groundwater [6]. However, the majority (90%) of surface water use was for cooling water, so the amount of non-cooling groundwater use exceeds non-cooling surface water use statewide [7]. Statewide, 800,000 small private wells, plus an additional 11,000 high capacity wells serve industry, municipal, and agricultural purposes [6,8]. Land use in the study area is characterized by a mix of urban development, small rural communities, and industries, including manufacturing, dairy production, and agricultural field crops [9].

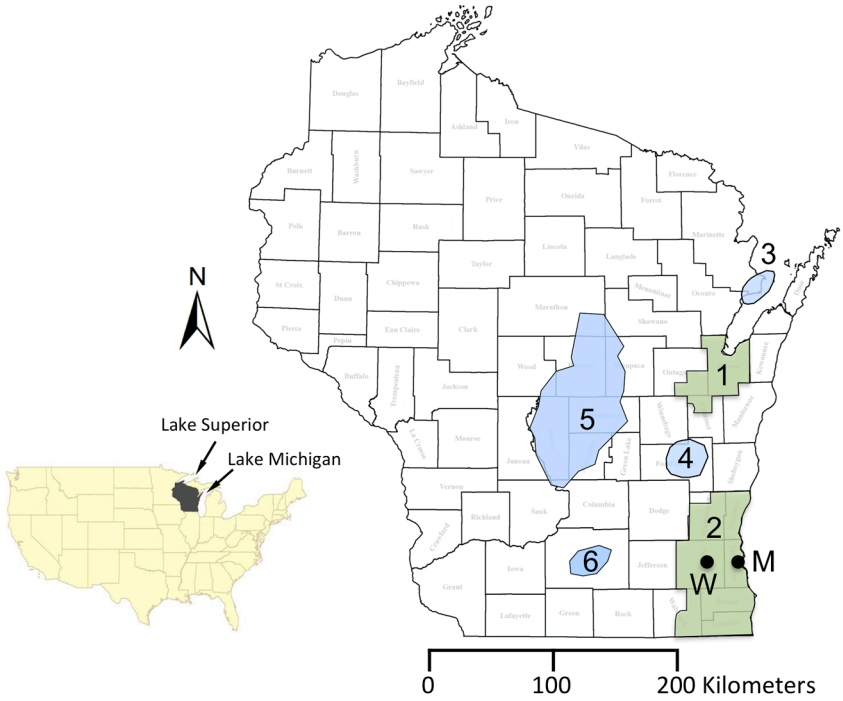

Figure 1. Map showing the location of Wisconsin counties with formally defined groundwater management areas of the state highlighted in green. Additional areas with significant drawdown are shown in blue. Inset map shows the location of Wisconsin in the lower 48 contiguous United States. Numbered regions are as follows: (**1**) Northeast Groundwater Management Area (Northeast GMA); (**2**) Southeast Groundwater Management Area; (**3**) area of drawdown in Marinette County; (**4**) area of declining water levels in Fond du Lac County; (**5**) area of declining water levels in Dane County; and (**6**) an area impacted by irrigation drawdowns in the Central Sands region [5,10,11]. Letter designations for cities mentioned in the text are Waukesha (W) and Milwaukee (M).

1.2. Sustainability and Groundwater Management Areas in Wisconsin

Groundwater sustainability has been a topic of concern in the region for over a century. The earliest known use of groundwater from the confined sandstone aquifer in the Northeast Groundwater Management Area (GMA) occurred during the 1880s in the cities of Appleton, Kaukauna, and De Pere [12,13]. Work during the middle of the 20th century addressed groundwater quantity issues [13–15] and presented an analysis of the first transition from groundwater to surface water by the City of Green Bay in 1957 [13]. In the late 20th century, a more comprehensive hydrogeologic framework was established that led to several numerical models for the confined sandstone aquifer in

northeastern Wisconsin [16–21]. In the last decade, research in and near the Northeast GMA has focused on bedrock mapping [22,23], structural mapping [22,24], and water age, quality, and quantity [25–29].

In response to potential unsustainable groundwater use, Wisconsin's Groundwater Protection Act, 2003 Wisconsin Act 310 [30], expanded the state's authority to consider environmental impacts of high capacity wells and instituted a framework for addressing water quantity issues in specific geographic areas of the state. The legislation directed the Wisconsin Department of Natural Resources (WDNR) to establish two GMAs in response to aquifer drawdowns. The two initial GMAs were established in northeastern and southeastern Wisconsin (Figures 1 and 2) in regions that obtain much of their groundwater from a confined, eastward dipping lower Paleozoic sandstone aquifer. The GMA boundaries were designated in or near areas in which "the groundwater potentiometric surface has been reduced 150 feet (45.7 m) or more from the level at which the potentiometric surface would be if no groundwater had been pumped" [30]. Future GMAs could be defined by using other criteria such as change in flow or impacts to surface waters rather than change in head, depending on conditions in those areas.

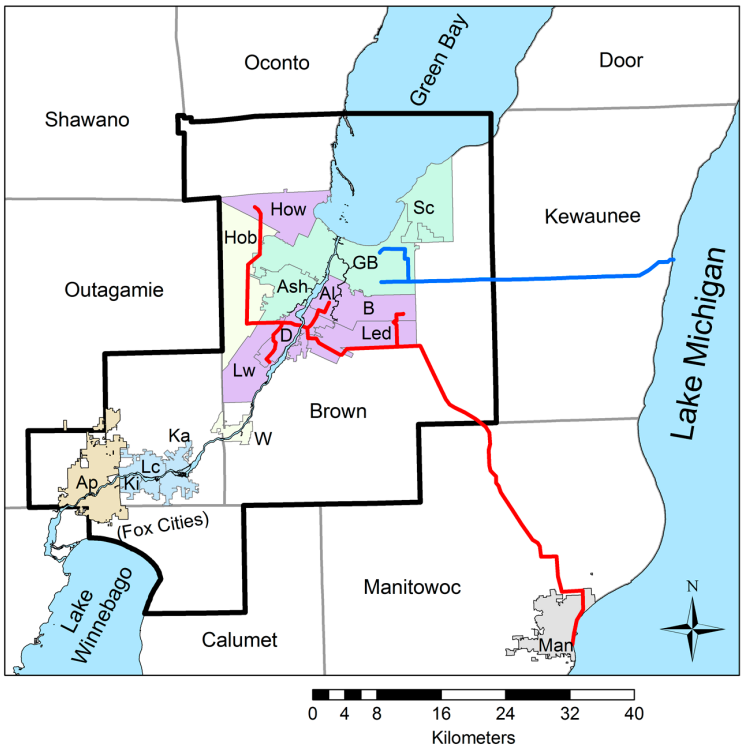

Figure 2. Map of the Northeast GMA (bold black line) illustrating the location of relevant municipalities and surface water pipelines described in this paper. In the region of central Brown County, municipalities served by the Green Bay Water Utility's pipeline (blue) are Green Bay (GB), Ashwaubenon (Ash) and Scott (Sc), Hobart (Hob), and Wrightstown (W). Communities served by the Central Brown County Water Authority's pipeline (red) include Bellevue (B), Allouez (Al), Ledgeview (Led), De Pere (D), Lawrence (Lw), and Howard (How). Areas to the south include the "Fox Cities" of Kimberly (Ki), Little Chute (Lc), and Kaukauna (Ka) and Appleton (Ap). The Fox River connects Lake Winnebago to Green Bay.

1.3. Purpose of the Research

This article presents the history of the Northeast GMA in Wisconsin (Figure 2), with a focus on recent water level changes since 2005. Figure 3 shows a timeline of major changes in the Northeast GMA that can help the reader place historical events into a broader context. In this article, we present a history of groundwater management and corresponding aquifer water level changes in a groundwater

management area in the central United States. We provide this example as an illustration of how this particular society dealt with changes in sustainability of its groundwater resources over the course of more than a century.

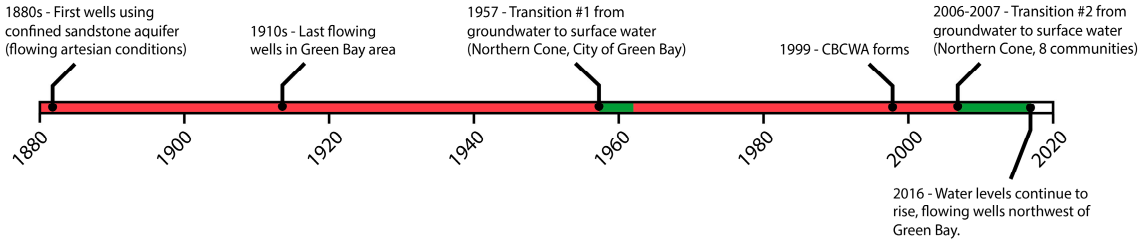

Figure 3. Timeline of major events in the Northeast Groundwater Management Area. Red periods indicate intervals of aquifer drawdown, while green periods indicate periods of aquifer recovery.

2. Geologic and Geographic Setting

2.1. General Geography of Eastern Wisconsin

Wisconsin lies at the junction of the Superior uplands in the north, and several subsections of the Central Lowlands Province in the United States. The region has a humid continental climate and cold winters, with mean annual precipitation (liquid equivalent) between 75 and 84 cm [31]. Its population is just under 5.7 million people [32], with the largest density in the eastern and southeastern portions of the state. The largest municipalities in the Northeast GMA include Green Bay and surrounding communities in central Brown County, as well as the "Fox Cities" region from Appleton to Kaukauna along the Fox River in Outagamie County (Figure 2).

2.2. Geology and Hydrostratigraphy of Eastern Wisconsin

The bedrock geology of eastern Wisconsin consists of a complex array of eroded Precambrian crystalline rocks, overlain by a sequence of Paleozoic marine rocks that are as much as 700 m thick (Figure 4). These units dip eastward away from central Wisconsin, toward the Michigan basin in the east (Figure 4b). Overlying these rocks are Pleistocene glacial, glaciofluvial, and glaciolacustrine sediments that range in thickness from 0 m to over 100 m and are important confining layers in parts of the region [33,34]. Table 1, Figure 4, and Supplementary File S3 present a generalized hydrostratigraphy and structure for northeastern Wisconsin. Additional details are available in Krohelski [16], Luczaj [24], and Luczaj et al. [35].

The Paleozoic strata in the Northeast GMA can be separated into three hydrostratigraphic groups. The lowermost groups include the Cambrian-Ordovician sandstone and dolostone units that are informally known as the "confined sandstone aquifer" in the region. The Cambrian units are generally 120 m thick high conductivity ultramature quartz sandstone, with lesser amounts of shale and dolomitic and glauconitic sandstone. The overlying Prairie du Chien and Ancell groups constitute the remainder of the confined Cambrian-Ordovician sandstone aquifer. The Ancell Group is dominated by the St. Peter Sandstone, an exceptionally mature quartz sandstone that fills a network of unconformity generated paleovalleys up to 100 m deep [17,24,36]. Together, this ~180 m sequence of Cambrian-Ordovician rocks is treated as one confined aquifer.

The Ordovician Sinnipee Group (aka Trenton-Black River Group) and the Late Ordovician Maquoketa Shale are two significant low permeability units overlie the Cambrian-Ordovician sandstone aquifer and act as regional confining layers and are about 160 to 210 m thick. The Sinnipee Group is a uniform 61 m thick and is mainly tight dolostone with a minor shale layer in the middle. The Maquoketa Shale is only present in the eastern half of the GMA (Figure 4). The uppermost Paleozoic bedrock unit present in the region is a set of four Silurian dolostone formations that are typically treated as a single unconfined karst aquifer [9,24]. The units range in thickness from a few

meters near parts of the Niagara Escarpment to nearly 150 m thick in the eastern part of the GMA. Pleistocene glacial, glaciofluvial, and glaciolacustrine sediments are spatially variable in thickness and hydraulic conductivity, but they typically act as important confining layers in the Northeast GMA because of their clay-rich characteristics [16,18,34,37].

It is important to note that the confined sandstone aquifer is not in hydrologic communication with surface water bodies such as the Fox River, Lake Winnebago, or Green Bay (Figure 2) because the recharge zone for the sandstone aquifer is located to west, and the upper Ordovician bedrock units and the Pleistocene sediments act as effective confining units across the Northeastern GMA. This is corroborated by ^{14}C dating, noble gas chemistry, and stable isotopes suggesting recharge by subglacial meltwater from the Green Bay Lobe of the Laurentide Ice Sheet between about 12,000 and 25,000 years ago [27,29].

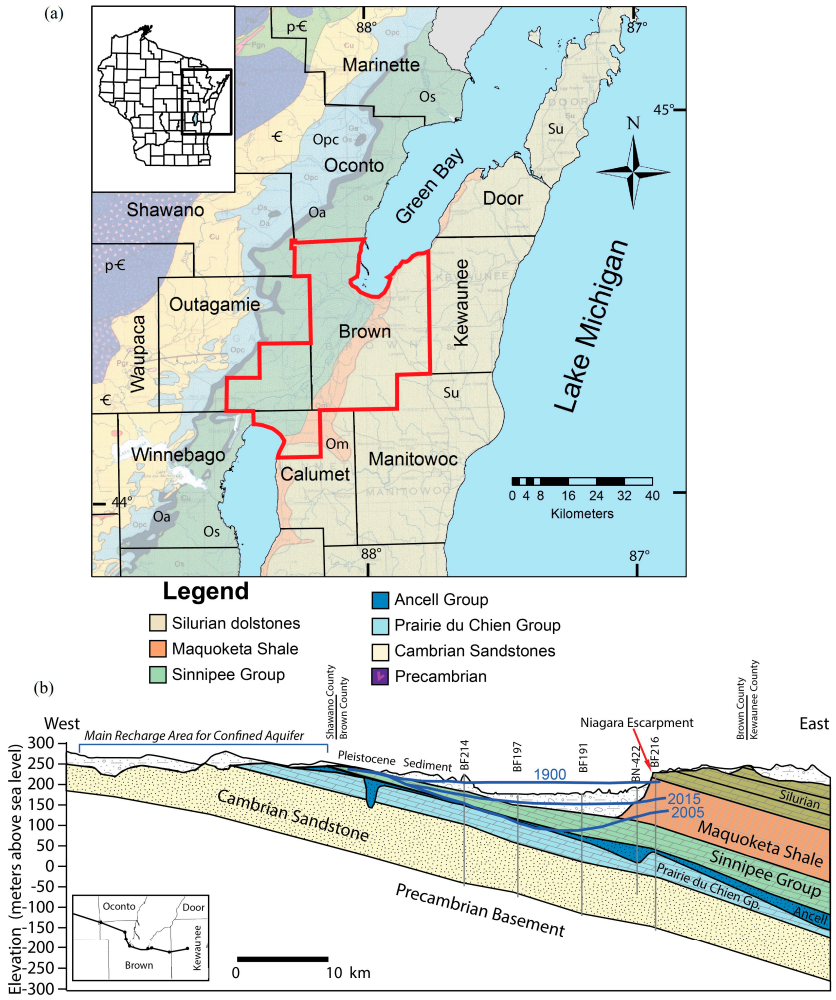

Figure 4. Geology of northeastern Wisconsin. (**a**) Bedrock geologic map with the northeast GMA outlined in red. Names indicate counties. Inset map shows the location in the state of Wisconsin, USA. Base map after Mudrey et al. [38] shows the following units: pЄ = Precambrian, Є = Cambrian sandstones, Opc = Ordovician Prairie du Chien Group, Oa = Ordovician Ancell Group, Os = Ordovician Sinnipee Group, Om = Ordovician Maquoketa-Neda formations, and Su = Silurian dolostones; (**b**) West to east cross section through portions of Shawano, Brown, and Kewaunee counties, Wisconsin [35]. Paleozoic strata typically dip southeastward between about 5 and 7.5 m/km toward the ancestral Michigan basin. Vertical lines with labels indicate Wisconsin Unique Well Numbers (WUWN) for wells in the Green Bay region of Brown County. Blue lines with years show confined aquifer potentiometric levels for predevelopment (ca. 1900), 2005, and 2015. Vertical exaggeration is 45 times.

Table 1. General hydrostratigraphy within the Northeast Groundwater Management Area of Wisconsin (after [5,16,19,21,25,26]).

Geologic Age		Geologic Unit (Thickness, Meters)	Lithology	Hydrostratigraphic Unit
Cenozoic	Quaternary (Pleistocene)	Unconsolidated deposits (0–60 m) Locally > 100 m	Lacustrine silt and clay, glacial till, fluvial sand and gravel, and other deposits.	Local unconfined aquifer (sand and gravel; Kh = 4.1×10^{-3} cm/s) or regional confining unit (lacustrine clays and glacial till; Kv = 2.5×10^{-6} cm/s)
Paleozoic	Silurian	Undifferentiated (0–150 m)	Dolostone; fractured and karsted in many locations.	Upper Aquifer; Karsted in many locations of northeastern Wisconsin. (Kh = 3.4×10^{-3} cm/s)
	Ordovician	Maquoketa Formation (0–150 m)	Shale, dolomitic shale, and dolomite.	Confining Units; Sinnipee Group Carbonates are locally used as aquifers for domestic use. (Kv = 1.2×10^{-8} cm/s)
		Sinnipee Group (120 m)	Dolostone with some shale.	
		Ancell Group (0–100 m)	Silty sandstone, fine- to medium-grained sandstone, sandy shale. Fills paleovalleys.	Upper Unit of the Confined Sandstone Aquifer (Kh = 1.7×10^{-3} cm/s)
		Prairie du Chien Group (0–60 m)	Dolostone with varying amounts of oolitic chert and minor interbedded sandstone.	Generally an aquitard relative to the adjacent sandstones in eastern Wisconsin, but locally an aquifer for domestic use.
	Cambrian	Trempealeau Group (0–15 m)	Fine- to medium-grained sandstone with some silty glauconitic dolomite.	Lower Unit of the Confined Sandstone Aquifer (Kh = 5.3×10^{-4} cm/s; up to Kh = 2.9×10^{-3} cm/s for the Elk Mound Group)
		Tunnel City Group (30–46 m)	Fine- to medium-grained sandstone, silty sandstone to sandy dolomite. Abundant glauconite commonly observed.	
		Elk Mound Group (75–90 m)	Very-fine to coarse-grained sandstone.	
Precambrian	Precambrian	Undifferentiated	Crystalline rock, predominantly red granite, contains igneous and metamorphic rock. Limited sedimentary rocks (sandstone, dolostone)	Yields little to no water in many cases. Not used as an aquifer in the Northeast GMA.

3. Methods

Existing publications, available digital records, historic paper records, and direct contact of high capacity well operators were used to compile the history of the Northeast GMA in Wisconsin. Pumping estimates and water levels were made only for the confined sandstone aquifer. An analysis for Silurian or Pleistocene aquifers is beyond the scope of this article.

Recent pumping data through 2014 were obtained from WDNR records [39]. Estimates for residential water use from the deep aquifer by domestic self-supplied wells was made using methodology defined by Maas [26], along with a WDNR database [40].

Long-term records of water levels include observation wells monitored by the Wisconsin Geological & Natural History Survey (WGNHS) and the United States Geological Survey (USGS) (e.g., [41]), and static water levels from municipal well operators. High-quality data from WGNHS and USGS are reported to the nearest ~3 mm. Complete or partial records of static water levels (SWLs) were compiled for 17 municipalities in or near the Northeast GMA (File S2). Most municipal well

water levels obtained using compressed air lines and pressure transducers reported water levels with a precision of 0.3 m and are considered are accurate to ±3 m [42]. Other municipal wells had more precise readings from pressure transducers or other equipment, with precisions of about ±0.08 m. Some municipal water level data were obtained from the WDNR database of static water level data for municipal well operators [43,44].

Contour maps for 1949, 1957, and 1960 were traced from existing publications and converted to standard international units. Contour maps for 1990 to 2015 were constructed in ArcMap 10.3 (ESRI, Redlands, CA, USA), using ordinary kriging and inverse distance weighting techniques and then traced in Adobe Illustrator (Adobe Systems, San Jose, CA, USA). Overall uncertainties for calculated water level elevations are estimated to be ±2–3 m. A complete set of contour maps is available in Supplementary File S1.

4. Early History of the Northeastern Wisconsin Groundwater Management Area (Predevelopment through Year 1998)

The history of the Northeast GMA is split into two major time periods. An early period includes predevelopment (late 19th century) through about the year 1998. Details from this period are available through a few key scientific publications and other sources that detail major changes in water use due to population and industrial growth, as well as changing water supply sources. The second time period includes the turn of the 21st century to the present and is the focus of this article (Section 5).

4.1. Predevelopment and Early Development Conditions of the Confined Sandstone Aquifer

Although the formal delineation of the Northeast GMA was made only in 2003, the confined sandstone aquifer in this region has been extensively used as a potable water source for well over a century. The earliest known use of groundwater from the confined sandstone aquifer in the Northeast GMA occurred during the 1880s in the cities of Appleton, Kaukauna, and De Pere [12–14]. Over a century ago, flowing artesian conditions for wells penetrating the confined sandstone aquifer were reported from many areas in eastern Wisconsin (Figures 5 and 6a), from the Milwaukee region in the southeast, all the way north to the Michigan border at Marinette [12]. In what is now the Northeast GMA, the initial hydraulic head of the wells reached 27.4 m above ground level in De Pere and 29.6 m above ground level in Green Bay. These were the strongest artesian flows observed in northeastern Wisconsin, although parts of southeastern Wisconsin had hydraulic head levels that reached at least 32.6 m above ground level.

In West De Pere, for example, the water pressures (275.8 kPa) were sufficient to convey water across the city distribution system for domestic and city uses and for fire protection between 1886 and 1905, even for two-story buildings [12]. Initial capacity of the individual flowing artesian wells in Green Bay and De Pere was about 3.78 ML/day. Although water level data are sparse for this period of time, Figure 6a shows a regional contour map of the potentiometric surface in the confined sandstone aquifer ca. 1900, constructed using data from [12].

By 1910, average daily pumping from the eight wells in the City of Green Bay was about 4.94 million liters. By 1915, pumping and leakage had decreased hydraulic heads to only 3.7 m in De Pere and 2.7 m above ground level in Green Bay. In De Pere, pumping plants and storage reservoirs were added as artesian pressures declined. At this point in time, at least 24.4 to 26.8 m of drawdown had already occurred in central Brown County.

In the southern portion of the GMA (i.e., near the "Fox Cities" region), flowing wells were also common in the early 20th century, with hydraulic heads as much as 10.7 m above ground level in Kaukauna [12]. While the confined sandstone aquifer was sufficient to develop municipal water supplies for Kimberly, Kaukauna, and Little Chute, groundwater supply was apparently insufficient for the city of Appleton, which had already changed its water supply to the Fox River by 1915.

Industrial development in the Fox River Region during the early 20th century resulted in increasing population and industrial demand for water. By the late 1940s, water levels had been

lowered dramatically (Figure 6b), and by the early 1950s, water quantity problems were a concern limiting growth in Green Bay [45]. By the mid-1950s, water levels had declined substantially from predevelopment conditions in central Brown County, as well as in the Fox Cities region in in the southern portion of the GMA. Drescher [14], LeRoux [15], and Knowles [13] describe the hydraulic conditions during the 1950s in the confined sandstone aquifer in Outagamie County and central Brown County. By 1957, net drawdown in the central Brown County region was approximately 126 m from predevelopment conditions, with the potentiometric surface elevation in the center of Green Bay at 78 m above sea level [13] (Figure 6c).

Less is known at this time about the drawdown near the Fox Cities in southeastern Outagamie County, as no clear cone of depression had been fully mapped in the southern part of the GMA. However, a comparison of data from Weidman and Schultz [12] and LeRoux [15] suggest drawdown of the potentiometric surface in Kaukauna was at least 22.9 m below predevelopment conditions by 1954, with as much as 10.6 m of this drawdown occurring between 1947 and 1954. This left few remaining flowing artesian wells in the region [15].

Knowles [13] provides a thorough description of the pumping changes and corresponding confined aquifer water level changes that occurred in central Brown County during the middle of the 20th century. In central Brown County, groundwater withdrawals from the confined sandstone aquifer averaged about 22.7 ML/day by 1940, 37.8 ML/day in 1950, and 49.2 ML/day in the first half of 1957.

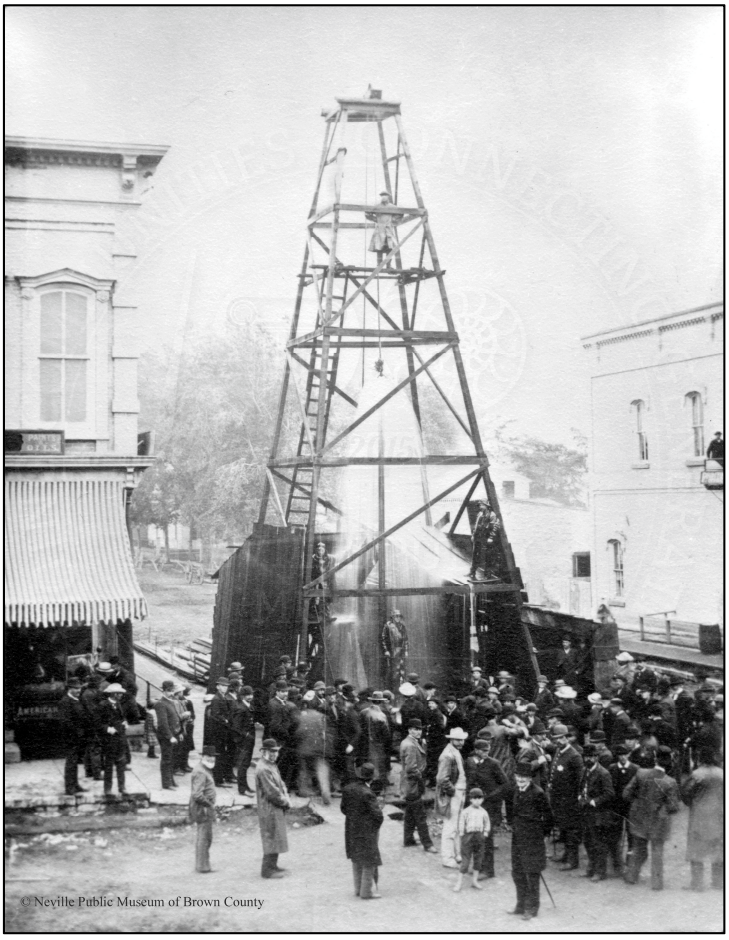

Figure 5. Photograph of flowing artesian conditions encountered during drilling of a well into the confined sandstone aquifer in De Pere, Wisconsin ca. 1890. Image courtesy of the Neville Public Museum in Green Bay.

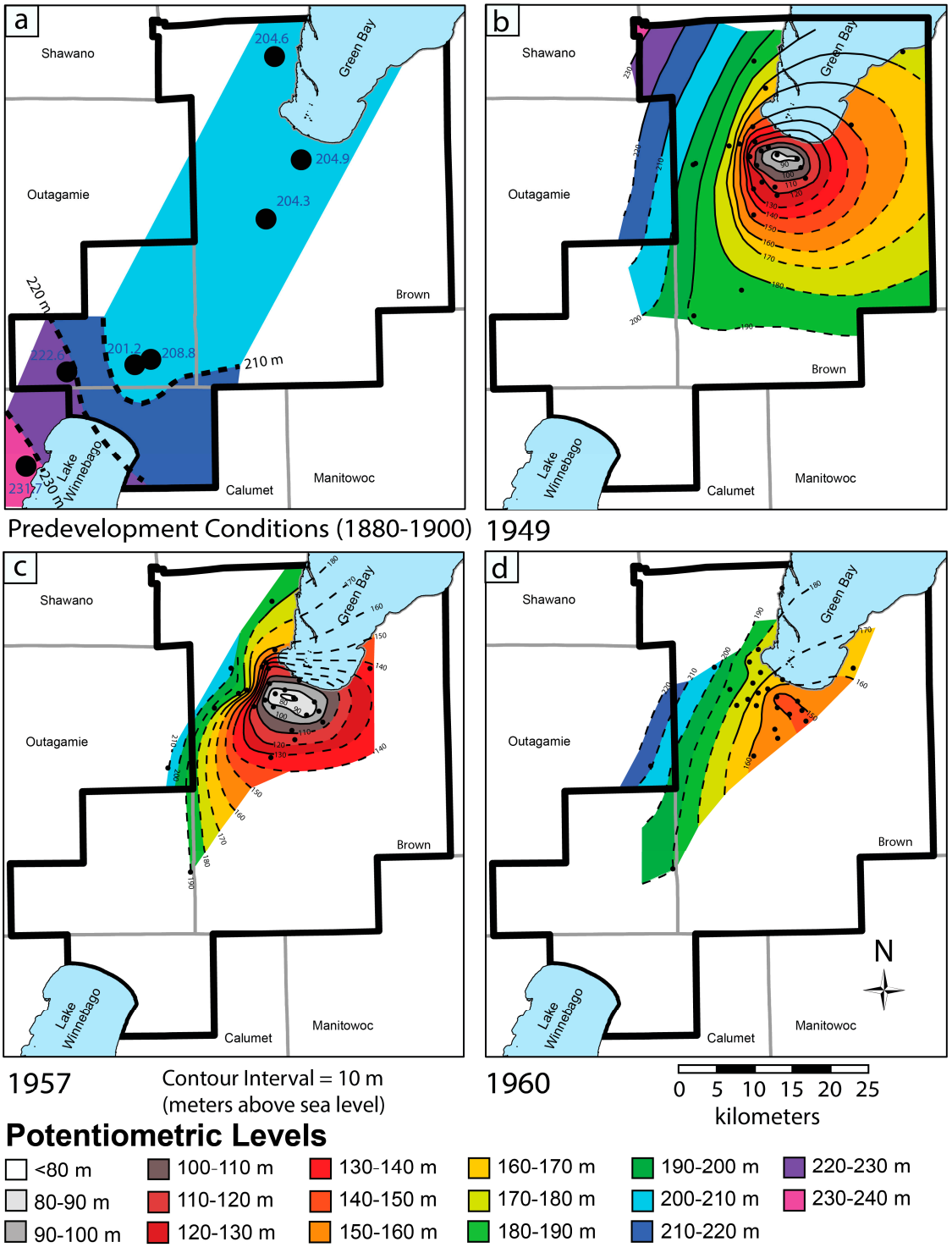

Figure 6. Regional maps of the potentiometric surface in the Cambrian-Ordovician confined sandstone aquifer from predevelopment conditions through the first transition from groundwater to surface water. For reference, the bay of Green Bay is 176.8 m above mean sea level. White color indicates areas with no data. (**a**) Water levels circa 1900 with the best known estimate of the predevelopment conditions in the aquifer using data from [12]; (**b**) The potentiometric surface during 1949 [14]; (**c**) The potentiometric surface during 1957 [13], immediately predating the first transition from groundwater to surface water by the City of Green Bay in 1957; (**d**) The potentiometric surface during 1960, three years after the first transition from groundwater to surface water by the City of Green Bay in 1957 [13].

4.2. Transition #1—1957–1960 Switch by City of Green Bay to Surface Water Pipeline

Plans to make the first switch from groundwater to surface water supplies began in 1953 when a study by the Green Bay Water Commission warned that aquifer levels were falling in Brown County. Two years later in 1955, the Green Bay Water Commission voted to build a water pipeline to Lake Michigan at a cost of $5 million, which was approved by the city council and the mayor. At this time, the nearby villages of De Pere and Allouez refused to join the regional water commission for political and economic reasons [46]. They likely reasoned that the reduced use by Green Bay would increase the amount of groundwater available for their communities. This decision was not without political consequence. After unsuccessful reelection, all members of the city council and the mayor of Green Bay were replaced. In 1955, the City of Green Bay was sued to stop construction of the pipeline. The Wisconsin State Supreme Court ruled in favor of the Green Bay Water Commission allowing for construction of the pipeline to begin [47].

Completion of the new 43 km pipeline between Green Bay and Lake Michigan (Figure 2) occurred in 1957. At this time, Green Bay stopped using most of its wells, allowing for major regional recovery of the northern cone of depression centered beneath central Brown County. Cessation of pumping by Green Bay during August 1957 resulted in an overall reduction in pumping from the confined aquifer from about 49 million liters per day to about 20.8 million liters per day after the switch to surface water. This resulted in rapid recovery of the potentiometric surface in central Brown County. Within just 3 years between 1957 and 1960, the potentiometric surface in the center of the northern cone rose from about 78 m above sea level to around 148 m above sea level, with a maximum recovery of up to 87.8 m on the west side of Green Bay [13] (Figure 6).

4.3. Regional Growth (1960–2000)

During the following decades, the population of the Green Bay metropolitan region increased, especially in De Pere, Allouez, and other communities surrounding Green Bay that still relied on groundwater from the deep sandstone aquifer. The focus of major pumping shifted southward to De Pere and Allouez in central Brown County. Figure 7 illustrates both the major recovery in 1957, as well as the subsequent water level fall due to regional growth from 1960 to about 2005.

In the mid to late 1970s, predictions were made warning of groundwater shortages within 10 to 20 years for central Brown County. Engineers predicted an additional drawdown of 8.2 to 9.1 m/year if the City of Green Bay began pumping 37.9 ML/day. They also recommended that regardless of whether Green Bay decided to utilize its wells again that metropolitan communities surrounding Green Bay should proceed as rapidly as possible to develop an alternative water supply source due to eventual water level declines that would render their wells inadequate [48]. By 1979, about 49 ML per day were being pumped from Brown County [16]. This led to a 1980 lawsuit by the City of De Pere to prevent Green Bay from using its wells during the summer months, which constituted the seasonal demand peaks. Green Bay agreed to voluntarily shut down their wells for the specified time period [46].

Subsequent water use studies warned that groundwater levels in Brown County would continue to fall, with a corresponding rise in contaminants such as dissolved arsenic and radium. Figure 8a illustrates the potentiometric surface in the Northeast GMA during 1990. In 1992, The Brown County Planning Commission Potable Water Study Committee concluded that serious groundwater supply issues were imminent and groundwater could not supply the long-term needs of the Green Bay area communities. They recommended that a lake water source be pursued [49].

In a continuation of decades of political disagreement, the City of Green Bay mayoral race resulted in the first new mayor in 16 years. Campaign slogans such as "No Giveaway of Water System to Suburbs" indicated how important the issue was to the region [46].

Walker et al. [20] concluded that all of the water demand for the southern portion of the GMA through the year 2030 could be supplied by groundwater if communities in the central Brown County converted to surface water sources. This claim might not have been accurate for several reasons. First,

Conlon's 1998 model underestimated drawdown by approximately 15 m in Brown County wells, possibly due to the limited information on structural faults, stratigraphic variations in the sandstone aquifer, and the thickness of unconsolidated Pleistocene glacial deposits that act as a confining layer. In addition, little was known about aquifer compartmentalization in the 1990s in the Northeast GMA, but subsequent research suggests that a major east-west dip-slip fault trends between the two cones of depression [22,24] and likely acts as a major hydrologic barrier for the confined sandstone aquifer [28,29].

A potentially important effect of drawdown is the geochemical reactions that can take place in the event that water levels are lowered to a position below the base of the confining layer (i.e., below the top of the aquifer). Northeastern Wisconsin has an extensive regional groundwater quality problem with arsenic and other metals related to oxidation of a sulfide cement horizon at the top of the Ancell Group (e.g., [35,50,51]). While this problem is most prevalent along the western border of the Northeast GMA, a concern is that dewatering of the top of the Ancell Group near the center of the northern cone of depression might oxidize sulfide minerals in the aquifer. Several wells in the northern cone were observed to have water levels below the top of the Ancell Group as early as 1950 [14], but the water quality implications of this event are not known. More recently, Maas [26] demonstrated that several wells in the northern cone again had water levels below the top of the confined sandstone aquifer in 2005, and in at least one case as recently as 2011. While ongoing research is evaluating this issue, it does not appear that significant problems related to oxidation have impacted municipal supply wells, but data are limited.

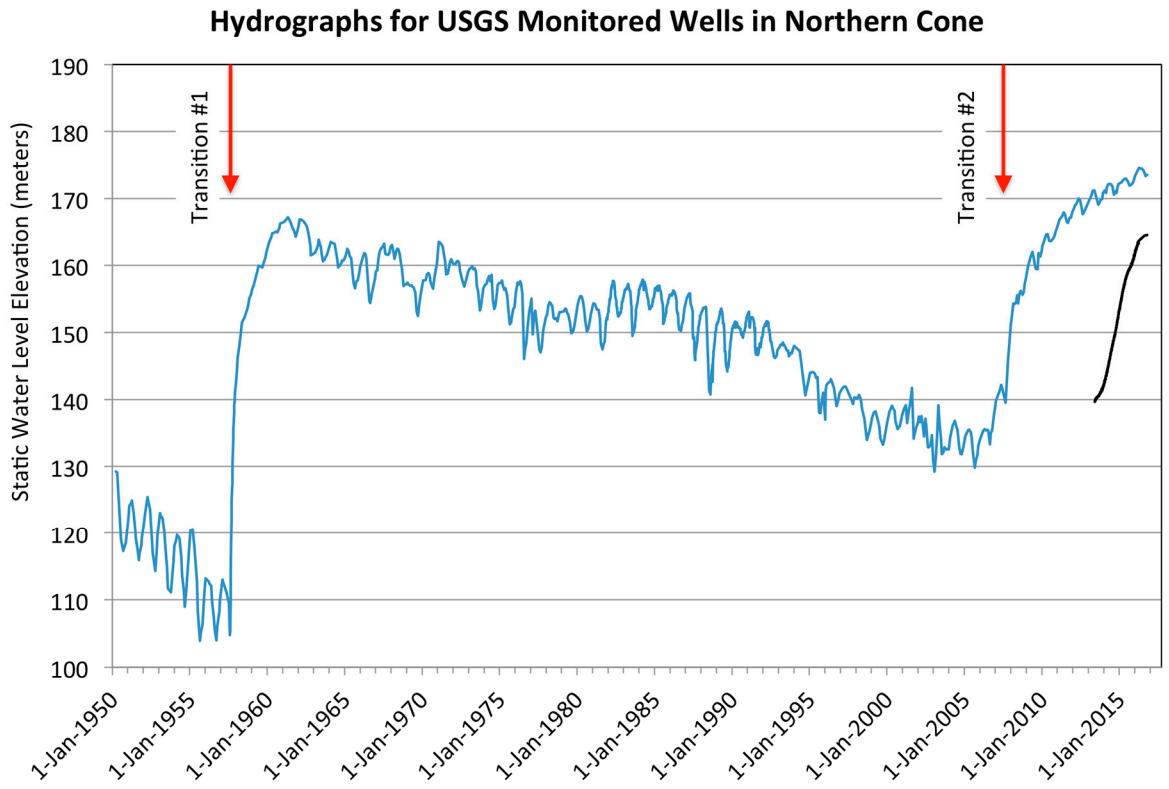

Figure 7. Long-term hydrographs of USGS monitoring wells in Green Bay region (central Brown County) from [41]. Red arrows indicate the two major transitions from groundwater to surface water supplies by Brown County municipalities in 1957 and 2007. Blue line is well BN-076, and Black line is well BN-0435. Note that the drawdown for BN-076 was not as significant at this location because it is on the northern edge of the cone of depression, and by 2005, the northern cone had moved southward to De Pere. BN-0435 is located near the center of the northern cone, but was not installed until after most of the recovery had already occurred.

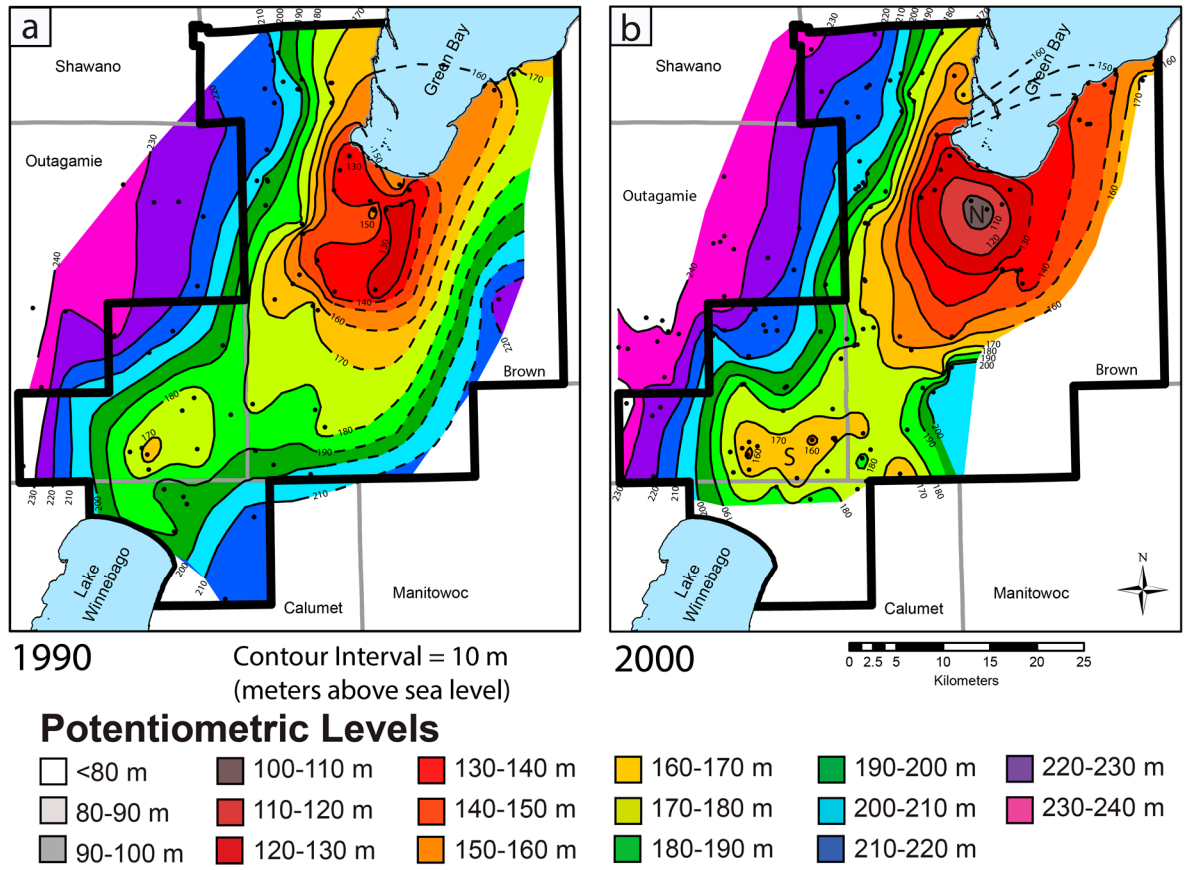

Figure 8. Maps of the potentiometric surface in the Cambrian-Ordovician confined sandstone aquifer during (**a**) 1990 and (**b**) 2000. "S" indicates the location of the southern cone of depression near the Fox Cities region. "N" indicates the location of the northern cone of depression in central Brown County near Green Bay and De Pere. Well locations are from Maas [26].

5. Recent History of the Northeastern Wisconsin Groundwater Management Area (1998–Present)

5.1. Formation of the Central Brown County Water Authority

A consortium of 12 Brown County municipalities formed in 1998 and was followed by negotiations between Green Bay and other municipalities in 1999. In 1998, the Central Brown County Water Commission introduced state legislation that allowed for the formation of joint water authorities in Wisconsin. In 1999, the Central Brown County Water Authority (CBCWA) was formally established under the new state law. In the same year, the City of Manitowoc, located approximately 56 km to the southeast of Green Bay along Lake Michigan (Figure 2), built a new microfiltration water treatment facility with substantial additional capacity.

5.2. Radium Regulations as the Driver for a Second Transition

A major turning point leading to the second major groundwater to surface water transition in the Northeast GMA occurred during 1998. The United States Environmental Protection Agency (USEPA) set December 2006 as the deadline requiring all municipalities to meet federal drinking water standards for dissolved radium. The standard limited combined radium (^{226}Ra and ^{228}Ra) to a threshold of 5 pCi/L (0.185 Bq/L), and fines of $5000 per day were to be levied for municipalities that exceeded this value. The Northeast GMA is located within a region of high dissolved radium levels, and most municipal wells in central Brown County would exceed the new USEPA standard for dissolved radium. By the year 2000, water levels continued to decline (Figures 7 and 8b).

Between 2000 and 2002, disagreements over whether Green Bay or the Central Brown County Water Authority would maintain control of the pipelines was seen as a major impediment to cooperation. The City of Green Bay did not give up pipeline control without prorated costs of the existing pipeline since construction in the 1950s being paid by the suburbs. Several CBCWA members refused any compensation to Green Bay because they wanted all rates to be the same. Along with election of a new Green Bay mayor in 2003, and subsequent changes to water commissioners and other personnel, it was clear that no deal was possible and that certain suburbs refused to buy water from Green Bay. As a result, Green Bay became a "defunct" member of the CBCWA. Additional political events resulted in the breakup of the original 12-member CBCWA [46,52]. In 2004, the village of Ashwaubenon and the Town of Scott agreed to a separate deal to buy water from the Green Bay Water Utility. Three other municipalities left the CBCWA and opted to keep their confined aquifer wells in operation.

In 2004, the CBCWA finalized an agreement with the City of Manitowoc to obtain water from their new treatment plant, which resulted in the decision to build another 105 km (65 mile) long pipeline at an estimated cost of $106 million USD. By 2005, the CBCWA members consisted of Allouez, Bellevue, De Pere, Howard, Lawrence, and Ledgeview. The total pipeline cost, including recently added storage facilities is more than $130 million [53]. In 2006, the Green Bay Water Utility built a second pipeline parallel to its existing pipeline at an estimated $35 million, which resulted in additional capacity for Scott, Ashwaubenon, and others in the future.

During this same period, Wisconsin Act 310 directed the WDNR to establish two GMAs for portions of the state in which the potentiometric surface has been reduced by at least 150 feet (45.7 m) (see Section 1.2). The timing of this legislation was beneficial to our understanding of the second major transition from groundwater to surface water in the Northeast GMA.

5.3. Transition #2—2005 to Present Switch by Several Communities in Central Brown County

By 2005, the two well-developed cones of depression are at their maximum drawdown values (Figure 9a). The "northern cone" is represented by communities in central Brown County and is centered near De Pere and Allouez, just south of Green Bay. Water level elevations in wells open to the confined sandstone aquifer were similar to those in early 1957 before the first transition to surface water by Green Bay. At this time, the maximum total drawdown from predevelopment conditions occurred, with approximately 128.6 m of total drawdown near the center of the northern cone. The "southern cone", which was located in southeastern Outagamie County and centered over the Fox Cities region of Kaukauna, Kimberly, and Little Chute also experienced significant drawdown.

The main transition from groundwater to surface water by 8 communities took place during 2006 and 2007. The village of Ashwaubenon and the Town of Scott switched in 2006 by connecting to the Green Bay Water Utility system. The remaining six communities constituting the CBCWA switched by late summer 2007, after construction problems delayed completion by the end of 2006 USEPA deadline. Since that time, two other communities have followed. In 2011, the village of Hobart began using surface water from Green Bay Water Utility's pipeline, and the village of Wrightstown recently joined an extension of the same pipeline in Fall 2016.

Although some wells in these eight communities were permanently abandoned, most of these wells remain functional and have been placed on emergency backup status, similar to the municipal wells in Green Bay. In the event that pipeline problems or other reasons require the regions backup wells to return to service, these wells have a reduced frequency of water quality testing. Nitrate and bacteria, however, are sampled either monthly or quarterly, depending on the municipality.

Figures 10–12 present the pumping history for parts of the Northeast GMA between 2006 and 2014. A clear change in pumping rates for municipalities in the northern cone occurred between 2006 and 2008 (Figure 10). A clear seasonal signal is present due to higher demand during summer months, in part due to irrigation wells for golf courses, swimming pools, etc. No substantial changes

in pumping occurred in the southern cone (Figure 11) during this period. Total pumping for the entire Northeast GMA, including outlying areas, is shown in Figure 12.

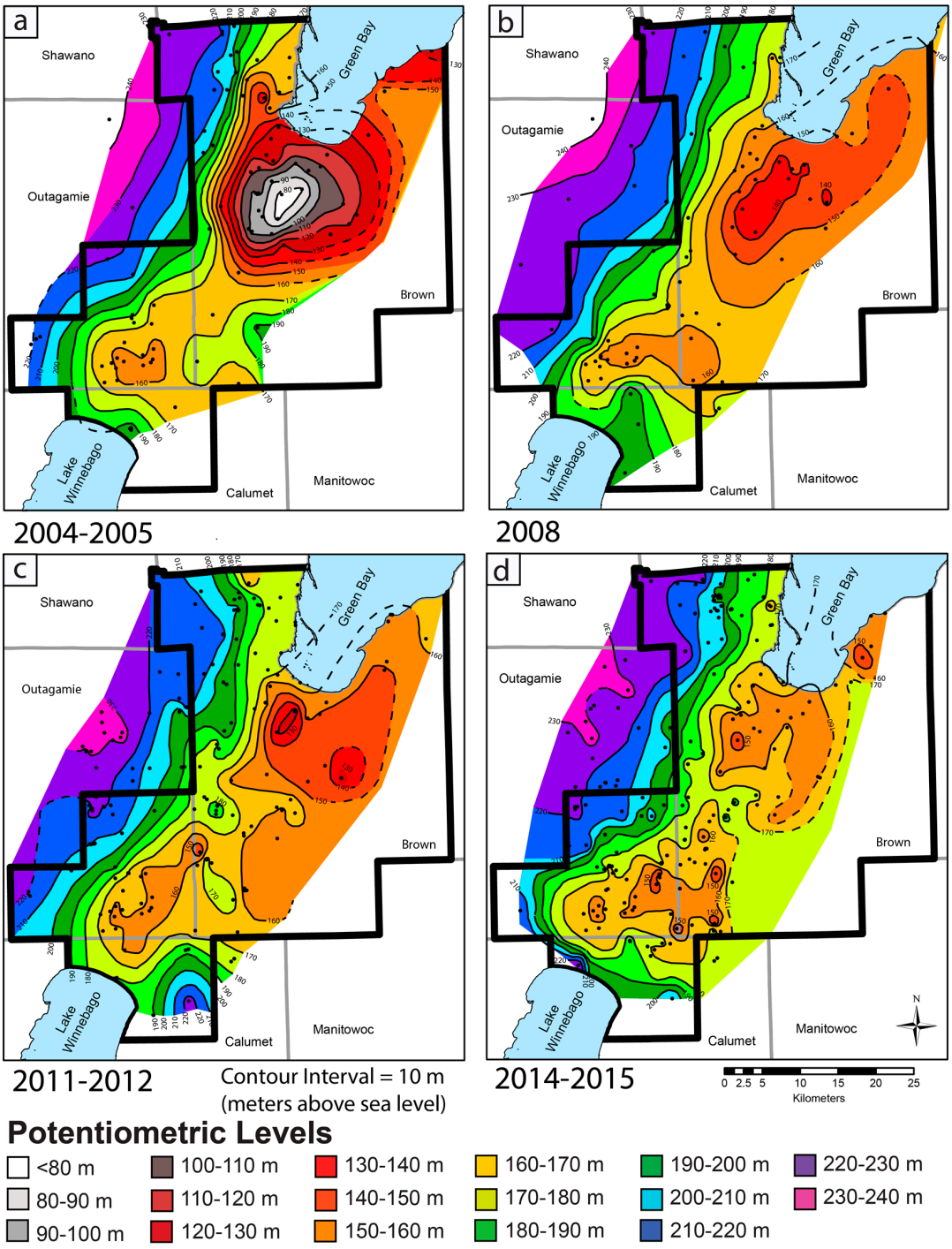

Figure 9. Maps of the potentiometric surface in the Cambrian-Ordovician confined sandstone aquifer illustrating the second major transition from groundwater to surface water in central Brown County. (**a**) Water levels during 2005 and immediately before the second transition by eight surrounding communities. Compare 9a to Figure 6c to see how the position of the northern cone shifted southward about 6 km due to water use changes in the northern cone; (**b**) Water levels during 2008, just after the transition, illustrating the major recovery that had occurred in the northern cone; (**c**,**d**) further recovery of the northern cone occurs by 2011–2012 and 2014–2015, respectively, while continued drawdown occurs in the southern cone.

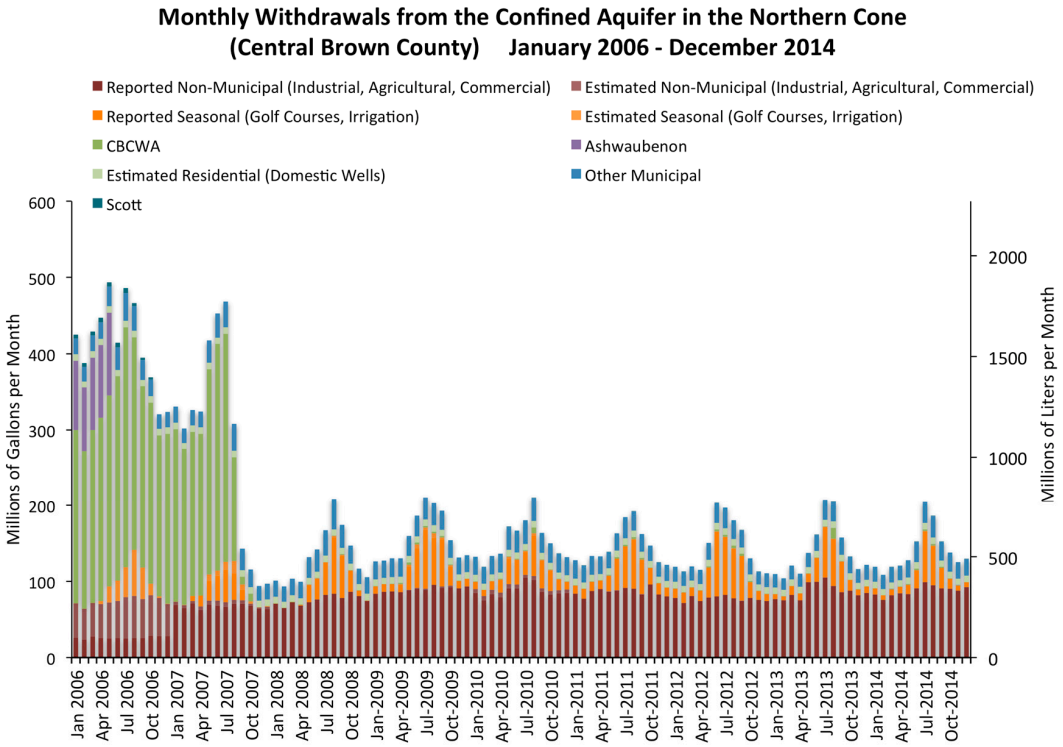

Figure 10. Monthly groundwater withdrawals from central Brown County (Northern Cone) between 2006 and 2014.

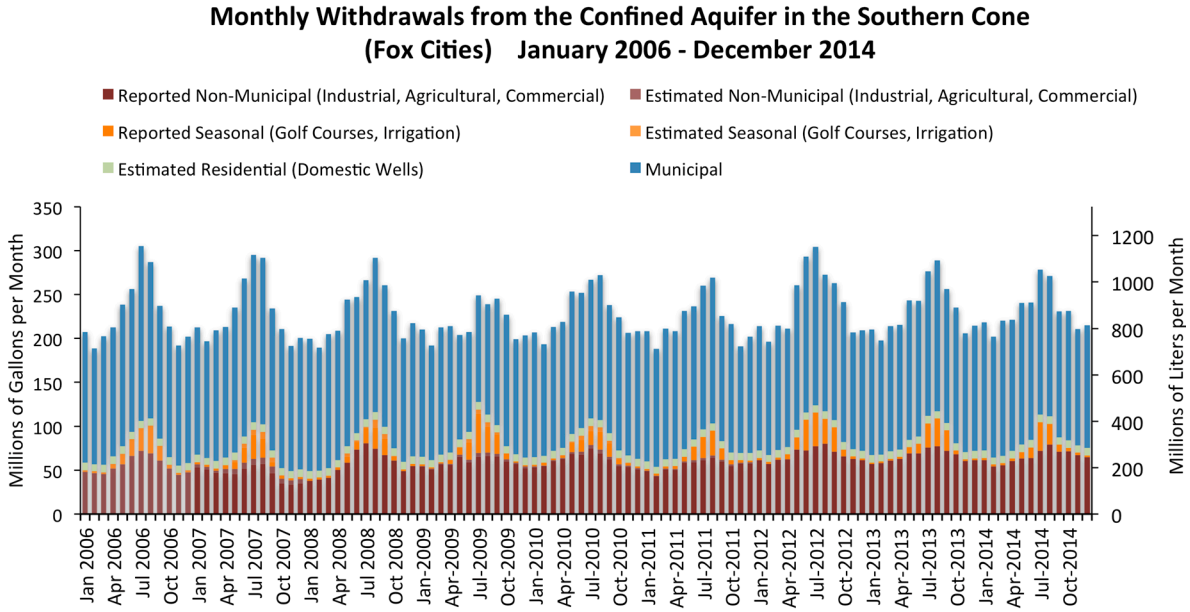

Figure 11. Monthly groundwater withdrawals from the Fox Cities region (Southern Cone) between 2006 and 2014.

A significant change in the type of water use occurred during Transition #2. Before the switch, total pumping in central Brown County was about 62.23 ML/day (Table 2), with municipal pumping comprising about 80% of total groundwater use. After the switch, total pumping in central Brown County decreased to about 15.86 ML/day (Table 3), with industrial pumping now comprising the majority of groundwater use.

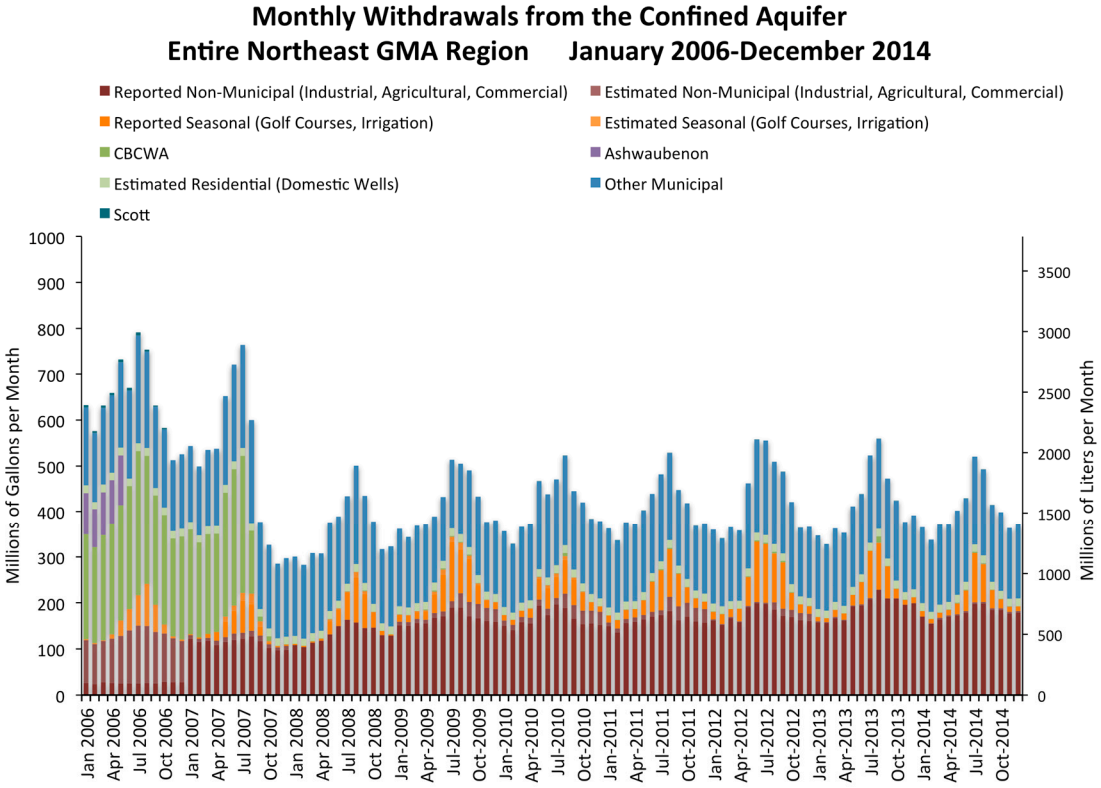

Figure 12. Monthly groundwater withdrawals from the entire Northeast Groundwater Management area between 2006 and 2014.

Table 2. Water use categories for water withdrawn from the confined sandstone aquifer in Central Brown County **before** eight communities switched from groundwater to surface water during 2006–2007. Data are calculated from [26].

Category	Volume (ML/day)	Percent of Total (October–March)	Percent of Total (April–September)
Municipal	49.6	83.0	77.1
Industrial	9.1	15.2	14.1
Seasonal (Irrigation) [1]	0.0–4.5	<1	7.1
Residential	1.06	1.8	1.7
Total:	**59.73–64.28 (ave. 62.23)** [2]	**100**	**100**

[1] Seasonal water use is mainly April through September; [2] Weighted average.

Table 3. Water use categories for water withdrawn from the confined sandstone aquifer in Central Brown County **after** eight communities switched from groundwater to surface water during 2006–2007. Data are calculated from [26].

Category	Volume (ML/day)	Percent of Total (October–March)	Percent of Total (April–September)
Municipal	3.14	23.6	17.6
Industrial	9.1	68.4	51.0
Seasonal (Irrigation) [1]	0.0–4.5	<1	25.5
Residential	1.06	8.0	5.9
Total:	**13.29–17.83 (ave. 15.86)** [2]	**100**	**100**

[1] Seasonal water use is mainly April through September; [2] Weighted average.

Transition #2 is well illustrated during this period by hydrographs from various central Brown County wells in the confined sandstone aquifer. Figure 7 (above), Figure 13a, and Supplementary File S2 present selected wells from central Brown County that show rapid recovery of the potentiometric surface between 2005 and 2008, followed by continued rising water levels to the present day in some areas. Total recovery has been at least 45.7 to 58 m in the northern cone since the transition, based upon water level records supplied by the Green Bay Water Utility. For example, in northern Green Bay (Figure 7), water levels are at their highest levels since at least 1950. More distally located wells, such as the village of Pulaski northwest of Green Bay, showed no major changes, despite their presence in the Northeast GMA (see Supplementary File S2).

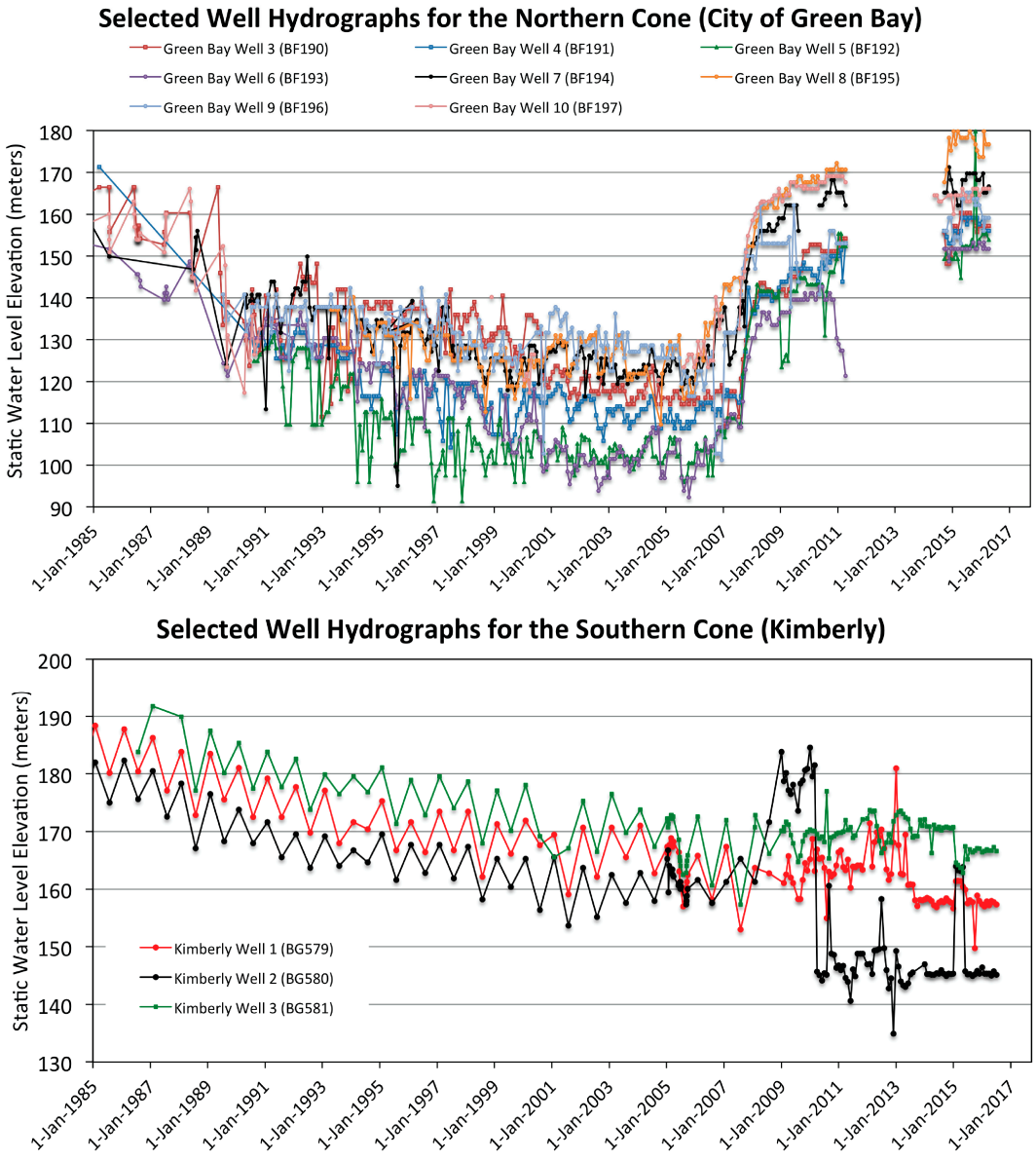

Figure 13. Hydrographs of selected municipal wells in the Northeast GMA over the past 30 years. (**a**) Hydrographs for the northern cone show a steady decline until 2006–2007 when the second transition from groundwater to surface water occurred and water levels rebounded dramatically. Data from April 2011 through mid-2014 were missing from the Green Bay Water Utility (GBWU) records; (**b**) Hydrographs for the southern cone show a long steady drop in water levels over time. The anomaly in Well 2 does not appear to be related to the transition from groundwater to surface water in the northern cone.

More recovery has occurred near the center of the cone, with lesser recovery near the margins, but the full magnitude of recovery is difficult to determine because wells closer to the center of the cone (De Pere and Allouez) are no longer capable of yielding water level measurements. However, observation well BN-0435 (Figure 7), situated near the center of the northern cone, has shown 35 m of recovery since installation in mid-2010, presumably after most of the potentiometric surface recovery had already occurred between 2006 to early 2010. Based on data from nearby wells in 2004–2005, as much as 67 to 88 m of recovery might have taken place at this location near the center of the northern cone between 2005 and 2016.

The southern cone shows a steady downward trend in water levels (Figure 13b) in the absence of significant changes in pumping rates (Figure 11). Reduction of pumping near the northern cone has apparently not significantly affected the southern cone. This may be due to several factors. First, the two cones are about 34 km apart. In addition, a major east–west fault is known to compartmentalize the aquifer and may act as a barrier to regional groundwater flow. Evidence for this includes changes in major ion composition and stable isotopic composition of hydrogen and oxygen on either side of the fault zone [28,29]. Additionally, pumping changes resulting from the 2016 switch to surface water by the village of Wrightstown, located between the two cones, are not captured by water level data available during this study.

Several contour maps of the potentiometric surface in the Cambrian-Ordovician confined sandstone aquifer illustrate the changes during the second transition period between 2005 and the present. Figure 9 shows a deep cone of depression centered near central Brown County that shallows between 2005 and 2015. By 2016, water levels in many central Brown County wells appear to have stabilized, but some areas continue to show increasing water levels (e.g., Figures 7 and 13a), albeit with a seasonal component due to differences in seasonal pumping rates.

While total drawdown from predevelopment conditions is more difficult to estimate for the southern cone, drawdown of at least 56.4 m has occurred in Kaukauna and Little Chute, and perhaps as much as 64 m in Kimberly. During mid-2016, SWLs in Little Chute well #3 indicated cumulative drawdown of about 78 m, although this might be temporary due to well maintenance scheduling.

6. Discussion and Implications

Globally, many areas suffer from declining groundwater levels and accelerating rates of depletion [1,54], and few aquifers have shown large-scale water level recovery due to improved management changes or alternative water supplies (e.g, [3,4,54] this study). In many cases, groundwater quality and quantity degradation occur due to increasing salinity, ground subsidence, and reduction in surface streamflow (e.g., [54]). However, the study area in northeastern Wisconsin does not suffer from these common effects because the principal aquifer is hosted by Paleozoic sandstone under confined conditions. In contrast, flowing artesian wells, flooding of quarries, and water quality changes relating to oxidation of sulfides appear to be of most concern.

6.1. Unintended Consequences

The recent transition from groundwater to surface water by 10 communities in Brown County might lead to specific unintended consequences including flowing wells, flooding of quarries, and possible spring activity. Many wells that are open to the confined sandstone aquifer have begun to flow since the transition to surface water in 2006 to 2007. These are most common to the northwest of Green Bay in the villages of Howard and Suamico. Well #3 in the village of Howard (Figure 2) began flowing in 2009 [26], and many residential and commercial wells open to the sandstone aquifer also flow seasonally or continuously in this area. This has led to concern that inactive, improperly abandoned wells might begin to exhibit flowing artesian conditions. Some of these wells may still exist and are typically located in the basements of buildings in the urban areas of Green Bay, or near former railroad fill stations, despite the long established requirement by WDNR to permanently abandon (fill and seal) these wells.

Another unintended consequence was accelerated flooding of a deep quarry resulting in flowing conditions. Also in the village of Howard, the Duck Creek Quarry penetrates the entire thickness of the Sinnipee Confining layer down to the top of the Ancell Group/St. Peter Sandstone. The quarry began filling in 2001 after the quarry ceased operation and dewatering pumps were turned off. At this time, the potentiometric surface was at or below the base of the quarry, and the flow of water was likely downward, recharging the sandstone aquifer below. Through compilation of historical photographs and direct measurements, Luczaj [55] demonstrated a change in the filling rate of the quarry that corresponded to pumping changes in the confined sandstone aquifer. Before the villages of Ashwaubenon and Howard ceased pumping groundwater in 2006 and 2007, respectively, the rate of water level rise was approximately 6.2 cm/week between 2002 and 2006. After the transition, the rate of rise of water levels in the quarry increased by 68% to 10.4 cm/week between 2007 and 2011. The quarry is only about 2.1 km south of the flowing municipal well in the village of Howard. By mid-2011, water levels reached the top of the bedrock, leading to lateral flow in unconsolidated Pleistocene sediments. This led the village of Howard to install an outfall to a nearby creek to avoid future problems. During May 2013, the quarry outfall had steady flow at approximately 530 kL/day.

Additional concerns of quarry flooding and even quarry floor buckling have been expressed by engineers regarding operating deep dolostone quarries near De Pere that approach the top of the Ancell Group [56].

Other possibilities include renewed flowing of springs and seeps in areas where fractures and other conduits allow for preferential vertical flow across the Sinnipee Group confining layer. The potential importance of such springs is now well known, but several clues suggest that preferential flow paths across the confining layer might exist. For example, recent engineering work in Green Bay has documented vertical fissures at least several meters long that cut through the Sinnipee Group dolostone [57]. While the Sinnipee Group does not have documented karst solution cavities within Brown County, other solution cavities in the same unit have been interpreted as hydrothermal solution cavities along northwest-trending structures near Chicago, Illinois [58].

Perhaps related, an enigmatic sinkhole in the Pleistocene glacial sediments occurs above one of the mapped northwest-trending faults along the East River in Allouez [22,59,60]. The origin of this sinkhole is not understood, but a connection with the confined sandstone aquifer is possible. At least one map from the late 1800s [61], when flowing artesian conditions would have been present, shows the feature to be a spring.

6.2. Current State of the Aquifer and Apparent Trends

As of 2016, water levels in the northern cone in central Brown County appear to have stabilized in many wells in the Green Bay region (Figures 9 and 13a), but some show slow, continued water level recovery (Figure 7). As described earlier, limited data are available near the center of the cone, but observation wells in Green Bay and Ashwaubenon show steady or slightly increasing water levels over time. Water levels in well BN-0435 have risen at a rate of about 6 m/year since installation in late 2010. Static water levels in Green Bay remain between about 16–27 m below ground level. Along the north side of Green Bay and north into Howard and Suamico, water levels continue to rise and are generally 3–5.5 m below ground level, and one of the wells in Howard has flowed since 2009. Water levels in BN-076 along the northern margin of the cone have risen steadily by about 1.5 m/year since 2010. In Wrightstown, located to the south between the two major cones of depression, water levels are rising at about 0.7 m/year during the past several years. Unfortunately, fewer data are available to monitor the water levels in the confined aquifer in recent years because of malfunctioning air lines, inaccessible well design, or well abandonment.

In the southern cone near the Fox Cities, water levels in most wells are steady, especially in Kaukauna, Darboy, Holland, and Forest Junction (File S2), with those wells showing the same water levels as those observed before the CBCWA transition in 2006 to 2007. However, two municipalities in the southern cone did show decreasing water level elevations. Wells in Kimberly showed overall

falling water levels, with some complex patterns due to well pumping variations, but with water levels certainly below those observed in 2005 (Figure 13b). This pattern continues a long downward trend that began during the late 1980s, with a long-term decrease in water levels of approximately 26 to 24 m over the past 30 years. Wells in Little Chute were fairly steady until a few years ago when pumping schedules for the wells were changed due to maintenance activities [62], forcing well #3 to be more heavily pumped. As a result, a rapid decline in the water level elevation has occurred, resulting in an additional 30 m of drawdown over the past 2.5 years (See File S2).

While flowing artesian wells open to the confined sandstone aquifer appear limited to the northwest of Green Bay in the villages of Howard and Suamico, it is possible that with further recovery, additional wells may begin flowing, even without further reductions in municipal or industrial well pumping rates.

6.3. Effects of Future Pumping Changes

Present groundwater abstraction from the confined sandstone aquifer in central Brown County is approximately 15.9 ML/day and is mainly comprised of industrial, and seasonal water uses. While golf course irrigation and other wells are unlikely to change significantly, potential ramifications of water use reductions by one or more major industries should be considered in future modeling efforts in the Northeast GMA. Significant reductions could lead to continued water level recovery in the aquifer approaching the predevelopment heads of around 29 m above land surface, resulting in flowing artesian well conditions similar to those seen in the early 1900s.

The recent switch by the village of Wrightstown to the Green Bay Water Utility (GBWU) surface water pipeline is unlikely to contribute much to the water level recovery in the region because of its small population (<3000 people).

6.4. Concerns over Arsenic and Sulfide Mineralization

In some regions of the world, groundwater fluctuations and water level rebound can result in major water quality changes, such as acidification and release of heavy metals. In parts of England, rising water levels threaten underground railway systems and the stability of building foundations. This is exacerbated by concerns of pH-reduced water relating to oxidation of sulfide mineralization in parts of the aquifer [54].

In Wisconsin, a significant concern regarding water quality in wells open to the confined sandstone aquifer stems from the fact that dewatering of the sandstone can occur in areas with greatest drawdown. Several wells in the central Brown County portion of the Northeast GMA reported static water level elevations below the top of the confined aquifer (File S3). While some wells are cased across the Ancell Group (Table 1), liberation of arsenic, nickel, cobalt, and other metals has been shown to be a problem in the aquifer when oxidative conditions prevail [50,51,63,64]. In the northern cone, at least five municipal or observation wells reported water levels that were below the top of the aquifer. One of these wells near the center of the cone (BN-0435) had a water level that did not reach the top of the aquifer until 2011, about four to five years after transition #2 began in central Brown County. While initial analysis of emergency backup wells does not indicate significant water quality problems [65], water quality data are limited mainly to wells that are only open to the Cambrian portion of the aquifer, potentially limiting or delaying any response in water quality resulting from oxidation of the Ancell Group.

In the southern cone, at least four wells have or once had water levels below the top of the confined sandstone aquifer in the villages of Little Chute and Kimberly. A water quality analysis for this portion of the aquifer is planned for the future, but there has been concern voiced over the potential for increased arsenic and radium concentrations as water levels decline.

6.5. Aquifer Sustainability

The sustainability of groundwater quantity in the Northeast GMA varies somewhat between the two cones of depression. After transition #2 in 2006 to 2007, the northern cone changed suddenly from

conditions of rapidly declining water levels in 2005 to a sustainable condition as of 2016. While it is possible that future suburban growth outside the regions supplied by municipal water might once again increase demand as it did between 1957 and 2007, there is significant additional groundwater capacity available in central Brown County at the present time for population growth or industrial use.

The assessment of groundwater quantity is less clear in the southern cone, and so water levels must be monitored. While many wells exhibit stable water level elevations, some wells have declining water levels. With population growth expected for northeastern Wisconsin, additional groundwater abstraction from the confined sandstone aquifer near the southern cone would put greater strain on a system where some but not all wells are showing declines in water levels.

7. Conclusions

This article reviews the history of groundwater use in a confined sandstone aquifer in northeastern Wisconsin, USA over more than a century. In the recently established Northeast GMA, two well-developed cones of depression result from pumping localized in two urban areas. Water levels in the southern "Fox Cities" cone of depression have decreased steadily for decades. In contrast, water levels in the northern "central Brown County" cone of depression have varied significantly in response to two cycles of population growth, followed by transitions from groundwater to surface water supply sources.

As of 2016, the northern portion of the Northeast GMA is considered to be in a sustainable condition, with steady or rising water levels that have recovered as much as 70 m in the past decade. In contrast, the southern region of the Northeast GMA exhibits a somewhat different set of conditions. While water levels in some wells are steady, others show slow declines, which will likely be exacerbated by continued population growth.

Supplementary Materials: The following are available online at www.mdpi.com/2076-3263/7/1/11/s1, File S1: Complete set of historical contour maps for the Northeast GMA. File S2: Selected hydrographs for municipal and observation wells in the Northeast GMA. File S3: Stratigraphic column and table showing wells in central Brown County with dewatered conditions since 2005. File S4: Water Level Data for selected municipal wells in the Northeast GMA. File S5: Water Level Data used to construct contour maps for 1990 to 2015.

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Abbreviations

The following abbreviations are used in this manuscript:

CBCWA	Central Brown County Water Authority
GBWU	Green Bay Water Utility
GMA	Groundwater Management Area
ML	Megaliters (millions of liters)
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
SWL	Static Water Levels
WDNR	Wisconsin Department of Natural Resources
WGNHS	Wisconsin Geological & Natural History Survey
WUWN	Wisconsin Unique Well Number

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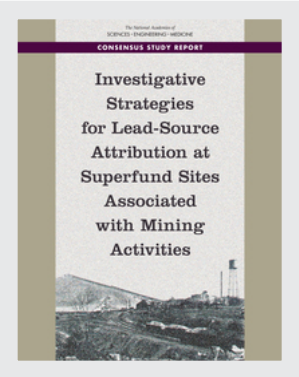

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Committee on Sources of Lead Contamination at or near Superfund Sites

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This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

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Contents

SUMMARY.....**1**

1 INTRODUCTION.....**7**
Superfund Program, 7
Southeast Missouri Lead Mining District, 7
The Committee and Its Task, 10
The Committee's Approach to Its Task, 10
Organization of This Report, 10
References, 11

2 SOURCES OF LEAD CONTAMINATION.....**12**
Natural and Mining-Associated Materials, 12
Other Sources of Environmental Lead, 18
References, 22

3 ENVIRONMENTAL DISPERSAL OF LEAD.....**25**
Aqueous Processes and Transport, 25
Air Transport, 33
Intentional Transport, 37
References, 37

4 INVESTIGATIVE STRATEGIES FOR LEAD-SOURCE ATTRIBUTION.....**42**
Soil, 42
Sediments, 50
Groundwater and Surface Waters, 59
Air, 63
References, 68

5 IMPLICATIONS FOR SOUTHEAST MISSOURI AND RESEARCH NEEDS.....**79**
Implications for Southeast Missouri, 79
Research Needs, 85
Other Applications of Recommended Analytic Techniques: A Case Study of Blood Lead and Isotopic Analysis, 87
References, 90

APPENDIXES

A CHALLENGES TO OBTAINING INFORMATION ABOUT LEAD SOURCES AT SUPERFUND SITES ASSOCIATED WITH LEAD-MINING DISTRICTS.....**93**

B BIOGRAPHIC INFORMATION ON THE COMMITTEE ON SOURCES OF LEAD CONTAMINATION AT OR NEAR SUPERFUND SITES.....**95**

C OPEN SESSION MEETING AGENDAS.....**98**

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BOXES, FIGURES, AND TABLES

BOXES

1-1 Steps in the Superfund Assessment Process, 8
1-2 Statement of Task, 10
2-1 Lead Isotopes: A Tool for Source Attribution, 15
2-2 Geology of Southeast Missouri Lead Mining District, 15
2-3 History of Lead Production in Southeast Missouri, 18
4-1 Lead Attribution Using Physical and Geochemical Fingerprinting Techniques, 43
4-2 Examples of Modifications of Investigative Strategy, 51
4-3 Historical Analysis of Lake, Bog, and Coastal Sediments, 57

FIGURES

S-1 Natural, mining-associated, and commercial sources can cause lead contamination in the environment through natural or intentional transport, 2
S-2 Compilation of $^{206}Pb/^{207}Pb$ ratios in North American ore deposits, gasoline, and paint samples, 4
1-1 Southeast Missouri Lead Mining District, 9
2-1 Natural, mining-associated, and commercial sources can cause lead contamination in the environment through natural or intentional transport, 13
2-2 Distribution of lead mineralization in Southeast Missouri and related features, including the Big River watershed, 16
2-3 Annual consumption of lead in the United States in paint and automobile gasoline, 20
3-1 Dominant lead species in water as a function of pH at (A) low and (B) high dissolved-total-carbonate concentrations, 26
3-2 General examples of lead adsorption (as percent uptake from solution) on mineral surfaces as a function of pH for three soil-mineral types: iron oxide or hydroxide, edge sites of clay minerals, and aluminum oxide or hydroxide, 27
3-3 Lead, zinc, and antimony concentrations measured in channel-bed sediments of the Chilco–Tupiza drainage system of southern Bolivia, 29
3-4 Schematic diagrams that illustrate potential sites of sediment-associated lead deposition in a river and the primary factors that influence lead concentrations in channel-bed sediment, 30
3-5 Mine tailings incorporated into floodplain deposits near Leadville, Colorado, 32
3-6 Time series of 24-hr average TSP lead concentrations at selected Missouri monitoring sites, 34
3-7 Illustration of different size fractions of airborne particles in a typical atmospheric particle-size distribution, 34
3-8 Example of windblown-dust suspension on a surface, 35
3-9 Comparison of PM_{10} suspended at different wind speeds from mechanically disturbed surfaces (such as a broken surface crust) and undisturbed surfaces of a coke storage pile; data collected using a portable wind tunnel, 36
4-1 Example of an investigative strategy for attributing sources of lead in soil, 44
4-2 Isotopic signatures of soil samples from the pristine Shale Hills site in central Pennsylvania compared with various sources of lead, 46
4-3 Representative SEM images of particles with aerodynamic diameters of (a) 0.32 μm and (b) 6.2 μm collected from a micro-orifice uniform deposit impactor at an active copper-smelting site (Hayden, AZ), 48
4-4 Example of an investigative strategy for attributing sources of lead in river (alluvial) sediments, 52
4-5 Downstream variations in total lead concentrations and $^{208}Pb/^{206}Pb$ ratios along the Wear River in northern England, 53
4-6 Changes in lead and barium concentration along the Big River, 54
4-7 Schematic diagram illustrating how the age of a sedimentary deposit can be combined with lead-concentration data to determine the source of lead in river sediments, 56
4-8 Example of an investigative strategy for attributing sources of lead in water at a Superfund site, 60
4-9 Investigative strategy for identifying sources of lead in air, 64
4-10 Chemical compositions differ among dust sources in the Canadian Oil Sands Regions, 65
4-11 Expansion of the committee's Tier II strategy for establishing source signatures to inform receptor modeling that can help to identify and quantify potential lead sources, 66
4-12 Expansion of the committee's Tier III strategy for estimating emission potential and particle-size distribution to provide inputs to modeling for source attribution, 67

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4-13 Comparison of size distribution of particles from Fresno (CA) paved-road dust, Bakersfield (CA) unpaved-road dust, Stockton (CA) agricultural soil, Visalia (CA) sand and gravel, and Owens Lake (CA) alkaline lake-bed sediments, 67
5-1 Compilation of $^{206}Pb/^{207}Pb$ ratios in North American ore deposits, gasoline, and all paints that have been published, 82
5-2 Recommended minimum soil sampling in yards greater than one-eighth acre, 83
5-3 Results from 2013 soil sampling in Southeast Missouri, 84
5-4 Compilation of $^{206}Pb/^{207}Pb$ ratios for one house within 1 mile of the Herculaneum Lead Smelter, 88

TABLES

2-1 US National Lead Air Emission Estimates for 2014, 19
5-1 Selected Characteristics of Exterior Surfaces of Privately Owned Occupied Housing Units Built before 1980 with Lead-Based Paint, 85

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Summary

The Superfund program of the US Environmental Protection Agency (EPA) was created in the 1980s to address human-health and environmental risks posed by abandoned or uncontrolled hazardous-waste sites. Identification of Superfund sites and their remediation can be an expensive multistep process. As part of this process, EPA attempts to identify parties that are responsible for the contamination and thus financially responsible for remediation. Identification of potentially responsible parties is complicated because Superfund sites can have a long history of use and involve contaminants that can have many sources. Such is often the case for mining sites that involve metal contamination; metals occur naturally in the environment, they can be contaminants in the wastes generated at or released from the sites, and they can be used in consumer products, which can degrade and release the metals back to the environment. Lead as an environmental contaminant associated with mining sites provides a prime example of the complexities that are involved in identifying potential sources in that it meets all the criteria noted. Given the complexities surrounding lead contamination, Congress asked EPA to commission a study by the National Academies of Science, Engineering, and Medicine to determine whether there are techniques or methods that can help to distinguish sources of lead at Superfund sites associated with mining activities. Accordingly, the National Academies convened the Committee on Sources of Lead Contamination at or near Superfund Sites, which prepared this report.

THE COMMITTEE'S TASK AND THE SOUTHEAST MISSOURI LEAD MINING DISTRICT

In brief, the committee was asked to examine the extent to which various sources contribute to environmental lead contamination at Superfund sites that are near lead-mining areas and to focus on sources that contribute to lead contamination at sites near the Southeast Missouri Lead Mining District.[1] The committee interpreted its task as a request for investigative strategies that could provide the evidence needed to identify lead sources in various environmental media. It did not consider its task to be determining lead sources; such an activity would require extensive sampling, analysis, and interpretation that the committee was not equipped to perform. As directed, the committee focused its efforts on whether sources of lead in the Southeast Missouri Lead Mining District could be distinguished by using various investigative strategies. The committee emphasizes that it did not consider exposure pathways, which would need to be considered for identifying which lead sources are contributing to human exposure.

The Southeast Missouri Lead Mining District provides a prime example of the complexities that a site might pose. It is composed primarily of three large subdistricts—the Old Lead Belt, Mine La Motte-Fredericktown, and the Viburnum Trend—and has a long history of lead mining: it began in the early 1700s and continues to this day. Some areas in Southeast Missouri are contaminated with lead, and several have been designated as Superfund sites. Determining the sources of lead at the sites, however, is complicated. First, the area is rich in naturally occurring lead-ore deposits that are at or near the surface. Second, as noted, the area has a long history of mining activities. Third, an enormous amount of wastes known as chat or tailings has been produced as a result of the mining activities; some of the waste materials have been dispersed from their original disposal sites by natural forces, such as wind and rain, and some have been intentionally transported off site. Fourth, lead has been used extensively over centuries in various products. Thus, lead at a site could result from naturally occurring deposits, from historical mining activities, from current mining activities, from consumer products, or from some combination. The following sections describe potential sources and environmental dispersal mechanisms, highlight the commit-

[1]The full statement of task is in Chapter 1 of this report.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

tee's investigative strategies and the implications for the Southeast Missouri Lead Mining District, and provide the committee's research recommendations.

SOURCES OF LEAD AND ENVIRONMENTAL DISPERSAL

Lead is a widespread, naturally occurring element that is found throughout the Earth's crust and occurs in virtually all rocks, soils, sediments, and waters at low concentrations. A variety of geologic processes can cause natural lead enrichment, and, in some cases, ore deposits are formed. Whether an ore deposit is mined depends on time, economics, technology, and natural processes. If various conditions are favorable, it might be decided to mine an ore deposit. Mining begins by physically extracting the ore; the ore is then processed to obtain a concentrate of lead minerals and smelted to obtain metallic lead, which is shipped to market for use in various consumer products (see Figure S-1). At each stage, materials are discarded, and this creates an opportunity for lead to be dispersed further in the environment. Historically, waste disposal was driven by what was easiest; thus, waste was generally discarded in the most efficient manner relative to the time and place. However, by the latter part of the 20th century, waste disposal was subject to regulatory controls and handled systematically in a mine's operating plan.

Sources of lead other than natural ones or those associated with mining can also cause environmental contamination. In the 20th century in the United States, lead was added to gasoline and paint; although those uses have been virtually eliminated, the legacy lead from them remains in soils and sediment and could be an important source of environmental contamination. Other uses of lead include plumbing materials, batteries, pesticides, agricultural amendments, ammunition, and other consumer products, such as jewelry, pottery, and glass.

Lead can be dispersed in the environment by natural processes and through intentional transport. A primary natural transport mechanism is via water. Although lead concentrations in water are generally lower than those of other dissolved species, lead can be transported in natural waters attached to colloidal or suspended particles. Depending on environmental conditions, sediment-associated lead in the river bank can be reintroduced into the river over both short and long periods. Depending on the prevailing weather, airborne transport has the greatest potential to disperse pollutants on regional and global scales because air is not confined by geographic barriers. Furthermore, transport rates of contaminants are often higher by air than by groundwater and surface waters. Intentional transport of mining materials and wastes has been an important mechanism for dispersal of lead in the environment. In the Southeast Missouri Lead Mining District, mine wastes (waste rock, tailings, and slags) were

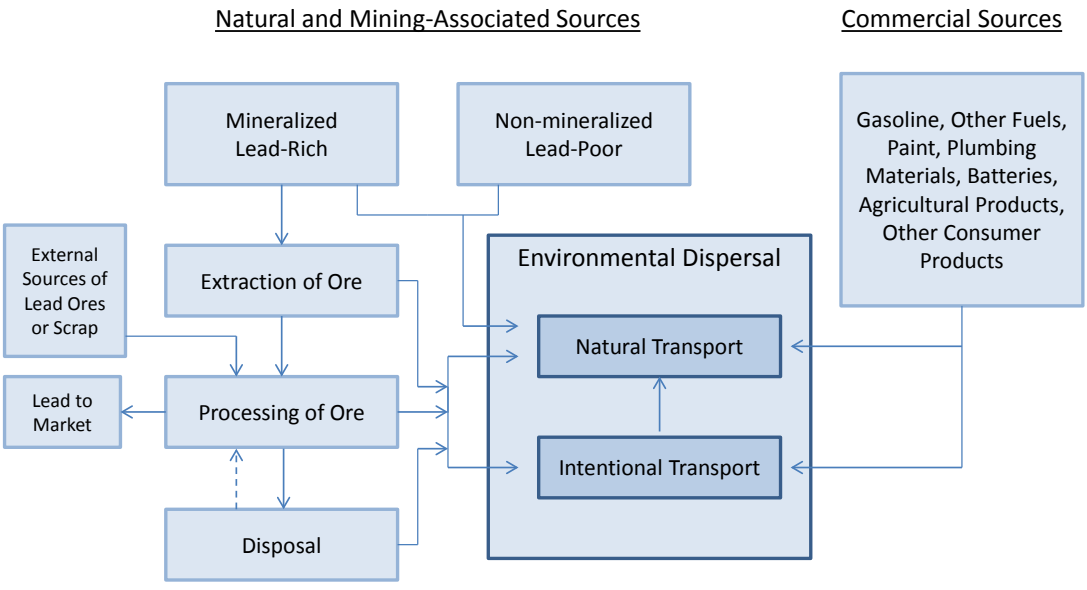

FIGURE S-1 Natural, mining-associated, and commercial sources can cause lead contamination in the environment through natural or intentional transport. *Natural transport* refers to environmental processes—such as wind, water flow, and soil erosion—that disperse materials; *intentional transport* refers to all human activities that move materials and have the potential for dispersal in the environment.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

transported for use as construction fill, roadbed materials, agricultural amendments, and building materials.

INVESTIGATIVE STRATEGIES FOR LEAD-SOURCE ATTRIBUTION

Over the years, a wide array of analytic techniques have been used to determine the relative contribution of lead from natural and anthropogenic sources to soil, sediment, water, and air with varied success. Most techniques rely on a fingerprinting approach in which unique physical or chemical properties of the lead or lead-associated materials are used to distinguish sources from one another. The committee reviewed the techniques and provides investigative strategies for determining lead sources in soil, sediment, water, and air in Chapter 4 of this report. The approaches rely on systematic collection, analysis, and interpretation of multiple lines of evidence; an investigation continues until there is sufficient confidence that an accurate lead-source attribution has been reached. The committee emphasizes that its strategies are illustrative and that the sequence of steps will depend on site-specific conditions, availability of analytic techniques, and cost and time considerations.

The investigative strategies for soil, sediment, and water begin with a site characterization.[2] The goal here is to develop a site conceptual model that can guide investigations toward likely lead sources. Ideally, site characterization should document the source locations, the form of lead and other materials associated with sources, pathways and processes by which lead could be transported from a source, and, for anthropogenic sources, the history of lead use or processing. Once basic questions have been answered, a detailed sampling protocol can be developed for the specific site, and decisions can be made as to the best analytic approaches to pursue.

For the strategies noted, the committee concluded that lead isotopic analysis should be considered first for laboratory analysis of samples. Lead-isotope ratios in geologic materials vary owing to the production of lead isotopes from the radioactive decay of uranium (U) and thorium (Th). On geologic timescales, ^{235}U decays to ^{207}Pb, ^{238}U decays to ^{206}Pb, and ^{232}Th decays to ^{208}Pb; ^{204}Pb is primordial and has no radioactive parent. Various factors, such as geologic conditions and ages, result in a wide array of lead-isotope ratios among lead-bearing ore deposits and other geologic materials. Consequently, ore deposits can have unique lead-isotope ratios (signatures) that distinguish them from each other. When lead is purified from the ores and used in industry, the lead-containing commercial products retain the lead-isotope ratios of the ore deposits used to make the products. Thus, the technique works well if there is an isotopic contrast between the sources that one wishes to distinguish, but it can be equivocal if there are overlapping isotopic ratios in the various potential sources. In most cases, some potential sources can be eliminated and thus focus the investigation on fewer possible sources.

If the isotopic analysis does not yield unique signatures or if additional confidence is needed to reach conclusions, the committee suggests other analytic techniques and methods, such as ones that rely on analysis of mineralogy, particle size, chemical speciation, or other source-associated elemental ratios or isotopes. Each method has the potential to provide additional evidence to identify lead sources. However, the committee emphasizes that even after extensive sampling and analysis it still might not be possible to attribute lead to particular sources with confidence.

IMPLICATIONS FOR THE SOUTHEAST MISSOURI LEAD MINING DISTRICT

Isotopic analytic techniques might be especially promising for distinguishing non-native ores (or products made from non-native ores) from the natural or locally mined materials in Southeast Missouri. The committee tested the possibility by compiling and comparing ^{206}Pb/^{207}Pb ratios of North American lead ores, gasoline, and paints from around the world. As noted, various ore deposits can have different lead-isotope ratios, and gasoline producers and paint manufacturers used lead mined from different ore bodies. Therefore, it is expected that in some specific cases the lead isotopic composition of gasoline and paint might differ from that of local ore bodies; in other cases, they might be the same and therefore not useful for source attribution. The lead ores from Southeast Missouri have an extremely unusual lead isotopic composition, and the isotopic composition of lead mined from Southeast Missouri (and adjacent areas in the tristate region) appears to be distinct from that of nearly all other major lead mines (and products made with lead from them) in North America.

Figure S-2 clearly shows that Southeast Missouri ores, especially those from the Old Lead Belt, have higher ^{206}Pb/^{207}Pb ratios than other ore deposits, gasoline, and paints used in the United States. The only exceptions are the lead ores from the Upper Mississippi Valley District, which were probably not produced in substantial quantities in the 20th century compared with those from Southeast Missouri, and a single sample from a house within 0.5 miles of the Herculaneum lead smelter that could be the result of lead contamination from the smelter. Thus, the committee concludes that in the case of the Southeast Missouri Lead Mining District, it is likely that lead-isotope ratios can be used to attribute the sources of lead in

[2]The investigative approach for air is different from that for the other environmental media in that it uses a tiered approach that focuses primarily on modeling for source attribution, although similar techniques to analyze airborne lead particles are noted.

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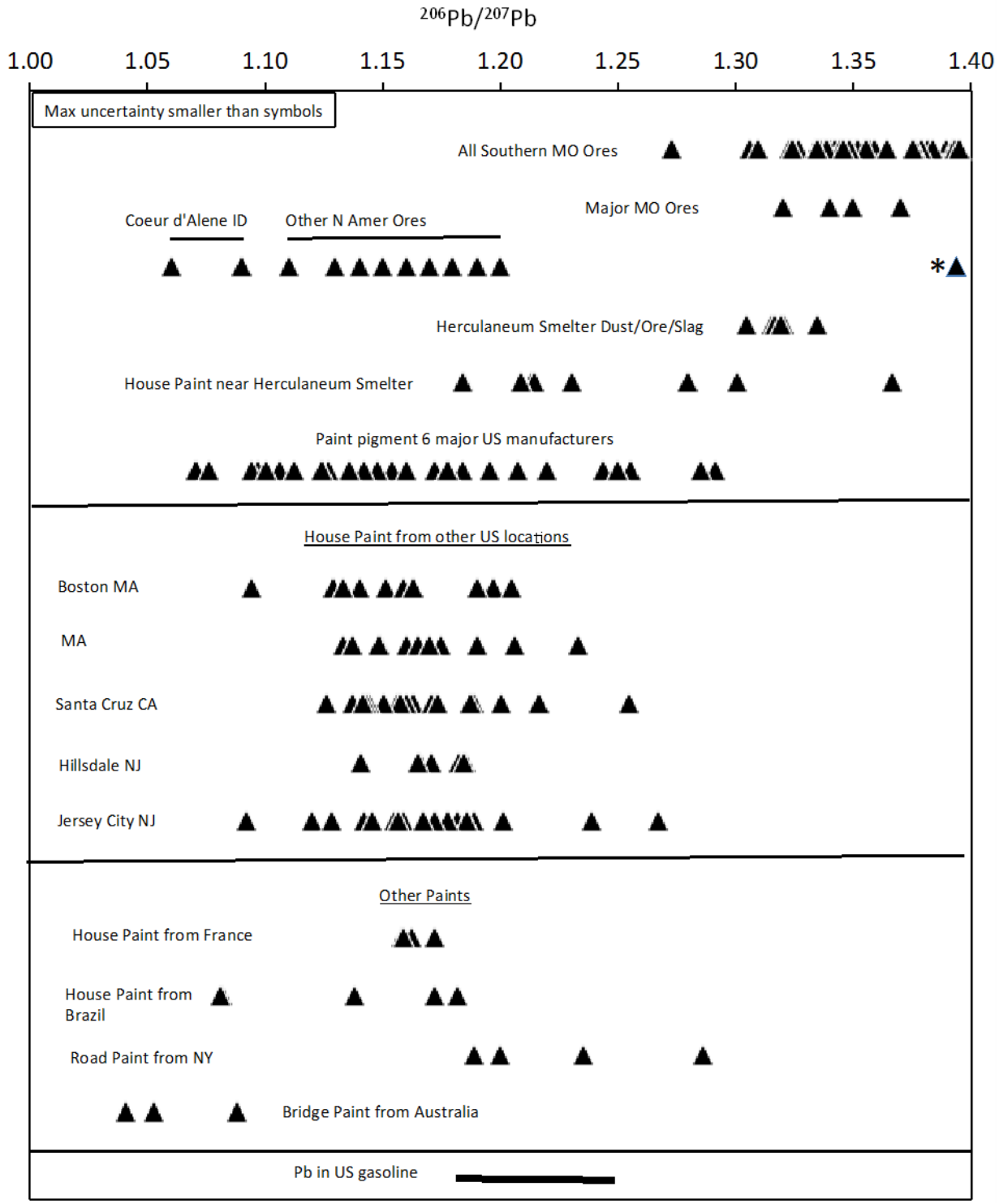

FIGURE S-2 Compilation of $^{206}Pb/^{207}Pb$ ratios in North American ore deposits, gasoline, and paint samples. The asterisked triangle represents the average $^{206}Pb/^{207}Pb$ ratios in ores from the Upper Mississippi Valley District. References for the data sources can be found in Chapter 5, Figure 5-1, and corresponding reference list.

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environmental media between mining materials and gasoline and paint in most cases. If there are non-native ores or other lead-containing consumer products at the site—such as plumbing materials, batteries, or pesticides—lead-isotope studies of those materials might establish their potential role as a source of lead contamination at a site.

Distinguishing lead from natural (background) sources and lead from local mining materials or waste is much more challenging in contaminated soil. Natural and mined materials from the same region will typically contain lead that exhibits similar lead isotopic composition, and this would hinder the use of lead isotopic analysis to determine source. However, one might be able to use other methods alone or in combination—such as analysis of grain size, structure, and composition of soil particles, and depth distributions of metals in soils—to attribute potential sources. For example, smelter-derived particles in soils often contain spherical grains that are composed of sulfides, oxides, or glassy particles, and their spatial distribution is also likely to vary as a function of wind direction and distance from the smelter. With time, however, weathering of minerals derived from primary ore or smelter sources in soils might alter or dissolve them and potentially disperse them in the environment. The committee emphasizes that the selection of specific properties to be used for source attribution must be based on physical, compositional, mineralogic, or geochemical differences in the materials that make up the various source materials that need to be distinguished. Furthermore, it might be necessary to use multiple methods to differentiate between sources. In some cases, even with multiple analytic approaches, source identification might not be definitive in distinguishing natural materials from local mined materials or wastes, especially in soils and sediments.

RESEARCH RECOMMENDATIONS

Additional research will provide opportunities to enhance the analytic techniques and methods that make up the committee's proposed investigative strategies and to reduce uncertainty in their implementation. The committee finds that characterizing potential sources has high priority for research and lists below several topics that deserve attention. The research needs are not listed in order of priority.

• *Improved characterization of lead isotopic composition of historical paints.* To evaluate the utility of lead isotopic analysis for distinguishing lead sources, additional study of lead isotopes will be necessary. There appear to be few data on the lead isotopic composition of house paint in Southeast Missouri, and the committee recommends systematic sampling and lead isotopic analysis of paint in houses built before 1980 throughout the Southeast Missouri Lead Mining District. Such study would give a much clearer indication of the lead isotopic composition of paint used in the area and would clarify the degree to which lead isotopes provide a method for attributing some lead sources.

• *Improved characterization of lead-bearing geologic materials and mining wastes.* Because lead isotopic analysis will probably not allow distinguishing natural materials from mining materials or wastes, physical and chemical properties of the latter materials need to be characterized better so that the properties can be used to help to distinguish sources. The goal is to identify fine-scale variability in the sources on the basis of isotopic composition, elemental chemistry, mineralogy, grain size, or texture.

• *Capability to model metal concentrations in soils as a function of depth.* The science of modeling sediment distributions in river floodplains is relatively advanced. In contrast, modeling of metal movement through soils is less developed. Studies could be completed on soils near known metal-emitting sources to map and model how the metals have moved, if at all, through the soils as a function of time.

• *Characterization of size distribution of suspended particles in air samples.* Tailings impoundments, chat piles, and smelter emissions are important sources of airborne lead in a mining district, and little is known about the size of suspended particles and their mobility. Size-selective sampling of air samples in the Southeast Missouri Lead Mining District should be conducted to determine the particle-size distribution. Size-selective sampling can be conducted upwind or downwind of a source, such as a smelter or tailings impoundment, to evaluate contributions from the source.

• *Characterization of source strength of airborne particles from mining wastes.* Little is known about rates of emission of airborne lead from stockpiles of mining wastes. Portable wind tunnels can be used to estimate the airborne particle emission rates and dust production from stockpiles of mining wastes and to measure the threshold wind velocity at a specific site that results in particle suspension and later transport downwind. That information can help to establish whether airborne lead from mining wastes is an important source of lead contamination downwind.

• *Investigation of industrial archeology as a tool for source identification.* Industrial archeology is the systematic study of material evidence associated with historical industrial activity. Although historical industrial processes were generally on a smaller scale than modern industry, they operated less efficiently, were more likely to use processes and materials that produced hazardous byproducts, and lacked pollution controls. An understanding of historical practices could shed light on their relative

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importance as a source of legacy pollution that persists long after the industries have disappeared.

Although the committee was not asked to identify possible exposure pathways or methods for determining which lead source at a contaminated site might be the most important for human exposure, it did consider whether its investigative approaches could help to answer such questions. Blood lead is often used as a measure to determine whether (and how much) lead exposure has occurred. The committee's recommendation for using lead isotopic analysis also applies to investigating sources of blood lead. Although additional study would be needed to determine where and under what conditions lead isotopic analysis could provide unambiguous lead-source attribution for people who have high blood lead concentrations, the approach appears promising for the Southeast Missouri Lead Mining District and possibly other mining districts, such as Coeur d'Alene, Idaho.

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1

Introduction

In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which established the Superfund program to address environmental contamination in the United States. As part of the Superfund program, the US Environmental Protection Agency (EPA) conducts site investigations, determines whether a site needs to be remediated, and attempts to identify parties who are responsible for the contamination and thus financially responsible for the remediation activities. Identifying potentially responsible parties is often difficult because sites can have a long history of use and involve contaminants that have many potential sources. That is often the case for sites that involve metal contamination; metals occur naturally in the environment, they can be contaminants in the wastes generated at or released from a site, and they can be used in consumer products, which can degrade and release the metals into the environment. Lead as an environmental contaminant associated with sites at or near lead-mining districts provides a primary example of the complexities that are involved in identifying potential sources. Lead occurs naturally in the environment, is present in wastes associated with lead-mining districts, and has been used in various consumer products that are known to have resulted in environmental contamination, such as leaded gasoline and paint. Given the complexities surrounding lead contamination, Congress asked EPA to commission a study by the National Academies of Sciences, Engineering, and Medicine to examine the extent to which various sources contribute to environmental lead contamination at Superfund sites that are near lead-mining areas. Accordingly, the National Academies convened the Committee on Sources of Lead Contamination at or near Superfund Sites, which prepared this report.

SUPERFUND PROGRAM

As noted, the Superfund program was established to address human-health and environmental risks posed by abandoned or uncontrolled hazardous-waste sites. CERCLA gave EPA the resources and authority to clean up sites and seek reimbursement from potentially responsible parties. The Superfund process begins with the identification or notification of a potentially hazardous release and involves several steps, which are described in Box 1-1. If EPA's investigation results in listing of a site on the National Priorities List (NPL), the site is eligible for cleanup under the Superfund program. As of March 2017, 1,337 sites were listed on the NPL (EPA 2017a). They include manufacturing plants, processing facilities, landfills, and mining sites and involve a wide array of contaminants. Some of the most complex sites are mining sites not only because of their size but because their contaminants can have multiple possible natural and anthropogenic sources; this is problematic when one is trying to identify contaminant sources and assign financial responsibilities for remediation activities. Appendix A provides information on the challenges of obtaining information that can help to determine financial responsibilities.

SOUTHEAST MISSOURI LEAD MINING DISTRICT

As noted, mining sites are typically large and complex, and the Southeast Missouri Lead Mining District provides a prime example of the complexities that a site might pose. It is composed of three large subdistricts—the Old Lead Belt, Mine La Motte–Fredericktown, and the Viburnum Trend—and several smaller ones (see Figure 1-1; Seeger 2008).[1] The area has a long history of lead mining that began in the early 1700s and continues today (Seeger 2008). Until the 1860s, the majority of mining was accomplished by digging shallow pits and extracting the ore near the surface (Buckley 1909; Seeger 2008). Mining practices changed dramatically in the 1860s; the Saint Joseph Lead Company was formed in 1864, and the diamond drill bit was introduced in 1869 (Bonne Terre

[1]The committee notes that considerable lead was also produced in the Washington County barite district in the same region.

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News 2008; Mugel 2017). Those events led to extensive underground mining in the area and the development of a complex of mines in the Old Lead Belt that were 200–300 feet deep and connected by over 250 miles of underground railroad (Seeger 2008). Mines in the Old Lead Belt were finally closed by the early 1970s because the higher-grade ore had been exhausted. At that time, the large and recently discovered deposits of the Viburnum Trend were coming into production (MO DNR 2017). Today, the only active mining in the area is along the Viburnum Trend, from which Missouri continues to supply most of the US primary lead with byproduct zinc, copper, and silver (Guberman 2014).

The mining sites typically included milling operations in which the ore was processed and the lead-bearing minerals were extracted. There were also smelting operations in the area that converted the lead from its mineral form to its elemental state. Waste materials were generated in processing the ore, and in the early years a density separation process was used and generated a coarse waste material often referred to as chat that was accumulated in enormous piles at the milling sites (ATSDR 1996, 1998). In the later years, a finer grinding of the ore allowed a more efficient separation process (flotation) to extract the lead minerals while generating much finer waste mate-

BOX 1-1 Steps in the Superfund Assessment Process

Site Assessment: The first phase of the Superfund process includes the *preliminary assessment* and *site investigation* in which EPA gathers the site history and analyzes air, water, and soil samples to determine the risk that the site might pose to people or the environment. The data collected al-low EPA to determine whether any immediate action should be taken to protect public health or the environment and to calculate a score by using its hazard ranking system (HRS), which helps to determine whether the site should be listed on the NPL.

NPL Listing Process: This process is started if the HRS score indicates that the site should be included on the NPL and includes an announcement and public-comment period regarding a potential listing of the site on the NPL. Once the comments have been reviewed and evaluated, EPA determines whether the site should be listed. The NPL contains the worst hazardous-waste sites that require extensive cleanup measures.

Site Characterization: This stage is undertaken if a site is listed on the NPL. It includes a *remedial investigation* in which numerous samples of air, surface water, groundwater, sediment, soil, waste, and biota are taken and analyzed to determine the specific risks associated with the site. A *feasibility study* outlines possible options for cleanup and discusses costs, advantages, and disadvantages of each option. A proposed plan for cleanup is developed and announced, and public comment is sought.

Record of Decision: A record of decision contains the final decision regarding cleanup measures. It provides information on "site history, site description, site characteristics, community participation, enforcement activities, past and present activities, contaminated media, the contaminants present, description of response actions to be taken…the remedy selected for cleanup…[and] consideration of how the site could be used in the future."

Remedial Design and Remedial Action: The next phase of the process includes the development of specific engineering details concerning cleanup measures and the process of undertaking cleanup.

Construction and Post-construction Completion: Construction completion is the signal that all physical cleanup activities have been completed. Post-construction activities can be initiated, such as site monitoring that is required to ensure public and environmental safety.

NPL Deletion: The site is considered for deletion from the NPL when cleanup is considered complete and the site is no longer judged to pose a risk to people or the environment. An announcement is made concerning the delisting, and public comment is sought. After reviewing and evaluating the comments, EPA determines whether the site should be removed from the NPL.

Reuse: The goal of the Superfund process is restoration of a site to productive industrial, commercial, residential, or recreational use.

Source: EPA (2017b).

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rials, known as tailings, that were pumped into settling ponds or impoundments (ATSDR 1996, 1998). The committee notes that mining waste or residual material from processing is typically referred to as tailings; however, the term *chat* is also used in the Southeast Missouri Lead Mining District to distinguish between coarse and fine waste material. Mining operations are discussed further in Chapter 2.

Some areas in Southeast Missouri are contaminated with lead, and several areas in St. Francois, Madison, Jefferson, and Washington Counties have been designated as Superfund sites (EPA 2017c). Determining the sources of lead at the sites, however, is complex. First, the area is rich in naturally occurring lead-ore deposits that are at or near the surface. Second, the area has a long history of mining activities. Third, an enormous amount of waste has been produced as a result of all the mining activities. For example, an estimated 250 million tons of tailings were generated from mining activities in the Old Lead Belt (ATSDR 1996, 1998). Some of the tailings have been redistributed from their original disposal sites by natural forces, such as wind and rain, and there has been intentional transport of

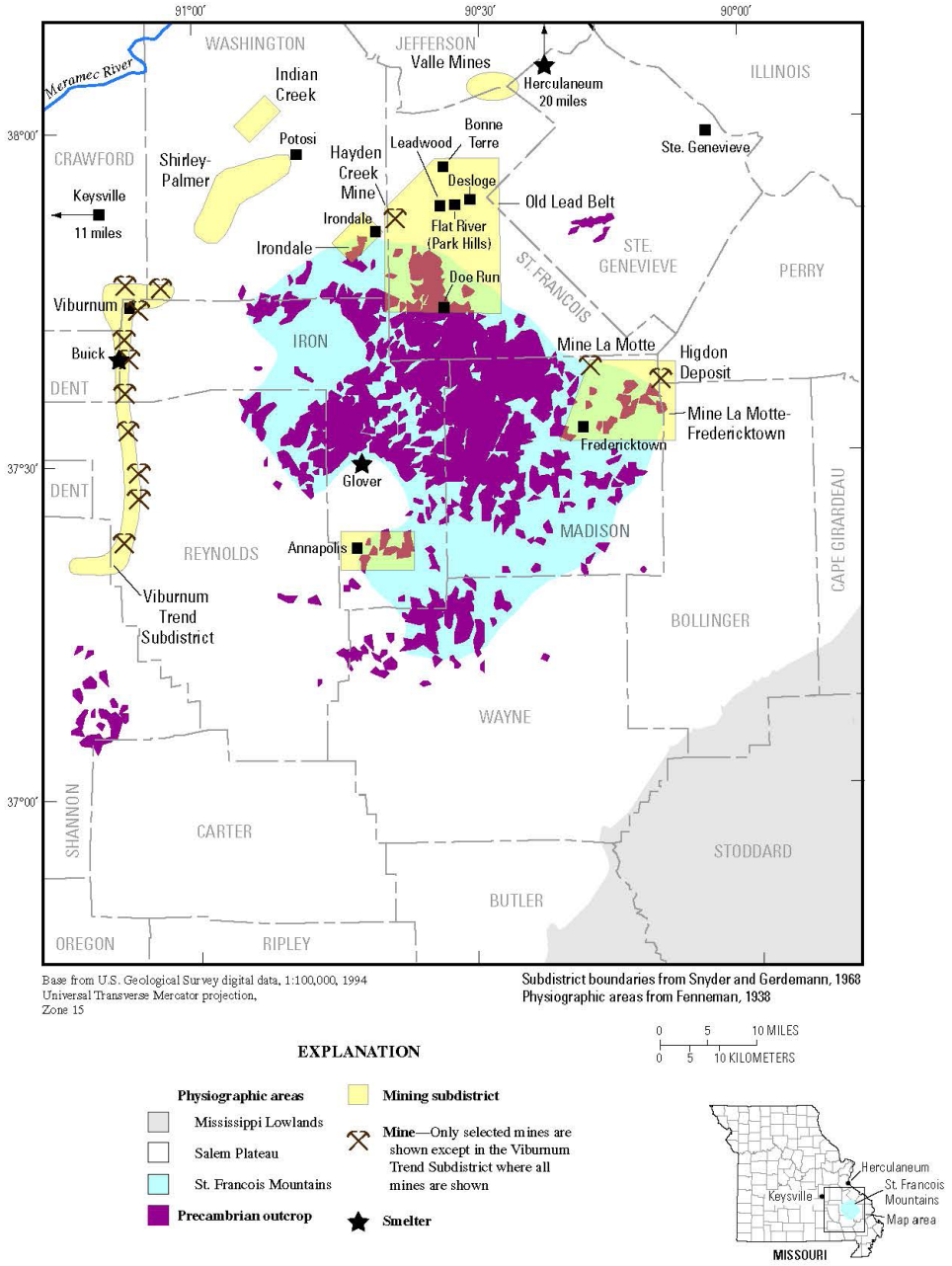

FIGURE 1-1 Southeast Missouri Lead Mining District. Source: Seeger (2008).

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chat and other byproducts offsite (ATSDR 1996, 1998). Specifically, the tailings were sold as agricultural lime, used as fill material, incorporated into asphalt, and used to treat roads (Meyers 1989; ATSDR 1996). There are even anecdotal accounts of the tailings being used for children's sandboxes (Lee 2006). Fourth, the picture is complicated by the long history of use of lead in consumer products, such as paint and gasoline. Thus, lead at a site could result from naturally occurring deposits, from historical mining activities, from current mining activities, from consumer products, or from some combination, and identifying the sources becomes problematic.

THE COMMITTEE AND ITS TASK

The committee that was convened as a result of the agency's request included experts in aqueous and soil geochemistry, economic geology, environmental fate and transport, lead-source characterization, environmental data analysis, risk assessment, and Superfund policy. Appendix B provides biographic information on the committee members. As noted, the committee was asked to examine the extent to which various sources contribute to environmental lead contamination at Superfund sites that are situated near lead-mining areas and to focus specifically on sources contributing to lead contamination at sites near the Southeast Missouri Lead Mining District. The committee's verbatim statement of task is provided in Box 1-2; it is important to note that the committee was not asked to identify human exposure pathways.

THE COMMITTEE'S APPROACH TO ITS TASK

To accomplish its task, the committee held five meetings. During its first two meetings, the committee held open sessions to hear from the sponsor, mining-industry representatives, and regional scientists from the US Geological Survey, the Missouri Geological Survey, the Missouri Department of Natural Resources, and the Missouri Department of Health and Senior Services. As part of the second meeting, the committee toured portions of the Southeast Missouri Lead Mining District to gain a better appreciation of the natural geology and geography, the mining and tailings sites, and the remediation activities. Appendix C contains the agendas of the open sessions. The committee reviewed numerous scientific publications and all materials submitted to it from outside parties.

The committee interpreted its task as a request for investigative strategies that could provide the evidence needed to identify lead sources in various environmental media. It did not consider its task to be determining lead sources; such an activity would require extensive sampling, analysis, and interpretation that the committee was not equipped to perform. As directed, the committee focused its efforts on whether sources of lead in the Southeast Missouri Lead Mining District could be distinguished by using various analytic techniques. The committee emphasizes that it did not consider exposure pathways, which would need to be considered for identifying which lead sources are contributing to human exposure.

ORGANIZATION OF THIS REPORT

The committee's report is organized into five chapters and three appendixes. Chapter 2 describes possible sources of lead contamination. Chapter 3 describes mechanisms of environmental dispersal of lead, and Chapter 4 proposes investigative strategies for determining sources of lead in various media. Chapter 5 discusses the implications of the committee's strategies specifically for the

BOX 1-2 Statement of Task

An ad hoc committee will examine the extent to which various sources contribute to environmental lead concentrations in areas at or near Superfund sites that are situated within or adjacent to lead-mining areas. The committee will consider whether sources, such as naturally occurring lead, lead-based paint, and the consumer use of products that contain lead, are significant contributors to environmental contamination problems identified through the Superfund site assessment process. In addition, it will consider the extent to which the chemical form of lead in the environmental media can be attributed to particular kinds of sources.

The committee will focus primarily on sources contributing to environmental lead concentrations at or near Superfund sites within or adjacent to the Southeast Missouri Lead Mining District. It also will consider several Superfund sites within or adjacent to other lead mining areas in the United States.

The committee will recommend potential improvements in approaches used for assessing sources of lead contamination at or near Superfund sites, without recommending changes to the clean-up requirements or remediation activities at any designated site. The committee also will identify important research needs.

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Southeast Missouri Lead Mining District and describes the research needed for identifying lead sources at Superfund sites associated with mining activities. Appendix A provides information on the challenges of obtaining information on lead sources, Appendix B provides biographic information on the committee, and Appendix C contains the agendas of its open sessions.

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2

Sources of Lead Contamination

As noted in Chapter 1, environmental lead can have many sources. It can occur naturally or result from mining or other industrial activities or from the production and use of consumer products that contain lead. This chapter describes the various sources that potentially contribute to lead contamination at or near a Superfund site (see Figure 2-1), and Chapter 3 describes the mechanisms by which environmental dispersal might occur.

NATURAL AND MINING-ASSOCIATED MATERIALS

Lead is a widespread, naturally occurring element found throughout the Earth's crust and is commonly enriched in many materials in mining districts. It occurs in virtually all rocks, soils, sediments, and waters at low concentration; however, it can occur at high concentrations over large areas because of natural and human-caused processes. A variety of geologic processes can cause natural lead enrichment, commonly in association with other metal enrichment; in some cases, concentrations of economic interest (ore deposits) are formed. Natural processes that operate at or near the Earth's surface can concentrate lead further or disperse it into the environment. Such processes could include volcanic emissions, forest fires, and various erosional processes. Similarly, human activity, particularly mining of metallic ores, leads to concentration and dispersion (see Figure 2-1).

In most rocks, lead occurs at low concentrations and behaves geochemically like the alkalis and alkaline earths. As such, it is dispersed in common rock-forming minerals, such as feldspars, amphiboles, micas, and sulfates, where it substitutes for potassium, barium, and similar elements (Sahl et al. 1978). At high concentrations, it forms discrete lead-rich minerals, notably sulfides, carbonates, sulfates, and oxysalts (Sahl et al. 1978). Of the roughly 400 lead-rich minerals known (Back et al. 2008), the most common and essentially the only ore minerals are lead sulfide (galena, PbS), lead carbonate (cerussite, $PbCO_3$), and lead sulfate (anglesite, $PbSO_4$). In this section, the committee briefly discusses the types of lead-bearing mineral deposits, the natural distribution of lead, and mining processes that can lead to dispersal of lead in the environment.

Lead-Bearing Mineral Deposits

Many mineral deposits—rocks that contain materials of potential economic interest—and their surrounding materials contain lead in such concentrations as 0.01 to over 10 wt %, which are well above the typical concentrations (5–80 ppm, and usually less than 20 ppm) in rocks and soils found outside mineralized regions (Faure 1998; Smith and Huyck 1999; Rudnick and Gao 2014). As noted above, human activities have led to environmental dispersal of lead; lead concentrations in post-industrial soils and sediments are about 50–100 ppm (Callender 2005), and concentrations at contaminated sites vary widely—up to thousands of parts per million (Gutierrez et al. 2016).

The decision to recover any particular commodity depends on economics, geology, available technology (extraction methods), and other incentives, not simply on the characteristics of the ores themselves. Thus, anywhere from none to most of the lead might be recovered from mined materials. For example, in Southeast Missouri, lead was the primary product from numerous small operations in the Washington County barite district before the 1920s, at which time production of barite became the focus of mining, and lead from that area became a co-product or a byproduct, or was discarded (Wharton 1972; Mugel 2017). Given the various factors that determine whether a commodity is mined, four categories of mineral deposits might be encountered at a Superfund site, as described below.

- Primary lead deposits in which lead is the primary or sole commodity (primary product) that motivates mining. The classic example is the Southeast Missouri Lead Mining District, where the principal value in most deposits is lead.

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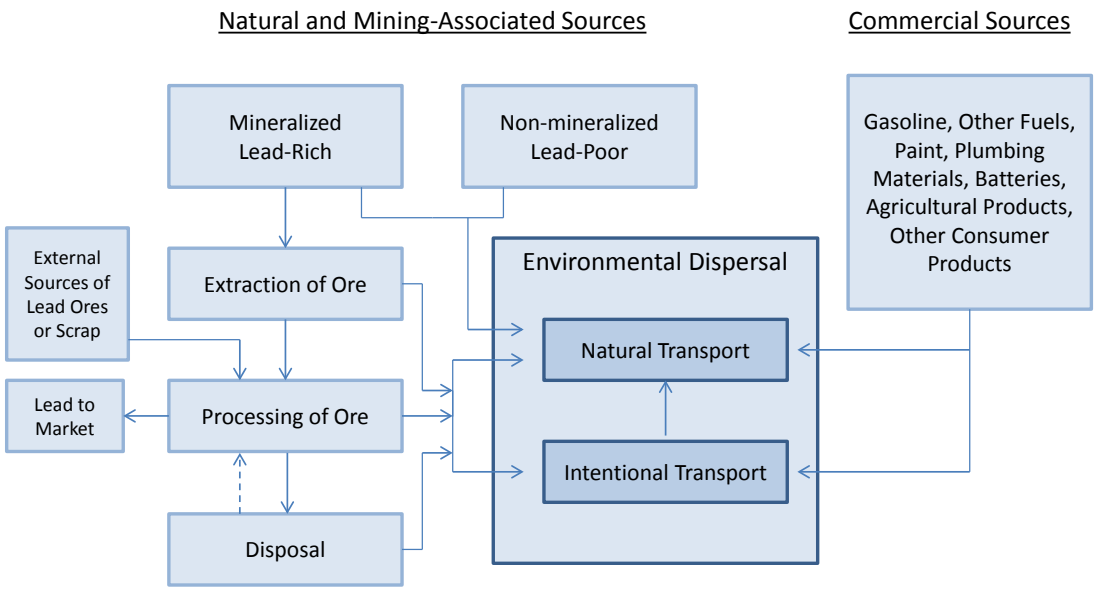

FIGURE 2-1 Natural, mining-associated, and commercial sources can cause lead contamination in the environment through natural or intentional transport. *Natural transport* refers to environmental processes—such as wind, water flow, and soil erosion—that disperse materials; *intentional transport* refers to all human activities that move materials and have the potential for dispersal in the environment.

• Mineral deposits in which lead is a co-product, and its recovery is an essential part of the economics, but production of other metals is also essential. There are a number of examples, including the midcontinent Tri-State district (Missouri-Kansas-Oklahoma), where lead was co-produced with zinc; Coeur d'Alene, Idaho, where most deposits produced lead and silver; and Leadville, Colorado, where lead was co-produced with silver, gold, and zinc.

• Mineral deposits in which lead is recovered as a byproduct because it is economically profitable to do so but not necessary for profitability. Examples include the vein deposits of the Silverton district, Colorado, which include the Gold King, Sunnyside, and related mines that were produced primarily for gold and silver, but where other metals, including lead, were common byproducts.

• Mineral deposits where lead at lower concentrations (commonly less than 0.5%) is mined with the ore but is not recovered. An example is the Ducktown district, Tennessee, which produced copper and iron sulfide (for sulfuric acid).

Metallic mineral deposits form when geologic processes concentrate metals into small volumes of rock from much larger, relatively dilute sources. As in the case of lead, concentrations in ores are typically a thousand times as great as in the source rocks. Lead-bearing deposits form in many geologic settings with a corresponding diversity in ore types and characteristics. The geologic occurrence and the geochemical nature of lead-bearing ores have fundamental effects on how lead gets into the broader environment, whether through natural dispersion or by mining and related human activities (du Bray 1995; Plumlee 1999). The most important lead-bearing deposits and some of their principal characteristics are summarized below.

• *Deposits associated with sedimentary basins*. These deposits constitute the most important lead ores globally and include the Mississippi Valley Type (MVT) ores of the middle of North America (Leach et al. 2005, 2010) and the ores of the Southeast Missouri Lead Mining District. The deposits are typically stratabound (confined to favorable layers), and the rocks that host the deposits are commonly rich in carbonate minerals. The low iron sulfide and high carbonate concentrations of these deposits limit acid production during weathering and thus limit lead solubility and mobility in the surface environment.

• *Deposits associated with hot waters generated from or circulated by magmatism*. These deposits include carbonate replacement, polymetallic veins, and seafloor massive sulfides. They are the most common types of mineral deposits and typically have small to moderate quantities of lead with other base and precious metals (Ridley 2013). They commonly have abundant sulfide minerals, and their host rocks might lack appreciable acid-neutraliz-

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

ing capacity. Thus, lead can be appreciably mobile under these circumstances.

• *Deposits associated with waters circulated during metamorphism*. These deposits are mainly vein gold deposits with relatively low lead concentrations (Goldfarb et al. 2005), although the Coeur d'Alene silver–lead deposits of Idaho fit this category (Ramos and Rosenberg 2012). The moderate sulfide and carbonate mineral concentrations result in moderate acid production and acid-neutralizing capacity.

• *Residual deposits associated with weathering*. Chemical weathering processes can substantially increase the concentration of lead minerals because of removal of other, more soluble components. This situation is common in the weathered zone of many metal deposits and in the clay-rich soils formed on lead-bearing carbonate host rocks, such as in the Washington County barite district, Missouri (Wharton 1972; Kaiser et al. 1987). Acid production is minimal, and neutralization capacity is moderate.

Geologic differences are important because they lead to different environmental consequences, they allow possible fingerprinting of sources, and they influence the choice of mining and processing methods by which lead and other commodities are produced. Among the important ore characteristics are the capacity to produce acid waters when weathered, the content of toxic elements, and the geologic form and hydrologic setting of the deposits (du Bray 1995; Plumlee 1999; Smith and Huyck 1999; Smith 2007). As summarized above, acid production correlates with the abundance of iron sulfide minerals (pyrite, pyrrhotite, and marcasite), whereas acid-neutralizing capacity is highest in carbonate-hosted deposits, such as those of the midcontinent and many igneous-related replacement deposits. Conversely, seafloor massive sulfide deposits and many vein deposits have relatively high sulfide concentrations and host rocks that are poor acid neutralizers, and these characteristics lead to the wide availability of acid and dissolved metals in groundwater and surface waters.

Lead concentrations (and other element concentrations) vary greatly among ore deposit types and within individual deposits or districts (du Bray 1995; Plumlee 1999; Smith and Huyck 1999). Some ore deposits and ore districts have relatively uniform compositions and host rocks (for example, many MVT deposits and districts), but many exhibit strong spatial variation (zoning) in metals, other elements, and the nature of the local host rocks (for example, magmatic-related hydrothermal systems; Ridley 2013). Lead concentrations can span several orders of magnitude, depending on position; for example, ores at Bingham, Utah, ranged from greater than 10% in the carbonate rock-hosted part of the system to less than 0.1% in the igneous rock-hosted copper-rich core. Because the geochemical signatures vary with deposit type and location of a particular ore-forming system, they can be used to aid in the forensic identification of sources.

A particularly useful geochemical variable is the isotopic composition of lead itself (Box 2-1). Extensive study of lead isotopes in ores shows that different deposit types and regions have compositions that reflect the geologic history of the terrain and the processes involved in ore formation (Doe and Zartman 1979). For example, ores of the midcontinent have distinctively high ratios of the radiogenic isotopes of lead (^{206}Pb, ^{207}Pb, and ^{208}Pb) to non-radiogenic, or primordial, lead (^{204}Pb).[1] Such differences have the potential to distinguish geologic sources and even individual districts and deposits (Goldhaber et al. 1995; Sangster et al. 2000). Application of isotopic differences is discussed further in Chapter 4, and case studies are provided in Chapter 5.

Over 200 mining districts in the United States have produced appreciable amounts of lead (Long et al. 1998), and many more have accessory lead minerals. However, the principal lead production has come from only a large handful of districts. The most important are the Mississippi Valley ores of Southeast Missouri and the Missouri–Kansas–Oklahoma tristate district; the vein silver–lead ores of the Coeur d'Alene, Idaho; and various igneous-related polymetallic carbonate replacement deposits of Colorado (Leadville) and Utah (Bingham, Park City, and Tintic). Of those districts, Southeast Missouri (Box 2-2; Figure 2-2) has produced more than the others combined (Long et al. 1998) and collectively contains the world's largest known concentration of lead (Appold and Garven 1999).

Natural Distribution of Lead

When lead deposits form from hydrothermal fluids, the lead concentration rarely terminates abruptly at the edge of an ore body but rather falls off gradually; this is primary dispersion.[2] The original geologic dispersion reflects the facts that ore-forming fluids typically invade a considerable volume of rock and that the metal-trapping (precipitating) process is commonly inefficient (Rose et al. 1979). Such primary distributions can be highly focused, around a few meters or less, if the flow of mineralizing fluids was strongly focused (Barnes and Lavery 1977). In other cases, where fluid flow and conditions for precipitation were not localized, tremendous volumes of rock over large areas (tens to thousands of square kilometers) might contain anomalous metals. For example, minor quantities of galena and sphalerite (ZnS) are widely distributed in the

[1]Radiogenic indicates an isotope that has been created from radioactive decay.

[2]The edge of an ore body is an economic boundary that is influenced by a combination of geologic and technologic factors. In many cases, what might be waste under one set of conditions can become ore under more favorable conditions, or vice versa.

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BOX 2-1 Lead Isotopes: A Tool for Source Attribution

Lead-isotope ratios in geologic materials vary because lead isotopes are produced by the radioactive decay of uranium (U) and thorium (Th) over geologic timescales. ^{235}U decays to ^{207}Pb, ^{238}U decays to ^{206}Pb, and ^{232}Th decays to ^{208}Pb, whereas ^{204}Pb is primordial and has no radiogenic parent. Because of contrasting geologic histories, ages, and U/Pb and Th/Pb ratios, there is a wide range of lead-isotope ratios among lead-bearing ore deposits and other geologic materials (see, for example, Sangster et al. 2000; Faure and Mensing 2004). Lead isotopes are not altered in mining, processing, or manufacturing; thus, ratios of isotopes from a given source are the same whether in natural materials, lead-mining waste, or commercial products (provided that a single source has been used in the manufacturing process). A simple isotope mixing equation describes the lead isotopic composition of lead from mixtures of sources (Faure and Mensing 2004).

Lead-isotope ratios are often reported as $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$, and plots of these ratios give the most complete differentiation between ore deposits and between sources of environmental lead. The full complement of lead-isotope abundances is measured with thermal ionization mass spectrometry and multi-collector inductively coupled plasma mass spectrometry (ICP-MS). However, some studies that use single-collector ICP-MS do not measure the lower-abundance ^{204}Pb (which makes up about 1.5% of total lead) with adequate precision; therefore, to use all available lead-isotope data in the literature, environmental applications of the ratios often use the $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{207}Pb$ ratios or simply the $^{206}Pb/^{207}Pb$ ratio alone for comparisons between lead sources. Sangster et al. (2000) used a statistical analysis to demonstrate that ^{204}Pb was not critical for discriminating between most lead sources.

Numerous studies have used lead-isotope ratios to distinguish between potential sources of lead in soils and atmospheric and household dust (see, for example, Gulson et al. 1981; Graney et al. 1995). A smaller number of studies have included lead isotopic analyses of human blood or urine; that approach has in some cases allowed elimination of some potential sources and in other cases has allowed identification of the sources of lead exposure (see, for example, Manton 1985; Gwiazda and Smith 2000).

BOX 2-2 Geology of Southeast Missouri Lead Mining District

In Southeast Missouri, tremendous quantities of lead are present in flat-lying Cambrian and Ordovician sedimentary rocks (about 450–550 million years old) that surround and lap onto the edges of an ancient island represented by the 1.5-billion-year-old igneous rocks of the St. Francois Mountains (Figure 2-2). Lead and other components—such as barium, zinc, copper, cobalt, and nickel—were added by warm (about 100˚C) saline fluids derived from adjacent sedimentary basins to the south. The largest lead deposits occur in the oldest sedimentary rocks, mainly the Bonneterre Dolomite and underlying Lamotte Sandstone near where they terminated against the older igneous rocks. The yellow-clay soils that developed on the dolomite were enriched in lead; they were referred to as the “bonne terre” by early miners, reported to contain abundant galena in the upper few tens of meters, and attracted preindustrial development (Winslow 1894; McHenry 2006, p. 362). After the 1860s, the Bonneterre ores were hard-rock ores that were mined underground.

In contrast with the majority of the Bonneterre ores, the lead-bearing barite mineralization in the younger rocks of the Potosi Dolomite and overlying formations consists of residual deposits that formed from widespread but low-grade primary sulfide mineralization, which was concentrated by chemical weathering in residual soils. Because of lead’s relatively low solubility, galena and its oxidation products (cerussite and anglesite) remained in the clay-rich soils with similarly insoluble barite (Wharton 1972; Kaiser et al. 1987). Both commodities were readily recovered from numerous shallow mines, many of them open pits across a wide region, which date back into the early 19th century. Early mining and local mining focused on lead, but from the 1920s to the 1980s these residual deposits were mined by industrial methods for barite (MO DNR 2017; Mugel 2017).

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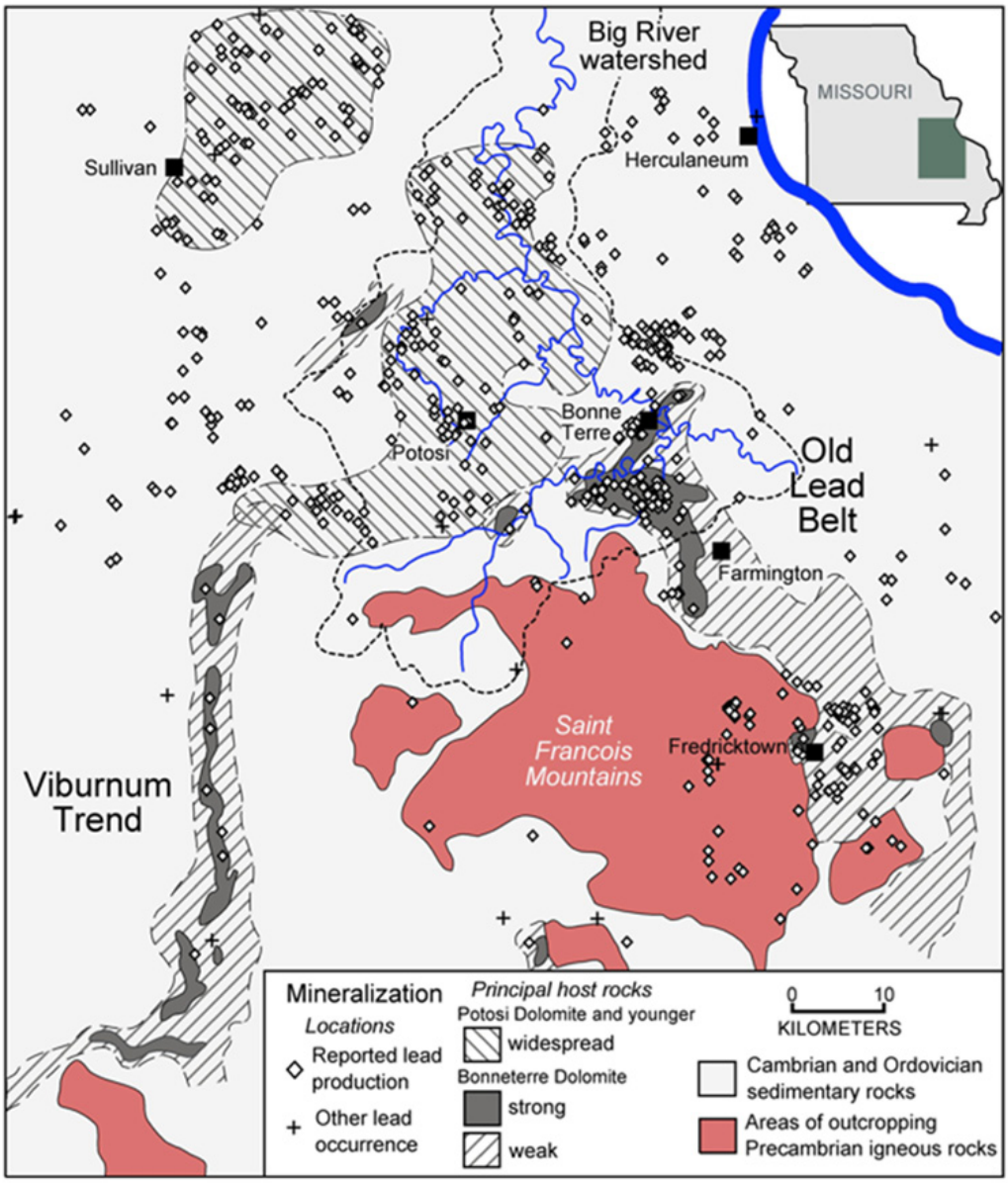

FIGURE 2-2 Distribution of lead mineralization in Southeast Missouri and related features, including the Big River watershed. The thin blue lines are rivers, and the thick blue line is the Missouri–Illinois border. Lead mineral occurrences are from the US Geological Survey Mineral Resources Data System (USGS 2015). High-grade lead mineralization occurs principally in the Bonneterre Dolomite and underlying Lamotte Sandstone, but low-grade lead mineralization is widespread with barite in the residual ores of the overlying Potosi Dolomite and younger formations. Lead mineralization is widely present at the surface in the eastern and northern parts of the region but is essentially restricted to the subsurface along the Viburnum Trend to the west. The boundaries for the Bonneterre-Dolomite mineralization were redrawn from a review by Zientek and Orris (2005), which did not define *strong* and *weak* in the figure inset. However, *strong* appears to refer to regions of mineralization that incorporate areas where there has been substantial lead mining, and *weak* to regions that rarely had any lead production but commonly had lead mineralization in trace quantities.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Paleozoic sedimentary rocks of the midcontinent, where they represent the sparse products of the metalliferous fluids that flowed regionally along these sedimentary layers (McLimans et al. 1980; Goldhaber et al. 1995; Leach et al. 2005; Figure 2-2).

Weathering and erosion of primary metal concentrations lead to dispersion at or near the Earth's surface. Given the relatively low solubility of lead in most surface fluids, chemical weathering concentrates lead in residual materials in gossans (weathered ores) and clay-rich soils (Rose et al. 1979; Smith and Huyck 1999). The residual materials are ultimately eroded (mechanically removed by running water) and contribute to the overall sediment load in rivers and streams. Only in sulfide-rich deposits that have poor neutralizing capacity is lead dispersed mainly in solution. Environmental dispersal of lead through those various processes is discussed in detail in Chapter 3.

Concentration and Dispersal of Lead by Mining

Lead is concentrated to yield a product but also dispersed by mining (Figure 2-1). Mining begins by physically extracting ore; this is followed by processing of the ore to obtain a concentrate of lead minerals and then by smelting to obtain metallic lead, which is ultimately shipped to market. At each stage, materials are discarded. In the extraction process, waste consists of materials that are moved to mine the ore but that lack economic concentrations of metal. Waste rock can vary greatly in mineralogy, composition, and size. Because the distinction between ore and waste is economic, large volumes of waste can have elevated lead concentrations compared with those of ordinary rocks. Indeed, what is waste under one set of conditions or at one time might be ore in other circumstances, and reprocessing for environmental or economic reasons is common in many long-lived mining districts. Historically, waste disposal was driven by what was easiest; thus, waste was generally discarded in the most efficient manner for the time and place, such as on the surface in dumps or replaced in mine openings. However, by the latter part of the 20th century, waste rock disposal was subject to regulatory controls and handled systematically in a mine's plan of operation.

Processing of lead-bearing ores typically involves physical separation as is the case with all lead minerals. However, some lead-bearing ores might be chemically processed; for example, a cyanidation process is used to treat lead-bearing gold deposits. Tailings are the residua of mineral processing after much of the valuable content has been removed in the form of a concentrate. The efficiency of concentration reflects available technology and economics, and recovery of valuable components can vary from less than 50% to 95%. For example, early and primitive techniques used hand-picking or simple gravitational separation with rockers to upgrade the content of the valuable fraction of the ore; the techniques were inefficient and often resulted in less than 50% recovery, and the balance went into the mine waste or tailings (Mugal 2017). Given the high lead content of ores, tailings typically contain lead concentrations of a few hundred to thousands parts per million, depending on recovery efficiency.

Most mineral processing depends on the characteristic properties of ore minerals that allow separation of the valuable constituents from the unwanted minerals, for example, by using density or distinctive surface properties. Gravity-based methods operate by separating dense ore minerals—such as galena, cerussite, and barite—from a less-dense waste fraction. If the lead-bearing materials are not consolidated, as is the case in residual ores, simple washing and gravity separation might suffice. For example, such methods were widely used in the barite-lead districts of Southeast Missouri, notably in Washington County. In that case, the efficiency of recovery depended on the main product—barite or lead—and, in many cases, a substantial fraction of lead was not recovered and thus discarded in the tailings. See Box 2-3 for additional information on the history of lead mining in Southeast Missouri (Wharton 1972; Mugal 2017).

In hard-rock mining, ores require crushing (milling) to liberate the valuable minerals from the unwanted gangue (waste) minerals. The degree of crushing depends on the nature of the ore, particularly on the grain size of the ore minerals. Except in unusually coarse-grain ores, efficient separation (for example, greater than 90%) commonly requires crushing to fine sand or smaller. How finely to crush the ore is a tradeoff in cost vs recovery. After the ore is milled, the ore minerals are separated from the waste to make an ore concentrate. Gravity separation is still commonly applied, but most sulfides are recovered through selective froth flotation. In froth flotation, hydrophobic surfactants specific to particular minerals are added to a slurry of the crushed ore. When air is bubbled through the slurry, the surface-coated minerals attach to the air bubbles and float to the surface. The metal-laden froth is continuously removed and dried to leave a high-grade mineral concentrate. The concentrate is the feedstock for the final steps in metal production.

Tailing characteristics—such as mineralogy, grain size, and chemical composition—reflect differences in processing, economics, and the broad social and regulatory environment. Over time, tailings disposal has seen an increasing focus on engineered impoundments. In recent decades, designed and built impoundments control not only the bulk tailings themselves but their potential water and dust effects. Early mining operations paid little or no attention to disposal methods; often, there was no effort at impoundment, and some tailings were discarded directly into streams. With time, tailings were typically discarded in designated areas, but often the areas were not designed

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to control slope failure, other types of erosion, wind effects, and water discharges.

The final steps in the recovery of lead are broadly termed smelting; they reflect conversion of the ore concentrate into metal and various waste products, including slag, gases, and dust (Vignes 2013). Smelter feed can include both primary sources (concentrates) and secondary sources (from recycling). As smelters became larger industrial operations through the 20th century, their feedstock evolved from local sources (one or more nearby mines) to a mix of sources.

Depending on the nature of the feed (recycled metals or ore concentrate), the smelting process begins with pretreatment that might include mechanical separation (secondary sources) or drying, calcining, or roasting (primary sources). The materials are then smelted and converted to metal by reduction from the sulfide or oxide form. The molten waste product (slag) contains iron, silica, calcium, some residual metal, and other minor components. Sulfide smelting involves passage of gases that carry off the sulfur, mainly as sulfur dioxide. The emitted gases also contain appreciable amounts of particulate matter in the form of melts or solids. As with mine waste and tailings, early smelting operations were typically inefficient and operated with no emission controls. Gases, slag, and dust were discharged directly into the environment. In more recent times, particularly with the passage of the Clean Air Act and resulting regulation, smelter emissions have been greatly reduced by treatment of sulfur-bearing gases and by control of dust and other particles. Slag is typically disposed of in heaps, where it is poured, cools, and solidifies. Ultimately, the metals produced by smelting might be further processed in a refinery to recover precious metals (notably silver in the case of lead) or to remove impurities that are not wanted in the final salable product. Like the earlier stages, solid and liquid refinery wastes have had a checkered history of disposal and might still contain appreciable metals. After smelting and mining, lead is distributed to other regions where it is converted into manufactured or chemical products, providing other opportunities for lead dispersion in areas that are typically well outside mining areas.

OTHER SOURCES OF ENVIRONMENTAL LEAD

There are possible sources of environmental lead in addition to natural sources and those associated with mining (Figure 2-1). Indeed, the 2014 National Emissions Inventory estimated that less than 1% of atmospheric lead emissions in the United States was the result of mining activities (Table 2-1). Mining-related emissions of lead in Missouri accounted for one-third of the national mining-related emissions but only 10% of the total lead emissions in the state. This section briefly discusses other sources of lead that could contribute to environmental contamination.

BOX 2-3 History of Lead Production in Southeast Missouri

The history of lead production in Southeast Missouri illustrates the challenges in attributing sources of lead to mining compared with other sources (MO DNR 2017; Mugel 2017). Early mining and smelting techniques were primitive; surface disturbance was extensive, and there were many local smelting operations. Lead minerals were recovered by hand, including primitive gravity separation techniques, and losses ranged from as little as 10% to greater than 50% of the total contained lead, which then ended up in mine waste and primitive tailings. Cerussite and galena were smelted locally with a series of open-air techniques that also failed to recover tens of percent of the lead contained in the ore mineral concentrates.

As noted in Chapter 1, industrial-scale mining began in the 1860s with development of the major underground ore bodies in the Old Lead Belt (Figure 2-2), but considerable small-scale surface mining continued by local landowners through the 1930s. Conversion to barite mining in the 1920s in the Washington County barite district was accompanied by a shift from largely local operations for lead to industrial-scale production of barite, which led the world in barite production for decades (Wharton 1972). High-grade ores in the Old Lead Belt were gradually exhausted with the last mine closing in 1972. By that time, the Viburnum Trend, or New Lead Belt (Figure 2-2), was in full production. Those ores, which are completely covered by younger rocks, were discovered in 1955, and the first production was in the middle 1960s. In contrast with the other areas in Southeast Missouri—where there was a century or more history of mining, processing, and smelting—the industrial-scale operations of the Viburnum Trend were developed in a far more consolidated manner with designed mine-waste dumps and tailings impoundments. In parallel with mining and milling, smelting operations were progressively more centralized, and smaller operations closed. The last primary smelter, at Herculaneum, Missouri (Figure 2-2), closed in 2013, although the Doe Run Company continues to run one of the world's largest secondary lead smelters for recycling of lead-acid batteries and other scrap at Boss, Missouri.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

TABLE 2-1 US National Lead Air Emission Estimates for 2014[a]

Sector or Source	US Lead Emissions (tons/yr)	Sector or Source Fraction (%)
Energy, all sources	88.9	12.2
Industrial processes		
Mining[b]	4.9	0.7
Metals[c]	137.8	18.9
All other	20.2	2.8
Transportation		
Aviation	456.3	62.5
All other	5.2	0.7
All other sources or sectors	17.0	2.3
Total	730.2	100.0

[a]Data compiled from the 2014 National Emission Inventory.
[b]*Mining* refers to mineral-extraction activities.
[c]*Metals* refers to smelting, refining, and other metal-processing activities.
Source: EPA (2017).

Gasoline and Other Fuels

In the United States, lead has been added to gasoline and other fuels since 1929 to prevent engine knocking. Mielke (1999) estimated the total consumption of lead in gasoline in the United States from 1929 to 1986 as 5.9×10^6 metric tons. The use of alkyl–lead additives in automobile fuels has been nearly eliminated since US Environmental Protection Agency (EPA) promulgated guidelines in the 1970s that mandated that new cars run on unleaded gasoline. The sale of leaded automobile fuels was discontinued in 1986, although a small amount of alkyl–lead continues to be used in racing sports and by owners of classic cars. The sharp decline in lead consumption in gasoline (Figure 2-3) resulted in a 98% decrease in total national lead emissions from 1970 to 1995 (EPA 2013).

Alkyl–lead additives are still used in aviation fuel, specifically for small piston-engine aircraft. Although emissions that result from the operation of those airplanes was a tiny fraction of total atmospheric lead emissions in most of the 20th century, they accounted for more than half the national lead emissions by 2008 (Rao et al. 2013) and for nearly two-thirds in 2014 (Table 2-1). Aircraft-related lead emissions are highly variable; areas near airports experience the highest loadings.

Although automobile-related lead emissions are now near zero, the legacy lead that remains in soils and sediments is a potentially important lead source at or near Superfund sites. Smith (1976) found that lead concentrations in the top 5 cm of roadside soils were up to 30 times the concentrations in soils away from the roadside. Emissions of gasoline lead, however, were widely dispersed around the country and resulted in deposition and accumulation of lead in soils and surface waters even in remote areas. Johnson et al. (1995) estimated that the total lead deposition in precipitation at the Hubbard Brook Experimental Forest in New Hampshire in 1926–1989 was 8.66 kg/ha. Because Hubbard Brook is remote from point sources of lead pollution, the lead deposition was interpreted as an estimate of gasoline-lead input into the forest. Lead is readily adsorbed in soil organic matter and clay particles (see Chapter 3), so nearly all the lead remains in the soil and makes up a large fraction (about 10%) of total lead in the soil (Johnson et al. 2004). At Hubbard Brook, the mass of the O soil horizon (surface soil layer), where most of the atmospherically deposited lead is stored, is 8.7 kg/m^2 (Johnson et al. 1991); thus, gasoline lead might account for up to 100 ppm of the total lead in the O soil horizon. Furthermore, the 1926–1989 atmospheric lead input was similar in magnitude to that of total lead released from soil minerals by chemical weathering in the 12,000–14,000 years since the last glacial retreat. The burden of gasoline-derived lead in soil can thus be quantitatively important in studies aimed at lead-source apportionment.

Paint

The use of lead in paints in the United States dates back to the colonial era. White lead provided a consistent base color for interior and exterior paints and made the paint more durable and easy to wash (Browne 1930; Hallett and Rose 1935). Widespread use of lead in US paint manufacturing began in 1884 and peaked in the 1920s,

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

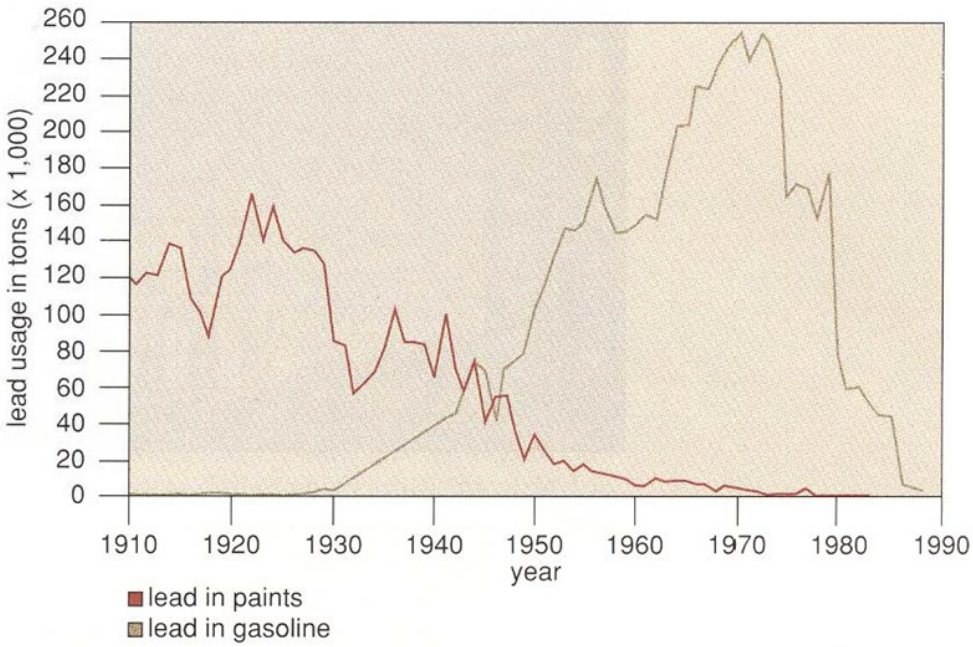

FIGURE 2-3 Annual consumption of lead in the United States in paint and automobile gasoline. Source: Mielke (1999). Reprinted with permission; copyright 1999, *American Scientist*.

but lead-based paints continued to be widely used, especially on exterior surfaces, into the 1970s (Figure 2-3). Baltimore, Maryland, passed the first municipal law that banned the use of interior lead paints in 1951. In 1978, the federal government banned the sale of all lead-based paints. The total consumption of lead by the US paint industry was similar in magnitude to that used in gasoline additives for automobile fuels (Mielke 1999). Therefore, as with gasoline, old paint could represent a quantitatively important source of lead in some soils.

Because of the durability of lead paints and the tendency to paint over, rather than remove, previous paint layers, a large amount of lead is associated with older buildings and with construction debris. Chipping, physical abrasion, and breakdown of paint surfaces by atmospheric chemicals, such as ozone and nitrogen dioxide (Edwards et al. 2009), lead to the release of particulate, aerosol, and gaseous lead from interior and exterior surfaces of residential, commercial, and industrial structures. Soils near buildings constructed before the 1970s often have high lead concentrations, especially near the drip lines where water runs off rooftops. In an extensive study in New Orleans, lead concentrations were substantially higher in soils collected along drip lines of residential homes than in soils near streets or in parks (Mielke 1994; Mielke and Reagan 1998).

Paints used for road markings have also historically contained lead. Abrasion of those paints by vehicles results in road dust with high lead concentrations, much of which is deposited along the sides of the road (Murakami et al. 2007). Some oil paints used by artists continue to contain lead.

Plumbing Materials

Lead pipes were used extensively in indoor plumbing and for residential service lines in most American communities well into the 20th century. Most municipal building codes now prohibit new installations of lead piping, but many homes and older buildings still have lead risers inside and lead service lines outside. In some municipalities—notably Flint, Michigan—lead service lines deliver large amounts of the domestic water supply. Furthermore, lead solder has been used to join copper pipes and pipe fittings and might also be a source of lead in domestic plumbing systems. Corrosion and chipping of the pipes are potential sources of lead contamination in drinking water and in soils outside residential and commercial buildings.

Demolition of aging buildings can result in large releases of lead into the environment if lead pipes and other building materials that contain lead are not removed. Construction debris is thus an important source of lead in many reclaimed urban sites. Superfund sites associated with industrial activities dating back to the first half of the 20th century or earlier might thus have substantial stocks of lead from plumbing and building materials.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Batteries

The manufacture of batteries is one of the largest industrial uses of lead globally. The lead-acid ($Pb–PbO_2$) battery remains the standard means for generating electricity in most vehicles. In the United States, there is an efficient recycling program for lead-acid batteries of all types, which has greatly reduced the amount of battery lead released into the environment generally and deposited in municipal landfills specifically. Smith (2004) estimated a recycling efficiency of 95% for lead in batteries in the United States. The domestic recycling efficiency was estimated to be 77% owing to the export of spent batteries (primarily to Mexico) for recycling. Papp (2013) used a different accounting approach and reported a similar value of 81% for 2011. Wilburn (2014) estimated that 95.5% of the mass of lead-acid batteries was recovered from the municipal waste stream in 2000–2010.

Estimates of lead recycling do not account for long-term storage of batteries before recycling. Substantial lead release can occur from batteries experiencing corrosion. Battery lead might thus be an important source of contamination at sites that host automotive repair businesses.

Agricultural Amendments

Mining wastes have been used as agricultural amendments because metals are commonly associated with carbonate or phosphate rocks (Davies et al. 1993). In the Southeast Missouri Old Lead Belt, for example, chat left over from the extraction of lead from the Bonneterre limestone was crushed and sold for use as agricultural lime through much of the 20th century. Much of that material was used in the surrounding region, but some was shipped by train and barge to towns and ports along the Mississippi River.

Pesticide use has also contributed to environmental contamination with lead. Arsenicals were widely used as pesticides and insecticides in the United States until they were banned in 1988. Lead arsenate—$PbHAsO_4$ or $Pb_5(OH)(AsO_4)_3$ (EPA 1986)—is believed to have been the most commonly used arsenical pesticide (Peryea 1998). It was used for a wide array of crops, but its use in orchards, especially for grapefruit and apples (EPA 1986; Peryea 1998), was particularly widespread. Lead arsenate was typically applied by handgun spraying, and application rates depended on the crop species and the target pest (Peryea 1998).

Extensive use of lead arsenate in orchard lands has necessitated remedial action when those lands have been reclaimed for residential use. Schooley et al. (2008) highlight cases from Virginia, North Carolina, Washington, New Jersey, and Wisconsin in which soil lead concentrations of up to 800 ppm were observed in former apple orchards. Contamination at pesticide manufacturing sites has also been documented. The Industri-plex Superfund site in Woburn, Massachusetts—the site of a former chemical plant that made arsenate pesticides—contained soils contaminated with lead, arsenic, and other metals (DOJ 2012). Ayuso et al. (2004) were able to use lead isotopic analysis to characterize the isotopic signature of lead-arsenate pesticides and concluded that the use of these products could be an important source of lead in soils of formerly agricultural lands in New England.

Other Consumer Products

Lead is an important component of a number of consumer products. Perhaps most notable is ammunition for firearms. Lead shot was nearly ubiquitous until the early 1990s. In 1991, its use in waterfowl hunting was banned. In January 2017, the use of lead shot on federal wildlife refuges was also banned—a regulation overturned in February 2017. The burden of lead in soils and wetlands in or near shooting ranges and popular hunting sites can be high enough to be a threat to wildlife, especially waterfowl and raptors (Kendall et al. 1996; Fisher et al. 2006). Lead sinkers can also be an important source of lead in lakes and rivers that are frequented by fishermen (Jacks et al. 2001; Scheuhammer et al. 2003).

Lead-containing toys, jewelry, and decorative arts are other potential sources that could be important in residential areas. Antique toys and toys that are imported from countries where the use of lead paint is permitted are particularly likely to have high lead concentrations. In some cases, the lead is found in the paint used to decorate the toys. Lead might also be incorporated into the plastics of inexpensive toys. Because lead helps to make plastic more malleable, it is likely to be found in soft plastic toys. Similarly, other household plastics, such as vinyl window blinds, can be an important source of household lead. Sunlight and heat can degrade the material and result in release of dust that has high lead concentrations (EPA 2016). In older homes, lead might also have been used in counterweights in windows.

Lead is abundant in several forms of glass. Leaded glass, which is used for artisan crystal and stained glass, is composed of 12–60% lead oxide, and opal illumination glass contains an average of 3.0% lead oxide (Spinosa et al. 1979). In the late 19th and early 20th centuries, Southeast Missouri hosted an active glass industry, including extraction of local sand for glass-making (Burchard 1907). Many glazes and solders have high lead concentrations. Leaded glazes are used because they provide a smooth finish that highlights bright colors. Terra cotta pottery from Latin America, such as Mexican bean pots, often has high lead concentrations, as do some highly decorated ceramics from Asia. Lead solder is often used in electronic parts and in inexpensive jewelry, and lead is used to make jewelry heavier.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

The interested reader is directed to Tables 3-3 and 3-4 in EPA (1998), which contain comprehensive lists of industrial and commercial uses of lead alloys and lead compounds, respectively. Lead derived from the decay of consumer products or present in demolition debris is a potential source to consider in attribution studies in lead-contamination investigations, especially those associated with exposures in the residential environment.

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3

Environmental Dispersal of Lead

Chapter 2 described many possible sources of lead that could cause environmental contamination. To assess whether a lead source might be contributing to observed contamination, one must first consider possible dispersal pathways. As shown in Figure 2-1, there are natural and intentional transport mechanisms; in this chapter, the committee discusses those mechanisms and how they might promote the dispersal of lead into the environment. Aqueous processes and transport are described first, then air transport, and finally intentional transport.

AQUEOUS PROCESSES AND TRANSPORT

A primary natural transport mechanism is water. In this section, the committee discusses lead solubility and species in water, lead partitioning between water and solid phases, and sediment-associated dispersal in rivers.

Lead Solubility and Species in Water

Dissolved lead concentrations can vary by orders of magnitude but are generally lower than those of other dissolved species. In uncontaminated fresh and saline waters, concentrations typically range from around 0.2 to 200 ppt (about 10^{-12}–10^{-9} mol/L). In contaminated waters, lead concentrations typically rise into the range of a few hundred parts per billion (about 10^{-6} mol/L). For example, a river contaminated by acid mine drainage and dissolved metals had a maximum lead concentration of 698 ppb (3.4×10^{-6} mol/L) and a mean concentration of 121 ppb measured over 2 years (Nieto et al. 2007); in contrast, mine runoff and discharge waters at near-neutral pH in a lead mining area had lead concentrations that averaged 2.6–14 ppb over 1.5 years (Schaider et al. 2014). For comparison, in a 7-month period in 1966-1967, the mean total lead concentration in rainfall in the United States was 34 ppb, and lead concentrations were higher near cities because of emissions from industrial activities and gasoline (Lovering 1976). As a result of lead accumulation in soils related to lead-containing precipitation before 1976, lead concentrations as high as 330 ppb were measured in runoff water from soils in some parts of New England (Hem 1976). In the United States, emissions of lead to the atmosphere and later deposition on land decreased substantially after the early 1980s, when the addition of lead to gasoline was phased out (Callender 2005). In highly contaminated surface waters and groundwater, lead concentrations can exceed 1,000 ppb (or 1 ppm), but this is generally rare, and most waters with high dissolved lead have concentrations well below parts per million. Away from contamination sources, lead is typically reduced to low concentrations by mixing and dilution with uncontaminated waters and by adsorbing to particles in the water column as described in the next section.

In most surface environmental settings, the lead in water is predominantly divalent lead, Pb^{2+}. In the absence of dissolved organic matter, Pb^{2+} has a strong tendency to form hydroxo species, such as $PbOH^+$, in solution with increasing pH (Figure 3-1A). In common surface waters and groundwater, the dissolved carbonate is typically about 10^{-5}–10^{-3} mol/L total carbonate, and lead-carbonate complexes will dominate over lead-hydroxo species over the typical pH range of natural waters, about 6.5–9.5 (Figure 3-1B). In contaminated waters that contain high dissolved sulfate, such as those associated with acid mine drainage, free Pb^{2+} is the dominant species below a pH of about 7, and the aqueous complex with sulfate, $PbSO_4(aq)$, is a minor species (Powell et al. 2009). In seawater and high dissolved-chloride systems, lead-chloride complexes—$PbCl^+$, $PbCl_3^-$, and $PbCl_2(aq)$—dominate over free Pb^{2+} below a pH of about 7.5. At alkaline pH and high chloride, dissolved lead is present mostly as aqueous lead-carbonate complexes, $PbCO_3(aq)$ and $Pb(CO_3)_2^{2-}$, rather than free Pb^{2+} or mixed carbonate-chloride and carbonate-hydroxo complexes (Powell et al. 2009).

Dissolved organic matter (DOM) forms strong complexes with Pb^{2+} that can dominate speciation in water, depending on the DOM concentration (Town and Fillela 2000a,b; Rozan et al. 2003). Because natural DOM is a heterogeneous and complex mixture that contains dif-

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ferent organic functional groups, many binding-site concentrations and stability constants for lead complexation have been reported (Town and Fillela 2000b). Researchers have attempted to use simple organic acids and ligands as proxies for DOM to describe lead–DOM interactions, but those attempts have had mixed success (Rozan et al. 2003; Vega and Weng 2013; Stockdale et al. 2015).

As discussed in the next section, lead can also be transported in surface waters or groundwater in association with colloidal or suspended particles. After a water sample is collected, it might or might not be filtered before the lead concentration is analyzed. If filtered, the pore size of the filter used can influence the measured lead concentration by removing fine particles that contain lead. A standard filter pore size is 0.45 µm (EPA 1996). The lead concentration measured in a sample after passing through a 0.45-µm filter is typically referred to as the dissolved concentration, whereas *total lead* generally refers to lead measured in unfiltered water samples after acid digestion. The two measurements differ if filtration removes particles that contain lead larger than the filter pore diameter. For example, in one study of more than 100 groundwater samples from private domestic water wells in Pennsylvania, total (unfiltered) lead concentrations varied from 0 to 100 ppb. When dissolved (filtered) lead concentrations were compared with total lead in the water samples, the authors determined that dissolved lead concentrations were lower by 6–18 ppb (Swistock et al. 1993).

Lead Partitioning

Given the low concentrations of dissolved lead found in most natural waters, surface sorption (adsorption or ion exchange) of Pb^{2+} onto mineral surfaces or organic matter will likely be the most common mechanism of lead removal from solution to solid phases in surface environments rather than precipitation of new lead species. Precipitation of Pb^{2+} salts, however, occurs in the surface weathering of lead minerals, in evaporative scenarios, and from high-lead surface waters or groundwater near, for example, mining sites or industrial lead sources (see below). Sorption of lead from solution onto mineral surfaces is controlled by pH, solution concentration, and type of mineral surface (Stumm 1992). For example, dissolved lead has a stronger binding affinity to iron hydroxide mineral surfaces than to aluminum hydroxide surfaces, and this results in greater lead adsorption to surfaces of iron hydroxide than to aluminum hydroxide at lower pHs if

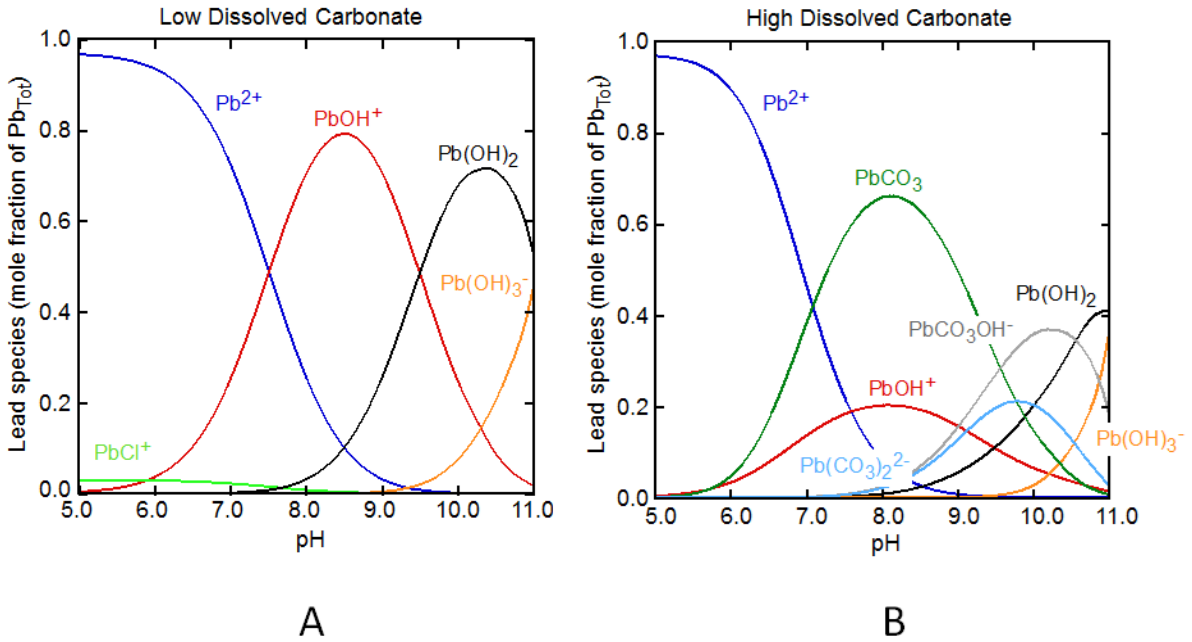

FIGURE 3-1 Dominant lead species in water as a function of pH at (A) low and (B) high dissolved-total-carbonate concentrations. *Low* dissolved carbonate refers to a solution in equilibrium with a partial pressure of CO_2 (g) (P_{CO2}) of about 10^{-5} atm, and *high* dissolved carbonate refers to a solution in equilibrium with a P_{CO2} of about $10^{-3.5}$ atm (about atmospheric CO_2). Calculated with PhreeqC by using equilibrium constants from Powell et al. (2009). Lead species that constitute less than about 1% of the total lead concentration of 2×10^{-6} mol/L are not shown. Source: Adapted from Powell 2009. Reprinted with permission; copyright 1999, *Pure and Applied Chemistry*.

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the solution concentration and mineral surface area are the same (Figure 3-2) (Serrano et al. 2009). The high affinity of lead for iron and manganese oxides also allows it to outcompete other ions for sorption. Clay minerals can bind Pb^{2+}, particularly at acidic pH, but the bound lead can be displaced by cations, such as Ca^{2+}, when they are present at concentrations similar to that of the Pb^{2+}. Pb^{2+} sorbs to calcite, $CaCO_3$, and other carbonate minerals at alkaline pH (Rouff et al. 2005).

Sorption of Pb^{2+} on mineral surfaces is relatively fast, typically minutes to hours. Depending on the mineral type and aging time, desorption of lead can be mostly reversible (that is, lead is completely removed from the surface and goes back into solution) or only partly reversible (that is, some lead remains bound to the surface) if pH or solution conditions change. Longer reaction or aging time can lead to incorporation of Pb^{2+} into a mineral structure or irreversible binding. For example, a minor amount of Pb^{2+} might be substituted for the divalent cation in carbonate mineral phases, or it might be incorporated into the structure of hydrated iron oxide phases (ferrihydrite or hydrous ferric oxide); this requires dissolution of the solid phase to release lead into solution. The observed slow release of lead from soils in leaching experiments has been attributed to the strong binding of Pb^{2+} to oxoanions in the interlayer of clay minerals and the resulting low rates of desorption from those sites (Serrano et al. 2013).

In soil and sediment weathering, lead-ore minerals, such as galena (PbS), might oxidize, dissolve, or change to form new minerals that might (or might not) be lead-rich solids, such as mixed-element salts or mineral solid solutions. The amount of weathering, rainfall, and leaching in a given environment determines whether lead minerals dissolve completely, change to other solids, or adsorb to other mineral surfaces if dissolved (Hayes et al. 2009). For example, in environments with high rainfall, such ions as lead tend to leach from soils to water, where they are transported as dissolved species, or to adsorb to particles or organic matter in water and migrate as particle-associated species (Schaider et al. 2014; Gutierrez et al. 2016). Organic matter in soils, which is typically more abundant in temperate and tropical environments, tends to retain lead by adsorption and hinder its release to water (Marzouk et al. 2013). In contrast, in arid and semiarid regions where soils undergo intermittent wetting and drying, weathering might result in the formation of carbonate, clay, hydrous oxides, sulfate, or mixed sulfate–hydroxide phases that incorporate lead into their structure or adsorb lead on their surfaces (Dutrizac and Jambor 2000; Jambor et al. 2000).

The pH of water—either surface water or water in the pores of soils and sediments—exerts a strong influence on the dissolution of lead solids derived from original sources (primary phases), the formation of new lead-

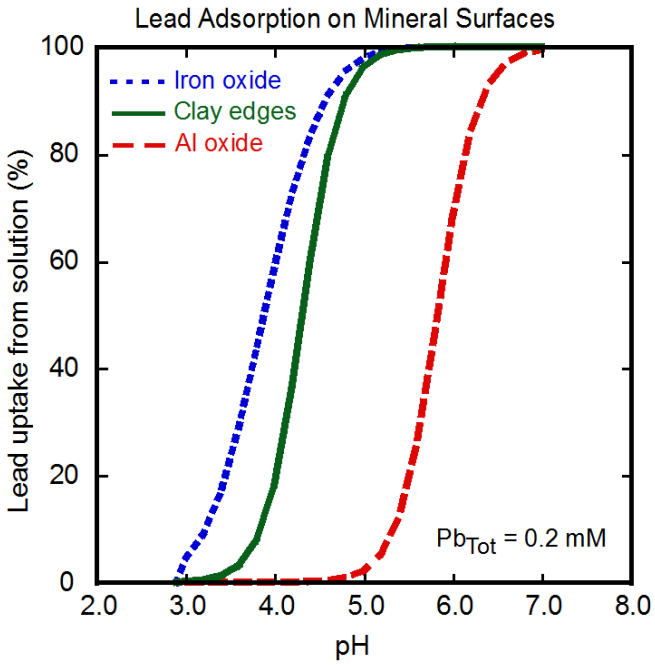

FIGURE 3-2 General examples of lead adsorption (as percent uptake from solution) on mineral surfaces as a function of pH for three soil-mineral types: iron oxide or hydroxide, edge sites of clay minerals, and aluminum oxide or hydroxide. The pH range over which lead sorbs in real systems will vary with solution and mineral-surface-site concentrations. Calculated with PHREEQC by using sorption parameters from Serrano et al. (2009). Source: Data adapted from Serrano et al 2009. Reprinted with permission; copyright 2009, *Geochimica et Cosmochimica Acta*.

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containing solids by precipitation (secondary phases), and lead adsorption to the surfaces of other soil minerals. The presence of carbonate minerals, such as calcite, in soils and sediments buffers pH near neutral or above (about 7.2–8.2). Given those conditions, lead is often retained by the precipitation of new carbonate minerals or by adsorption. For example, cerussite, $PbCO_3$, was noted as a major secondary weathering phase in sediments that were affected by a historic mining district of Wanlockhead, Scotland (Hillier 2001). Studies of the weathering of lead munitions illustrated that cerussite and hydrocerussite, $Pb_3(CO_3)_2(OH)_2$, were primary products that likely control dissolved lead concentrations in soil-pore water (Jørgensen and Willems 1987; Lin et al. 1995; Cao et al. 2003a; Hardison et al. 2004; Rooney et al. 2007). Similarly, formation of cerussite and mixed lead hydroxide–carbonate phases—including hydrocerussite and plumbonacrite, $Pb_5(CO_3)_3O(OH)_2$—have been reported as products of corrosion of lead pipes (Xie and Giammar 2011; Masters et al. 2016) or products of direct weathering of galena at alkaline pH (Hudson-Edwards et al. 1996; Root et al. 2015). Soils or sediments that have high phosphate concentrations, such as agricultural soils that receive high concentrations of fertilizer, might contain pyromorphite, $Pb_5(PO_4)_3Cl$ (Cao et al. 2003b). As a result of weathering or alteration, secondary lead phases form as crusts or scales on surfaces of galena, lead shot, or lead pipe where lead concentrations are relatively high (Cao et al. 2003a; Pieper et al. 2017). However, at lower concentrations as lead is dispersed, adsorption on clay minerals or amorphous iron oxides or aluminum oxides in soils and sediments is often the primary mechanism for retaining lead and limiting its mobility in water (Hillier 2001; Yang et al. 2006; Rooney et al. 2007).

In areas that have lead-bearing ore minerals and wastes from deposits that contain abundant iron sulfide minerals that produce sulfuric acid during weathering (see Chapter 2), extensive weathering and leaching result in progressively more acidic waters as carbonate is removed and buffer capacity is lost (Hayes et al. 2009; Nordstrom et al. 2015). In acidic conditions in soils and water, the concentrations of iron, aluminum, and sulfate are important controls on lead dispersal or retention in surface weathering or evaporative scenarios. Assemblages of anglesite, $PbSO_4$, and plumbojarosite, $PbFe_6(SO_4)_4(OH)_{12}$, with a wide variety of mixed-metal salts that contain iron, aluminum, and sulfate are common products of lead-rich weathered ore deposits and mine wastes (Dutrizac and Jambor 2000; Jambor et al. 2000). Soils and evaporated sediments that have high dissolved lead and sulfate concentrations, such as those associated with tailings impoundments or mine drainage, might contain anglesite; possibly linarite, $PbCu(SO_4)(OH)_2(s)$, if copper concentrations are high; or lead substituted in many other hydrated-sulfate salts (Jørgensen and Willems 1987; Bigham and Nordstrom 2000; Jambor et al. 2000). The sulfate–hydroxide phases often precipitate and dissolve quickly as conditions change, but reaction rates in different environments will depend on particle size, mineral crystallinity, pH, and solution composition.

Sediment-Associated Lead Dispersal in Rivers

As noted above, lead has a high propensity to be sorbed (attached) to particulate matter under the geochemical conditions observed in most rivers. The concentration of lead associated with particulate matter also tends to be orders of magnitude higher than the concentrations of dissolved lead in surface water or groundwater. Given the concentrations of lead associated with particles and the ability of rivers to move large quantities of sediment, rivers are highly efficient in transporting lead considerable distances downstream from a natural or anthropogenic source. The movement of sediment-associated lead from historical mining and milling operations can be particularly pronounced because waste materials were often stored within impounded river valleys and allowed to enter a river channel unabated.

The downstream transport of sediment-associated lead is a function of the size of the sediment that is being moved and the energy provided by the flow to perform mechanical work. In general, the higher the flow (discharge), the more sediment and sediment-associated lead can be transported through a given stream segment, although the relationship between flow and sediment transport is complicated. Transport of suspended sediment depends on factors—such as the existing soil moisture conditions; rainfall volume, duration, and intensity; and vegetation cover—that influence the movement of sediment from upland areas to the river. As a result, concentrations of suspended sediment and sediment-associated lead vary widely between floods and nonlinearly during a single event, and quantification of suspended sediment and particulate lead transported through a stream segment requires the monitoring of numerous floods over multiple years and an understanding of how concentrations of particulate lead change during a runoff event.[1]

The downstream dispersal of sediment-associated lead (and other trace metals) from a point source generally creates a distinctive systematic downstream decrease in lead concentrations in the sediments in the channel and its associated valley. Figure 3-3 provides an example of the spatial trends commonly encountered for metals downstream of point sources of contamination along the Rio Chilco–Rio Tupiza drainage system of southern Bolivia. Lead, zinc, and antimony concentrations are relatively low at site RC-3 and are comparable with local background values. Concentrations of the metals or metalloids abrupt-

[1]See Richards (2001) for a summary of methods to estimate pollutant loads.

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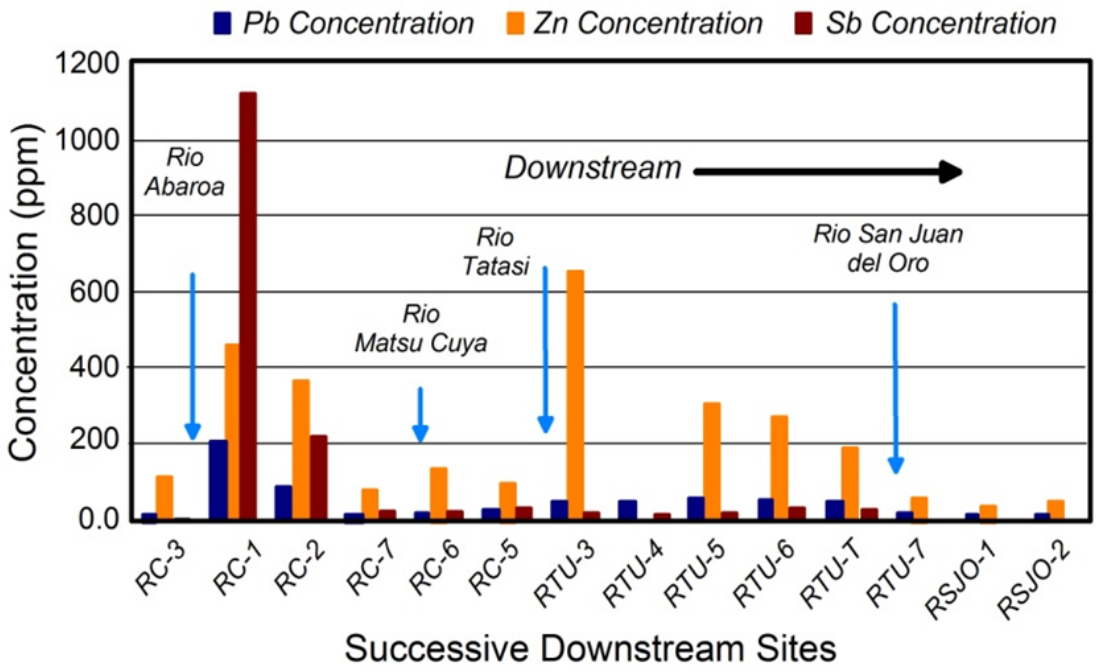

FIGURE 3-3 Lead, zinc, and antimony concentrations measured in channel-bed sediments of the Chilco–Tupiza drainage system of southern Bolivia. Antimony mines are in the Rio Abaróa and Rio Matsu Cuya tributary basins. Polymetallic tin deposits that contain little antimony are in the Tatasi River basin. Point sources of contamination are indicated by abrupt increases in element concentration followed by downstream declines. Source: Villarroel et al. (2006). Reprinted with permission; copyright 2006, *Environmental Geology*.

ly increase immediately downstream of the Rio Abaróa, a tributary contaminated by antimony mining and a tailings impoundment failure (Villarroel et al. 2006). The abrupt increase is presumed to result from the influx of contaminated sediment from the mine site. Concentrations of all three elements then decline systematically downstream. However, zinc concentrations abruptly increase again on reaching the confluence of the Rio Tatasi and to a lesser degree the Rio Matsu Cuya. Both drainages contain large-scale mining operations where tailings have entered the channel. Thus, the increased concentrations reflect the additional input of zinc-contaminated tailings into the river.

Longitudinal decreases in lead concentrations, such as those documented downstream of the Rio Abaróa, result from the interaction of multiple processes (Figure 3-4) (Lewin and Macklin 1987; Macklin 1996; Miller and Orbock Miller 2007). Those processes include (1) dilution associated with the dispersal of sediment-associated lead from a relatively small source area over a much longer segment of the river, (2) dilution caused by the mixing of contaminated particles with clean sediment from tributaries and eroded bank deposits, (3) the deposition and storage of lead in the channel bed and other alluvial deposits (a process that removes sediment-associated lead from further transport), and (4) the hydraulic sorting of contaminated particles as a result of the selective erosion, transport, and deposition of larger or denser grains, such as galena. In addition, geographic patterns in lead concentrations can be influenced by the geochemical processes described earlier. Although the downstream dispersal of sediment-associated lead can be systematic, a number of processes complicate geographic patterns in dispersal. The most important are described below.

Lead Partitioning between Particles That Have Different Physical Properties

In most rivers, lead is largely associated with chemically reactive, fine-grained sediments (Horowitz 1991). During their downstream transport, the sediments might be hydraulically separated by particle size and density in localized areas of the riverbed and its floodplain; each area has a distinctive range of particle sizes. Such areas in the river include pools, riffles, point bars, and glides (Figure 3-4a). Within the floodplain or bank, the particles form packages of sediment referred to as vertical accretion deposits, lateral accretion deposits, crevasse-splay deposits, and oxbow lake deposits, and others (Figure

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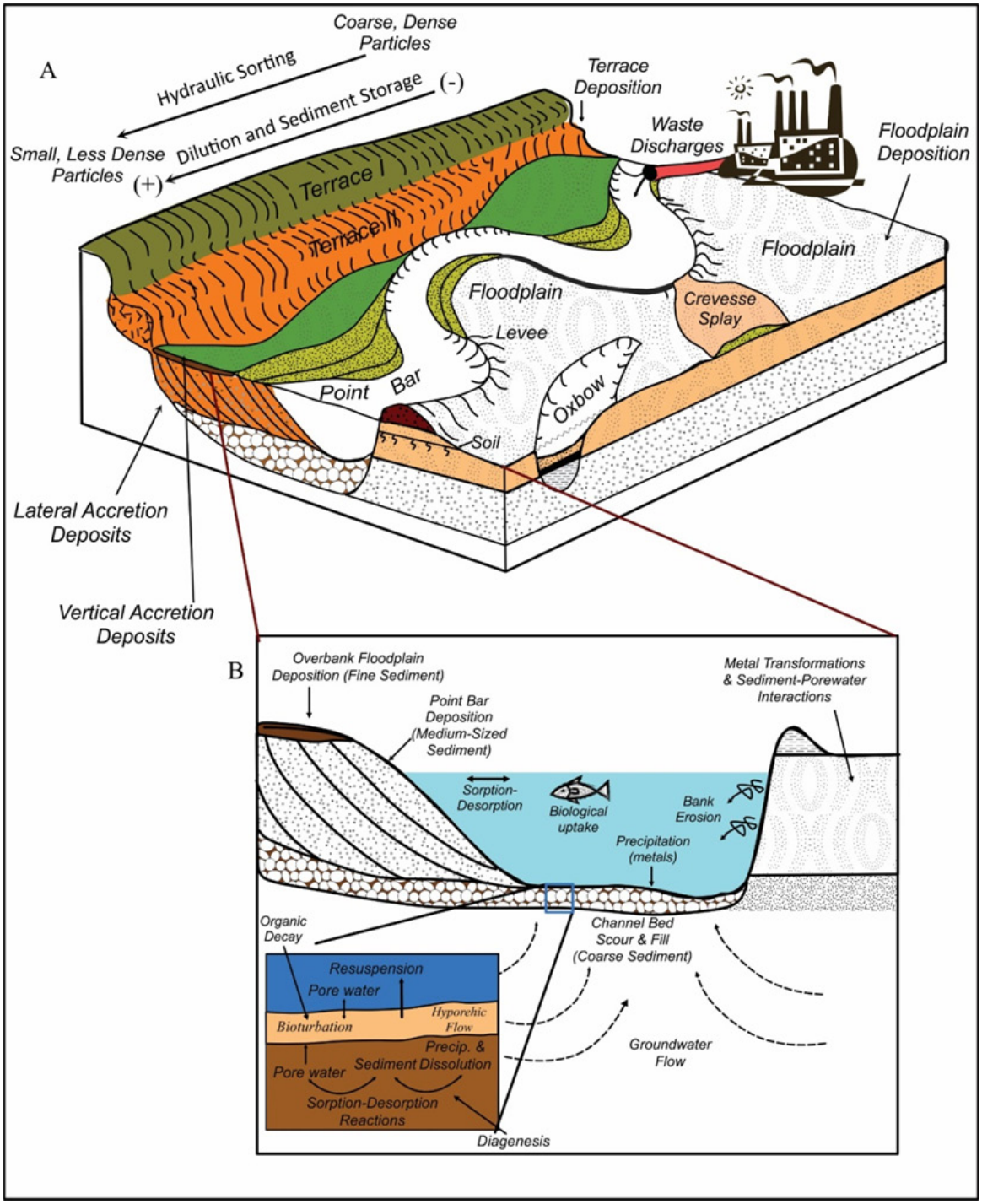

FIGURE 3-4 Schematic diagrams that illustrate potential sites of sediment-associated lead deposition in a river and the primary factors that influence lead concentrations in channel-bed sediment. (A) Processes operating along a stream segment include hydraulic sorting, dilution, and sediment storage; partition of sediment by size and density into various morphologic units is also shown. (B) Geochemical and biologic processes—including oxidation–reduction, precipitation, dissolution, and cation exchange processes—might also influence geographic patterns of contaminant concentration. Source: Adapted from Miller and Orbock Miller (2007). Reprinted with permission; copyright 2007, Springer.

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3-4a). Such particle partitioning results in the concentration of lead in specific areas of the drainage network that contain fine-grained, lead-enriched particles (Macklin et al. 1999; Macklin et al. 2006; Miller and Orbock Miller 2007).

Along rivers that are affected by the influx of mining and milling debris, lead is associated not only with fine-grained sediment but with coarse-grained sediment (Moore et al. 1989; Miller et al. 1998). The exact distribution depends largely on the milling process used and on how metals were incorporated into the tailings (waste) materials. For example, Pavlowsky et al. (2010) found that high lead concentrations in tailings from the Leadwood and National Piles in Southeast Missouri occurred in the sediment fraction measuring less than 63 μm and in the fraction measuring 4–8 mm. Lead concentrations associated with particles of an intermediate size were relatively low because the milling process was more efficient in recovering lead (and zinc) from these particle sizes. Thus, the geographic distribution of sediment-associated lead is likely to reflect the spatial distribution of particle sizes in the river valley.

In addition to particle size, grain density might affect partitioning of sediment, particularly in mineralized areas. For example, some minerals, such as gold and galena, have a relatively high density. Those dense mineral grains are often concentrated in localized zones in which the denser but smaller metallic grains coexist with larger but less dense minerals, such as quartz, feldspar, and carbonate minerals. The zones of concentration, which are called placer deposits, are created by the repeated processes of erosion and redeposition of particles of a given size range (Slingerland and Smith 1986). Placers tend to form upstream of natural protrusions that are caused by resistant strata where bedrock is present and upstream of manmade structures, such as road crossings and small dams. Placers might also form along rivers where the channel perimeter is composed of sediments. Those types of placers are formed in areas where the repeated erosion and redeposition of sediment concentrates the denser particles, such as at the base of point bars, the head of midchannel bars or islands, and the confluence of tributaries (Guilbert and Park 1986).

Not all differences in the concentration of sediment-associated metals observed between the depositional units of a river can be attributed to particle size and density (Graf et al. 1991; Hudson-Edwards et al. 2001). Areas in the channel that are inundated or flooded more often commonly exhibit higher sediment-associated metal concentrations (Graf et al. 1991). The influence of inundation frequency on metal concentrations is related to two primary factors. First, the more an area of the channel is flooded, the greater the opportunity for sediment-associated lead to be incorporated into the area's channel sediments. Second, the frequency of inundation depends on flood size: topographically higher and less frequently inundated areas are flooded during larger runoff events. In many contaminated rivers, sediment-associated metal concentrations decrease with increasing flow because there is an increased influx of clean sediments to the channel from upland areas of the basin. The clean sediments decrease the concentrations of the metals in the sediments that are incorporated into the less frequently inundated channel areas (Marron 1987).

Localized Downstream Variations in Sediment-Associated Lead Transport and Deposition

Many river systems exhibit abrupt changes in their capacity to transport sediment along the drainage network (Macklin and Lewin 1989; Miller and Villarroel 2011; Miller et al. 2012). For example, segments of the stream characterized by higher gradients and narrower than average valleys tend to transport sediment and sediment-associated lead with little deposition. In essence, flood waters are confined by the narrowness of the valley to a smaller area, which when combined with higher gradients creates more energetic and erosive flows. In contrast, sediment transport is reduced in sedimentation zones that are characterized by wide valleys and shallowness (Mackin and Lewin 1989; Mackin and Dowsett 1989; Mackin 1996; Miller et al. 2009). As a result, systematic downstream trends in the concentration and storage (deposition) of sediment-associated lead might be locally disrupted by changes in river and valley gradient and width. The influence of river or valley gradient and width on geographic patterns of sediment-associated metal concentrations is most pronounced along rivers in mountainous terrain but can also be important along lowland rivers.

Influence of River Transformations on Sediment-Associated Lead Dispersal

Lewin and Macklin (1987) argued that the dispersal of sediment-associated metals differs between rivers in a stable, equilibrium state and those in an unstable, disequilibrium state. The latter are characterized by continuing changes or transformations in channel width, depth, slope, and sinuosity caused by localized erosion or deposition. Transformations in river structure are important because they influence the rate at which sediment-associated metals are transported to downstream areas and are important determinants of the sites along the river where sediment-associated metals are deposited and stored. A relevant example is the influx of large quantities of sediment and tailings into a river from historical mining or milling operations. The increased sediment load often overwhelmed the transport capacity of the river near the site of sediment input and caused deposition on the riverbed and on the adjacent floodplain. Deposition was often substantial and in

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some cases measured several feet to tens of feet in thickness (Gilbert 1917; James 1989; Knighton 1991). Once the influx of sediment from the mines or mills decreased, the river was able to transport the previously deposited sediment downstream, but some remained in the stream segment and was exposed within the riverbanks, where it could be eroded and re-enter the river. The sediment that was transported downstream often overwhelmed that portion of the river and caused deposition there until sediment loads declined, at which point the riverbed was eroded and the cycle repeated itself further downstream. When viewed in its entirety, the cycle of deposition and erosion formed a kind of sediment wave that migrated downstream from the site of sediment input (Gilbert 1917; Knighton 1991; Nicholas et al. 1995). The downstream passage of the wave typically took decades to complete and strongly influenced the rate at which sediment-associated metals were transported along the river.

The influx of sediment from historical mining and milling operations is not the only type of disturbance that can cause such transformations in river structure and sediment transport rates. In fact, such changes in river function are associated with a wide array of natural disturbances (such as landslides and wildfires) and anthropogenic activities (such as deforestation and land-use change). One of the most widespread and extensively documented disturbances in the United States that led to such transformations in river form was land-use change initiated by European settlement during the late 19th and early 20th centuries (Trimble 1974; Knox 1989; Orbock Miller et al. 1993; Price and Leigh 2006; Leigh 2010). Specifics of the documented changes in the river basins vary between sites; however, they were generally characterized by (1) large-scale devegetation of hillslope and valley bottoms that resulted in an increase in runoff to the drainage network, (2) gullying and accelerated erosion of upland soils that led to an increase in sediment loads into the channel, (3) deposition of sediment on floodplains or riverbeds that produced what are commonly called legacy sediments, and (4) a period of reforestation and improved watershed management practices that resulted in reduced runoff, sediment yield, and, in many cases, channel erosion (Trimble 1974; Knox 1987).

During the above transformations in rivers and river valleys, lead associated with natural soil particles might be incorporated into the sediments that are deposited along the river, particularly the floodplain. After erosion of the riverbed, those sediments (including any lead that they contain) will be exposed in the riverbanks (see Figure 3-5), where they might continue to be eroded and reintroduced to the river (James 1989; Miller et al. 1998; Bain et al. 2012; Niemitz et al. 2013). Such processes might be particularly important along rivers that drain mineralized rocks, such as in Southeast Missouri.



FIGURE 3-5 Mine tailings incorporated into floodplain deposits near Leadville, Colorado. Erosion reintroduces sediment-associated lead into the drainage network.

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The erosion and lowering of the river bed also forms an alluvial terrace. Terraces are old floodplains that because of erosion and lowering of the river bed now exist topographically above and adjacent to the river and its floodplain (Figure 3-4). Terraces often contain sediment-associated lead that was deposited by the river but is now spatially removed from the modern channel. Geographic patterns in sediment-associated lead concentrations in terraces are influenced by the timing of lead inputs into the river, terrace height above the modern channel, and the frequency with which the terraces are flooded. During the period of lead influx, lower elevation terraces are likely to have higher concentrations and larger quantities because they are inundated more frequently. After the influx of lead, contaminated sediments on the lower terraces are likely to be buried more rapidly by sediments that have lower lead concentrations. Thus, lead-contaminated soils can be at or closer to the surface on higher terraces than on lower terraces or the floodplain (Brewer and Taylor 1997).

AIR TRANSPORT

Airborne transport has the greatest potential to disperse lead emissions because the air is not confined by geographic barriers. Furthermore, rates of transport of contaminants are often higher for the air pathway than for groundwater and surface-water pathways (Prabhakar et al. 2014). The potential for lead transport via the air pathway can be illustrated with data from Southeast Missouri. Specifically, lead concentrations that were reported as part of monitoring for National Ambient Air Quality Standard (NAAQS) compliance indicate that lead is transported via the air pathway, and the measurements provide some indication of the sources responsible for the airborne lead. Nonattainment occurred in three counties—Iron, Dent, and Reynolds—in the Southeast Missouri Lead Mining District. One site includes the nearby secondary lead smelter (Boss, MO) that reported a 3-month running lead average of 0.17–0.18 μg/m^3 in April–August 2016.[2] Some monitoring sites in the facility fence line reported higher 3-month average values of 0.24–0.33 μg/m^3 from December 2016 through March 2017 (MO DNR 2017). An example of long-term variation in ambient lead concentrations in 2011–2016 is shown in Figure 3-6 and summarizes US Environmental Protection Agency (EPA) data. Although large decreases in total suspended particulate (TSP) lead concentrations in the Herculaneum and Doe Run areas were found after the smelter closed at the end of 2013, 588 samples showed that 24-hr lead concentrations exceeded the NAAQS threshold, 0.15 μg/m^3, in 2014–2016 (EPA 2017).

A fundamental characteristic of suspended particulate matter (PM) that affects transport is its size distribution, often expressed as a function of the particle's aerodynamic diameter.[3] The size distribution affects aerosol physics, chemistry, and transport, and environmental and health effects. This section first describes particle-size distributions and how they affect transport and then fugitive dust suspension and deposition, which are probably the most relevant to lead dispersal from mining-associated sites and other sources. The section concludes with an example of modeling of air transport.

Particle-Size Distribution and Implications for Transport

Airborne PM can range in diameter from a few nanometers to a few hundred micrometers, a span of 5 orders of magnitude, and follows a size distribution like that shown in Figure 3-7. Particles that have an aerodynamic diameter of greater than about 2.5 μm are called the coarse fraction, and particles that have an aerodynamic diameter of less than about 2.5 μm are called the fine fraction, which includes the nucleation, ultrafine, and accumulation fractions. Because mass scales with the cube of the diameter, PM *mass* concentrations are often dominated by the presence of large particles. Conversely, PM *number* concentrations are dominated by the smallest particles. The different size fractions have different sources, removal mechanisms, transport characteristics, atmospheric residence times, and deposition patterns in the environment and the respiratory tract.

Coarse particles (greater than 2.5 μm) are generated by mechanical action, such as crushing, grinding, material handling, wind erosion, or vehicular traffic (Watson et al. 2000). Large particles have high gravitational settling velocities and can deposit onto a surface within a few minutes to a few hours after suspension. For example, chat piles in Southeast Missouri consist of large particles, which are unlikely to become suspended and transported long distances by direct wind action except during extreme weather events, such as tornadoes. Particles that have diameters of a few micrometers, however, can remain suspended for several days and can therefore be transported long distances, even across continents or oceans. Atmospheric turbulence plays an important role in lofting suspended particles from near the ground to higher altitudes, thereby facilitating long-distance transport (Pye 1987).

Fine particles (less than 2.5 μm) are typically generated by condensation of hot vapors and by diffusion and coagulation of gases and other fine particles. Like smaller particles described above, fine particles can be transport-

[2]Nonattainment occurs when air quality is not in compliance with the NAAQS; that is, when the rolling 3-month average exceeds 0.15 μg/m^3.

[3]Aerodynamic diameter (d_a) varies inversely with the square root of the density. It is different from the geometric diameter (d_g); $d_g = d_a/\sqrt{\text{density}}$.

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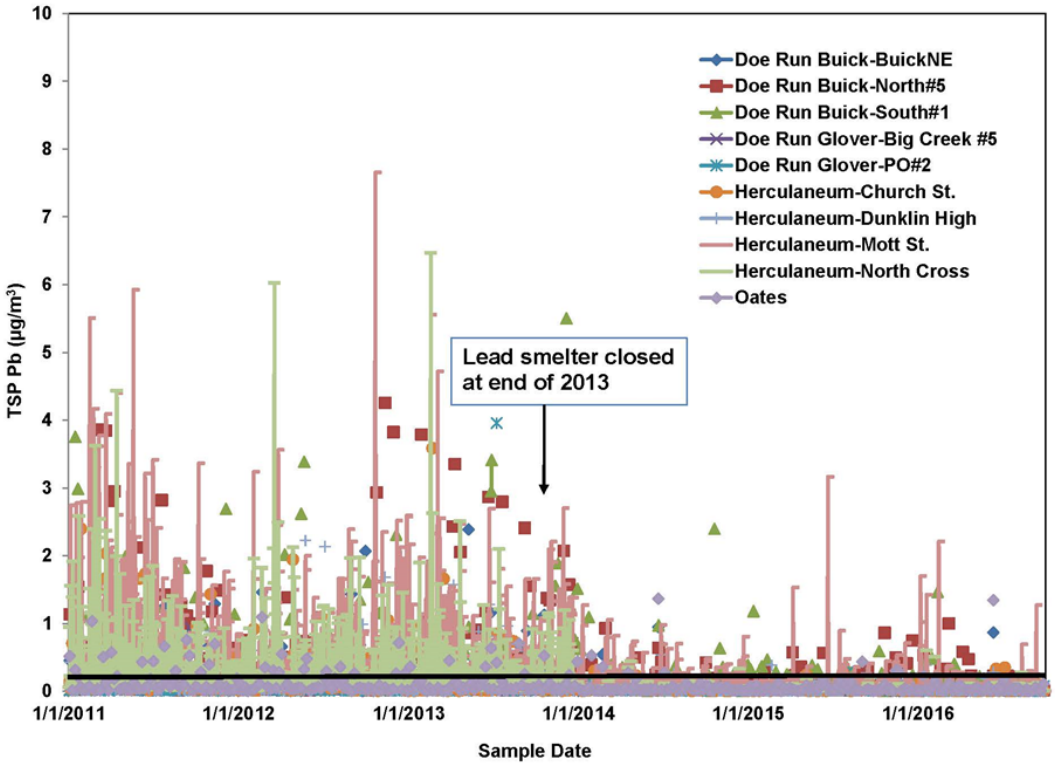

FIGURE 3-6 Time series of 24-hr average TSP lead concentrations at selected Missouri monitoring sites. The black line indicates the NAAQS threshold, 0.15 µg/m^3. Source: EPA (2017).

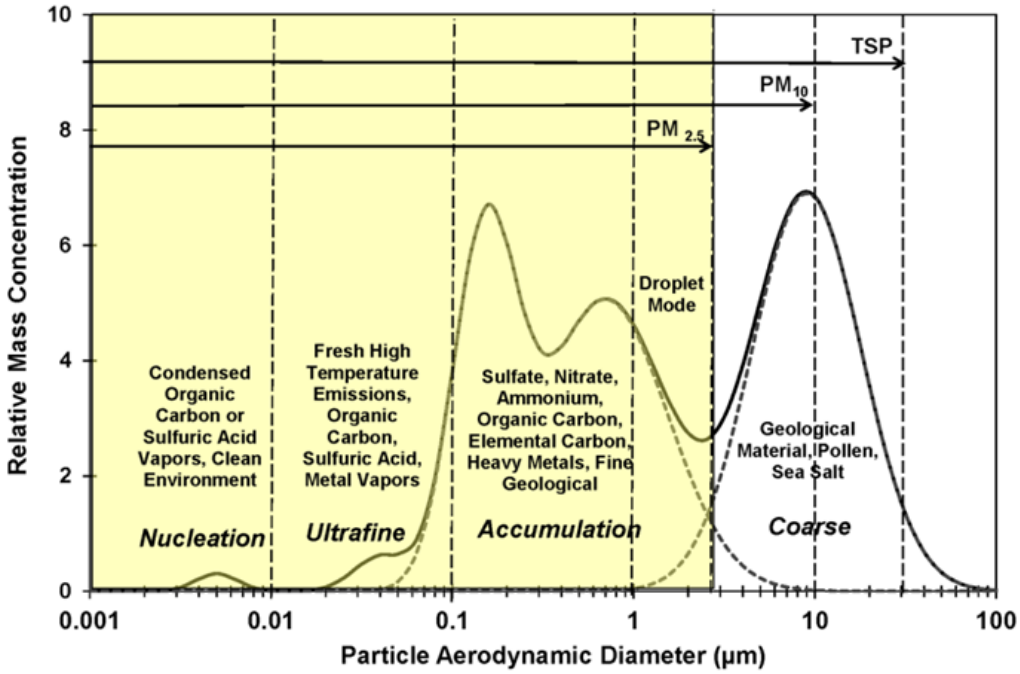

FIGURE 3-7 Illustration of different size fractions of airborne particles in a typical atmospheric particle-size distribution. Size-selective inlets with 50% collection efficiencies are used to determine aerodynamic diameters of $PM_{2.5}$ and PM_{10}. Sources and processes that affect each mode are indicated. Yellow-shaded area denotes fine-particle fraction (less than 2.5 µm). TSP refers to sizes up to about 30–50 µm. Source: Adapted from Chow (1995). Reprinted with permission; copyright 1995, *Journal of the Air & Waste Management Association*.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

ed long distances. For example, lead-smelting activities in Southeast Missouri probably emitted lead-containing vapors that nucleated and condensed into fine particles (Moravec et al. 2015) or that condensed onto the surfaces of pre-existing fine particles; these particles were then transported long distances and deposited on the Earth's surface through both dry and wet deposition where they might still be present in soils.

Fugitive Dust Suspension and Mechanisms

Fugitive dust (Chow and Watson 1992; Kinsey and Cowherd 1992; Watson et al. 2000; Amato 2001; Cowherd 2001) consists of small particles that are suspended in the atmosphere after emission from such sources as mining pits, open fields and parking lots, paved and unpaved roads, agricultural fields, construction sites, dry lakes (playas), unenclosed storage piles, and material transfer systems. Visible dust plumes are often noticed over those sources when wind speeds are high or when vehicles are moving. Studies show that, on the average, fugitive dust contributes about 40–60% of PM_{10} and about 5–20% of $PM_{2.5}$ measured in the atmosphere (Watson and Chow 2000). However, fugitive dust contributions are often overestimated when published emission rates are used in dispersion models that simulate contributions to receptor concentrations (Watson et al. 2000) because the meteorologic, physical, and chemical factors on which fugitive dust emission rates are based can vary widely on local, regional, and national scales.[4] Resolving discrepancies between emission estimates and ambient measurements is an important consideration in designing, applying, and evaluating control strategies that are intended to reduce fugitive dust emissions.

As illustrated in Figure 3-8, dust suspension involves a complex three-step process: creep, saltation, and suspension. Creep is the rolling of the largest particles (about 500–1,000 μm) that are not suspended without extreme wind events; as the wind pushes them along, they can roll over and disaggregate other particles. Saltation is the movement of large particles (about 100–500 μm) that bounce a few centimeters above the surface and then fall back down, thereby bombarding the surface; upon impact, they dislodge smaller particles (less than 100 μm) from the surface, which can be entrained in the prevailing airflow. Creep, saltation, and suspension are inherently chaotic processes that are difficult to model (Shao 2008; Kok et al. 2012; Valance et al. 2015). Instead, semi-empirical models are used to estimate dust production from soils and stockpiles, such as chat piles and mine-tailings impoundments.

The suspension of fugitive dust particles depends on particle sizes, surface loadings, surface conditions, wind speeds, atmospheric and surface moisture, and the existence of dust-generating activities, such as vehicular traffic. Windblown dust occurs when the wind exceeds a threshold velocity. The minimum threshold wind velocity is often found to be about 5–10 m/s when extrapolated to 10 m above the surface (the standard height for reporting wind speed). However, the threshold can vary widely because of such factors as surface roughness, moisture content, vegetative cover, and particle size. Portable wind tunnels are increasingly used in the field to measure dust emissions and threshold wind velocities directly

[4]For further information on emission factors, see https://www.epa.gov/air-emissions-factors-and-quantification/basic-information-air-emissions-factors-and-quantification#AboutEmissions Factors.

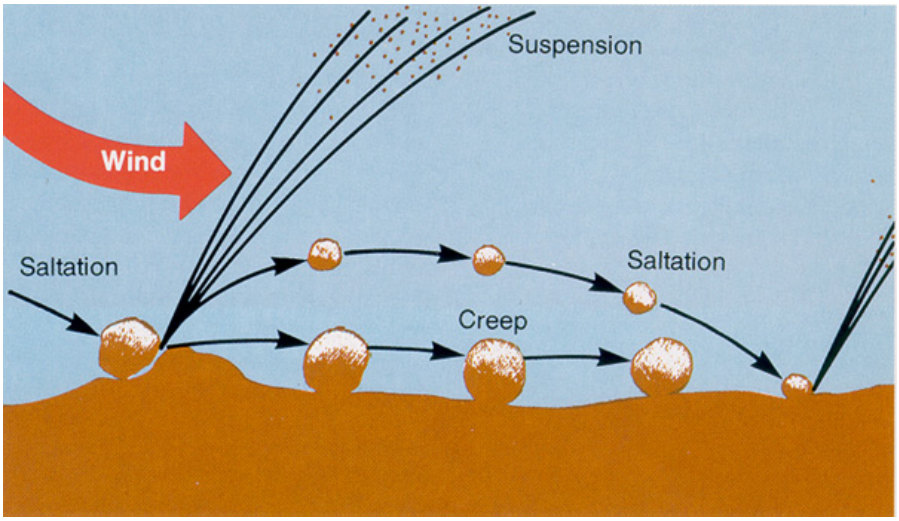

FIGURE 3-8 Example of windblown-dust suspension on a surface. Source: USDA (2015).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

(Etyemezian et al. 2007). Figure 3-9 illustrates how the PM_{10} emissions can vary as a function of wind speed and surface conditions. Such emission measurements can be used in computational fluid-dynamics models to simulate atmospheric dispersion of dust (Stovern et al. 2014). Those models, for example, can be coupled to lead-isotope data to improve attribution of lead to various sources (Stovern et al. 2016).

Mechanical suspension processes are dominated by moving vehicles, wherein the contact of a tire with the surface of a roadway grinds the dust to smaller sizes and injects it from the road surface into the atmosphere. Vehicle wakes that create turbulence are also sources of dust suspension, although they can also be classified as wind-induced. Other mechanical suspension methods involve transfer of bulk materials through uncovered conveyors, bulldozers, shovels, and open trucks.

Modeling Air Transport: An Example from Southeast Missouri

An example from Southeast Missouri illustrates the potential for air transport of lead-containing particles from chat piles and tailings. Abbott (1999) modeled the erosion and transport of airborne PM from chat piles and tailings impoundments at Bonne Terre, Desloge, Leadwood, National, Elvins, and Federal in Southeast Missouri. The model was evaluated using data from air-quality monitors—presumably TSP monitors, but that is not stated—at four locations and downwind soil sampling. As expected, predicted transport from coarse chat piles (0.5–1.0 km) was less than transport from the fine tailings (3–5 km). The highest deposition rates were predicted for areas east and southeast of the sources, which would be consistent with the prevailing wind direction. The maximum annual average calculated lead deposition rate 1 km downwind from tailings impoundments was about 1–30 $\mu g/m^2$-hr. Although model predictions and atmospheric observations varied from site to site, the predicted airborne lead at the Desloge site was reasonably close to observations with respect to both annual average (0.1 $\mu g/m^3$) and maximum 24-h average (1 $\mu g/m^3$) concentrations. Soil sampling showed the expected rapid decrease in lead concentration with distance that reached more typical concentrations at about 2 km downwind from the Bonne Terre sources, which were mainly tailings and a small chat pile.

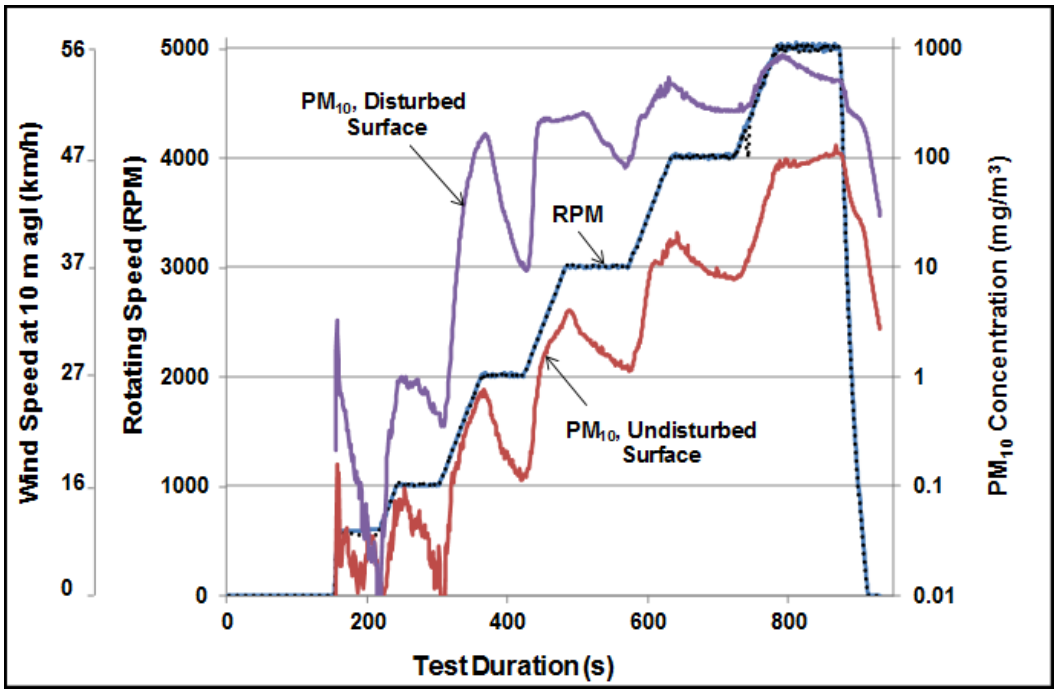

FIGURE 3-9 Comparison of PM_{10} suspended at different wind speeds from mechanically disturbed surfaces (such as a broken surface crust) and undisturbed surfaces of a coke storage pile; data collected using a portable wind tunnel (Etyemezian et al. 2007). Emissions increase with wind speed for both disturbed and undisturbed surfaces, but the emissions are more than an order of magnitude lower for the undisturbed surface. Source: Adapted from Watson et al. (2014). Reprinted with permission; copyright 2014, Desert Research Institute.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

A decade later, the Missouri Department of Natural Resources reported that airborne lead concentrations monitored near a chat pile during earth-moving operations could rise to 0.3 $\mu g/m^3$ (24-hr average) despite the coarse particle diameter of chat (MO DNR 2009). High lead observations from TSP monitors were also reported at St. Joe State Park (up to 0.9 $\mu g/m^3$) and from personal monitors (up to 6 $\mu g/m^3$, time-weighted average) worn by motorcycle riders in the vicinity of the disturbed surface of the chat pile (MO DNR 2009). Such observations near chat sources show that in spite of the very large particle diameter, chat can be an important lead source where anthropogenic mechanical disturbance occurs. That observation is important because chat was spread on roads, where the coarse particles can be ground up by traffic, and then suspended by the passage of vehicles or wind erosion. The grinding and resuspension of chat could be an important lead source; it has been reported that some road dust in Southeast Missouri contains higher lead concentrations than are measured elsewhere in the region (Witt et al. 2013, 2014, 2016).

The Abbott (1999) study used meteorologic observations from the St. Louis airport 80–100 km away; wind was predominantly toward the east and southeast, but these wind directions probably do not reflect local conditions, where the topography might channel the flow in a more northerly or southerly direction. The study demonstrates the importance of making local meteorologic observations for source dispersion modeling, as discussed further in Chapter 4.

INTENTIONAL TRANSPORT

Intentional transport includes all the human activities that move materials within and off a site. For example, intentional transport at mining sites in the Southeast Missouri Lead Mining District would include the mechanical, truck, or rail transport of lead ores, lead concentrates, or lead-containing mine wastes (waste rock, tailings, and slags) for further processing, disposal, or beneficial use, such as use of chat as soil amendments on agricultural fields and use of tailings as railroad-bed material. McHenry (2006) compiled a history of the mining companies and chat dumps of the Missouri Lead Belt in St. Francois County and reported considerable anecdotal information about transport of mine wastes, particularly chat, for beneficial uses. Before 1922, chat was offered "free for the asking and many thousands of tons were hauled away by local citizens, city, county and state government, and other industries in the area which had uses for it." As noted in Chapter 2, one primary use was as an agricultural lime; in 1922, chat began to be sold to limestone dealers for use as a soil amendment. Chat sales continued until 1972, when one chat pile that originally contained 3,522,000 tons was entirely gone (Karsch 1973). Other uses noted by McHenry (2006) were as a component of blacktop, concrete, fill material in building construction and road grades, sandbox sand, and grit for deicing streets and sidewalks.

The intentional transport of mine wastes for beneficial use is of concern as a potential vector for public-health and environmental problems. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remedial investigations (RIs) for mining sites and other industrial sites that have generated large quantities of potentially valuable byproducts do not systematically consider intentional transport mechanisms. Because intentional transport is a business activity, the process of identifying and quantifying intentional transport processes involves locating and auditing business records, such as transport manifests, invoices and receipts, inventory records, and informal communications (oral and written). The systematic consideration of intentional transport mechanisms then falls under the purview of accountants, economists, and historians, who are rarely engaged in such activity for CERCLA RIs, perhaps because of an absence of EPA guidance that articulates the need for and role of qualified practitioners in these professions in systematically considering intentional transport mechanisms.[5]

One approach for encouraging systematic consideration of intentional transport would be to eliminate the use of the term *migration* to describe the transport processes to be considered because its use implies that contaminant transport is governed only by air and water dispersion processes. Furthermore, a recommendation to consider intentional transport mechanisms could be added to guidance documents.

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[5]The committee notes that archeologists and historians are routinely enlisted at CERCLA sites to locate and document historical artifacts, as required to comply with the National Historic Preservation Act, but social scientists are not routinely enlisted to consider intentional transport mechanisms and their contribution to contaminant distribution systematically.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

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4

Investigative Strategies for Lead-Source Attribution

During the last several decades, a wide array of analytic techniques have been used, with varied degrees of success, to determine the relative contributions of lead from natural and anthropogenic sources in soils, sediments, water, and air. The US Environmental Protection Agency has used several methods in its investigations, including using elemental concentrations and ratios, isotopic analysis, and other soil-metal characterizations (Burgess 2016). Most techniques rely on a fingerprinting approach that attempts to identify unique physical or chemical characteristics that can distinguish lead or lead-associated materials between suspected sources (Box 4-1). Once the sources have been assessed, the distinguishing source characteristics can be compared with those of samples of soil, sediment, water, and air to assess the origin of the lead. Given the variety of analytic methods that are available, integration of the most appropriate techniques is challenging (Gallego et al. 2016).

In this chapter, the committee provides a series of investigative strategies that are stratified by media type. The strategies are intended to provide a logical framework for determining the source of lead while minimizing the time, effort, and financial resources required to do so. They are not intended to replace procedures associated with the remedial investigation and feasibility study but are meant to serve as a general guide to lead-source attribution. Given the highly variable nature of lead contamination near and adjacent to Superfund sites, not all the methods that are listed in the strategies will be applicable to all sites. In some cases, additional methods not cited in the strategies might be useful. Furthermore, the strategies might require modification to fit the specific characteristics of an individual site or operable unit.

The suggested strategies are based on a multiple-lines-of-evidence approach, in which data are systematically collected, analyzed, and interpreted until there is sufficient confidence that a method (or combination of methods) has resulted in a sound understanding of the sources of lead. The methods inherent in the strategies represent tested techniques that generate results that are widely accepted by the scientific community (unless otherwise stated). Preference was also given to techniques that generate quantifiable degrees of uncertainty.

SOIL

The committee's investigative strategy for soil is shown in Figure 4-1 and provides a guiding framework for deducing lead sources in soil. In this section, the committee focuses on soils derived from underlying rock strata as opposed to materials that are transported by river, gravity, or wind. The section that follows focuses on river sediments and sites within active floodplains where alluvial deposition is occurring regularly or has occurred over the duration in question for lead deposition.

The committee provides a possible sequence of analyses for soil based on typical successful outcomes, but the sequence might be adjusted on the basis of site-specific conditions, availability of instrumentation, and resource (cost and time) considerations. Before investigation of the source of lead, total soil concentrations need to be measured; sites (or samples) exceeding a regulatory threshold can then be examined for the lead source.

Site Characterization and History

Before a detailed chemical or mineralogic analysis is conducted, a basic site characterization and history should be developed that leads to a site conceptual model that can guide investigations toward likely lead sources; potential contributors of lead noted in Chapter 2 should be specifically identified. The landform of the soil or yard should be noted in terms of its current geology and likely geologic past. The US Department of Agriculture soil survey should be consulted for information on soils and landforms of the area. A history of land use at the site should also be constructed from public records and on-site observations to address appropriate questions, such as, Are there or have there been buildings constructed before the 1980s on the site that could have contributed lead-based paint to the

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

BOX 4-1 Lead Attribution Using Physical and Geochemical Fingerprinting Techniques

The attribution of lead in soils, sediments, water, and air commonly relies on the application of physical and geochemical "fingerprinting" methods. Although the approach varies widely with the media under investigation, the general assumption is that the physical or chemical composition of a sample is a function of the characteristics or composition of the lead sources and the relative amount of each source that contributes to it. This situation is referred to as an inverse (or unmixing) problem (Weltje 2012). Solution of the problem generally involves a four-step process (Zhang et al. 2012): (1) delineation and characterization of the lead sources, (2) identification of the physical or chemical properties (the fingerprint) that can distinguish the identified lead sources, (3) collection and characterization of samples from the media or site under consideration, and (4) determination of the relative contribution of lead by each source on the basis of some form of mathematical model. The latter step also includes an assessment of uncertainty associated with the modeling results.

Ideally, the fingerprint represents a unique property or set of properties that separate one source from all other sources. However, unlike a human fingerprint, the fingerprint of a lead source is, in many cases, imperfect. Because of inhomogeneity in the physical and chemical composition of the lead sources, the value or characteristics of the fingerprinting properties might be statistically distinct but overlap. The key, then, is to identify physical or chemical properties that most effectively distinguish between lead sources. A large number of physical and chemical measures have been used in fingerprinting analysis (see, for example, D'Haen et al. 2012 or Guzmán et al. 2013). Some use lead-related characteristics to fingerprint lead sources directly (such as lead concentrations, lead-isotope ratios, and ratios of lead concentrations to other elemental concentrations). Other fingerprinting analyses rely on properties of the media with which the lead is associated. For example, the fingerprinting of sediment-associated lead in rivers often relies on the concentration of multiple elements in the sediment or magnetic properties of the sediment in which lead is found.

Once a fingerprint to distinguish the sources has been defined, mathematical models of various types can be used to determine the relative contributions of lead from each source. During the last 2 decades, a wide array of analytic and statistical methods of increasing complexity have been developed to improve source attribution and to characterize the uncertainty inherent in the results.

soil? Are there obvious atmospheric point sources, such as a smelter or mine, in the near vicinity? Has mine-waste material with high lead concentrations been deposited on the site as backfill or roadway material? Is there evidence of storage or disposal of lead-acid batteries on the site? Once basic questions have been considered, a detailed soil sampling protocol can be developed for the specific site. As part of the development of a conceptual model, a handheld x-ray fluorescence (XRF) analyzer can be used to survey the surface-soil lead concentrations and guide soil sampling for additional analyses.

The field characterization should then proceed to determine whether the soil has been disturbed by human activity, whether the site is in an active floodplain and is a location where recent alluvial sediments have been deposited or eroded, and whether the soil was developed in situ (the nature of the underlying parent rock material). Disturbance by human activities is likely to alter spatial and depth trends in lead concentrations and might have led to the direct incorporation of anthropogenic lead into the soil. In Southeast Missouri, for example, coarse-grained tailings (chat) that contain lead were used extensively as fill and thus have been observed to be incorporated into disturbed soils in the region. Similarly, dispersal and source alteration from, for example, weathering processes described in Chapter 3 should be considered.

The distinction between soils composed of alluvial (riverine) and nonalluvial parent materials is an important consideration in site assessment because of differences in vertical patterns of lead concentration. Anthropogenic lead in soils of floodplains that were recently active (in the last century) often extends to depths measured in meters; anthropogenic lead in soils where the parent material was not deposited by the recent action of rivers is generally confined to within a few tens of centimeters of the ground surface. Thus, the topographic setting and type of soil parent material dictate the nature of the sampling program required to assess lead attribution. The following discussion of depth sampling and spatial analysis is for soil developed in place without active deposition where diagnostic vertical distributions tend to be retained as opposed to soils that are subject to recent alluvial deposits (active floodplains).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Spatial and Depth Sampling and Analysis

The spatial distribution of lead in a location is often a clue to its source. Anthropogenic sources of lead in soils are commonly deciphered by using two types of spatial analysis: an assessment of geographic patterns in lead concentration in the topsoil and a spatial analysis of lead as a function of depth below the ground surface. Geographic patterns in lead and other trace-metal concentrations are usually determined by collecting and analyzing composite samples of the topsoil with a gridded sampling scheme (Stafilov et al. 2010) or along transects that radiate from a suspected source, often corresponding to wind direction (Ettler 2016). Alternatively, the data might correspond to the distribution of residences that are sampled in urban areas. With the advent of hand-held XRF units, assessing spatial variation in lead can be easy and rapid and provide key information on lead sources. For example, high concentrations along the dripline of a home suggest that the source is paint or lead particles that have washed off the roof. Materials used for roads or driveways might contribute to high lead concentrations in nearby soils where concentrations decline with distance. Lead distribution, however, might also have nonunique source signals whereby natural, alluvial, or aerially deposited material might all show similar patterns that require further analysis.

Depth sampling and analysis might help to identify the lead concentration in soil parent material and layers that have been enriched by human activities and thus aid in source attribution. Here, the parent material for a soil is simply the rock (or unconsolidated rock material) that now underlies the soil. Soils develop through interaction of parent material with water, gas, living organisms, and organic matter in a given climate over an extended period. Parent material is generally determined through geologic inspection and chemical, mineralogic, and particle-size analysis of samples collected from the bottom of the soil profile and adjacent to the underlying bedrock. To confirm parent composition, multiple elements can be analyzed, and the measured composition compared with the expected weathering behavior of the underlying bedrock derived from modeling (Brantley and Lebedeva 2011). It is gener-

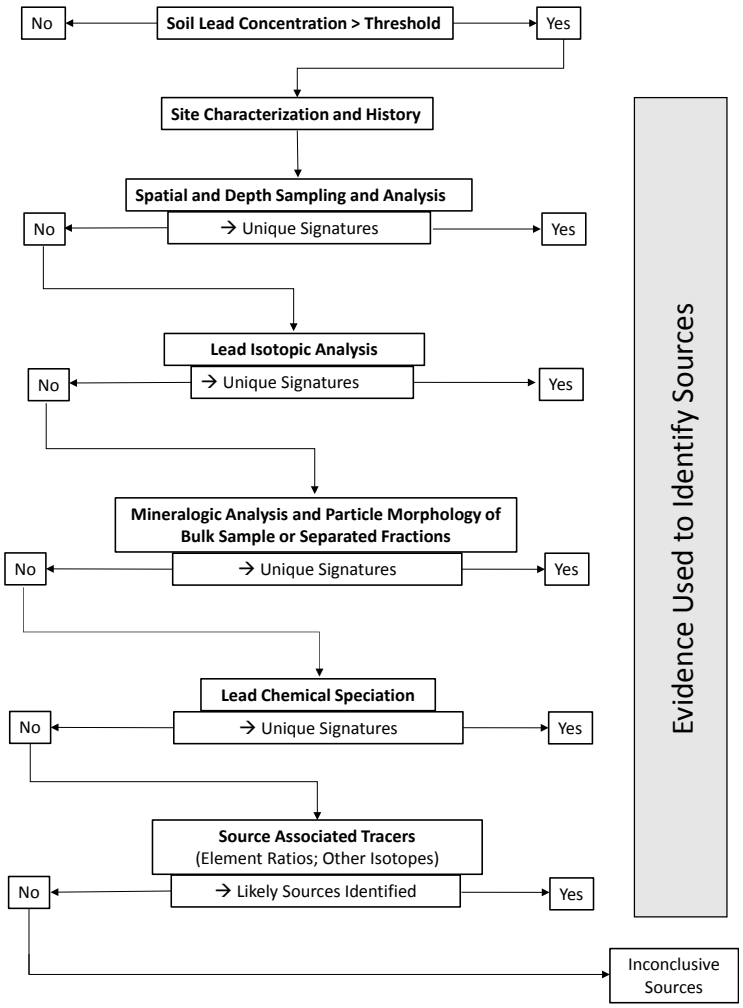

FIGURE 4-1 Example of an investigative strategy for attributing sources of lead in soil. The optimal sequence will depend on site-specific conditions, availability of analytic techniques, and cost and time considerations.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

ally helpful to collect multiple samples of parent material if possible to estimate compositional variability, including sampling of local outcrops or drilling material.

Once parent material is identified, the source of lead in the soil can be investigated. Lead that is present in uncontaminated soils derives from the parent material or from natural inputs of dust or sediment. In contaminated soils, lead derives from those sources and from anthropogenic inputs. By sampling and analyzing the depth distribution of lead and, for example, the isotopic signatures, specific minerals, or elemental ratios in the soil, one might be able to determine a scenario that most likely explains the source of the lead. If the physical or chemical characteristics of the lead in the soil are identical with those in the parent material *and* the depth distribution is consistent with this natural source of the lead, the simplest explanation is that all the lead in the soil is derived from the parent material. If the chemical or physical characteristics of the soil lead instead differ from those of the lead in the parent material and its weathering products, the lead has probably been added to the soil. The analytic methods described below help to define the chemical and physical characteristics of the lead to distinguish its source.

In areas of potential ore deposits, separating natural from anthropogenic lead can be complicated. However, for most cases of soils outside a recently active floodplain, anthropogenic lead will generally be concentrated at or near the soil surface and decrease downward to concentrations similar to those of the parent material. In some cases, if topsoil has been placed over mine wastes or chat, vertical distributions might document a layer that has a high lead concentration between layers that have low lead concentrations. Depth sampling of soil profiles can investigate such diagnostic distributions. Such sampling tends to be conducted at uniform increments or to be stratified according to naturally defined soil horizons.

Most commonly, the magnitude of anthropogenic lead is assessed by comparing concentrations in the surface materials with those in deeper horizons, including parent material. The analyses can be complicated by the downward migration of lead, which can occur by leaching (Miller and Friedland 1994; Prapaipong et al. 2008); the translocation of colloids and clay-sized particles (Citeau et al. 2003); biologic activity caused, for example, by earthworms, gophers, ground squirrels, and plant uprooting; and human activities, including gardening and plowing. The depth and rate of downward migration depend not only on the mechanism and timing of mixing but on the chemical form or speciation of lead in the soil; soil characteristics, such as pH, type and amount of organic matter, and clay content and mineralogy; climate conditions, such as rainfall and temperature; and the nature of the particles with which lead is associated (as discussed in Chapter 3).

Interpretation of lead concentrations as a function of depth in soils can also be complicated because even if lead is not added to or lost from a soil, its concentration can increase upward in a soil if high concentrations of other elements have been dissolved and transported out of the soil by natural processes over geologic time. In other words, lead that is not removed from a soil can become more concentrated near the surface when more soluble materials have been removed. To account for weathering, soil scientists generally normalize concentrations of the element of interest, such as lead, to that of another element that is not present in soluble minerals, such as titanium and zirconium. One such normalization, which has been used extensively in the recent literature, is the mass transfer coefficient[1] (Brimhall and Dietrich 1987; Anderson et al. 2002; Brantley and Lebedeva 2011). The mass transfer coefficient of lead is calculated by dividing two ratios. The first is the ratio of the lead concentration in a bulk soil sample to the concentration of an element, such as titanium or zirconium, that is present in the soil as an insoluble mineral. The second is the ratio of those same two elements in the parent material. When the mass transfer coefficient is analyzed as a function of depth, it can reveal patterns of addition or depletion in the soil that can be interpreted in terms of the lead source (Brantley and Lebedeva 2011). Observed depth distributions can be modeled in terms of processes, such as addition, depletion, or biologic cycling of elements into upper soil layers. Using those approaches, several investigators have modeled the addition of lead to soils from atmospheric deposition (Johnson et al. 1995; Drivas et al. 2011), and depth distributions coupled with isotopic signatures of various potential lead sources have been used to determine sources and migration of lead in soils (Prapaipong et al. 2008).

Lead Isotopic Analysis

Measurement of lead isotopic composition can potentially identify a lead source rapidly if the isotopic signature is unique. The effectiveness of isotopic composition as a fingerprinting tool is related to several factors: stable isotopes of lead can be measured with a high degree of precision and accuracy, lead is unreactive and immobile over a wide range of environmental (geochemical) conditions, and fractionation of lead isotopes by physical, chemical, and biologic processes is minimal in contrast with that of stable isotopes of light elements, such as sulfur, carbon, and oxygen (Keinonen 1992; Komárek et al. 2008; Balcaen et al. 2010; Bird 2011; Miller et al. 2012). Thus, isotopic composition of lead of natural and anthropogenic sources (including ore deposits) does not change appreciably as it is dispersed through the environment. In

[1]The use of the term *mass transfer coefficient* by the authors is different from its use in engineering where it is used widely to characterize the transfer rate of mass between phases.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

most cases, the variation in a soil will be small relative to the differences between the soil and external inputs; thus, observed differences in the isotopic composition of the soil in question can be attributed to its mixing with lead from other sources (Cheng and Hu 2010). Finally, lead isotopic composition of ore deposits on a global scale is highly variable (Bird 2011; Miller et al. 2015), and lead derived from ore deposits tend to differ from lead typically found in non-ore rocks and soils (Hopper et al. 1991). See Chapter 5 for a detailed case study.

Studies conducted over the last several decades demonstrate that lead isotopes are often effective in determining lead sources in soils if the isotopic values of the source materials are unique (Rabinowitz and Wetherill 1972; Gulson et al. 1981; Steinmann and Stille 1997; Steinnes et al. 2005; Clark et al. 2006; Mihaljevic et al. 2006; Prapaipong et al. 2008; MacKinnon et al. 2011; Ma et al. 2014). In many cases, analyzing the depth distribution and isotopic signatures of lead in the soil allows source determination. If the isotopic character of the lead in the soil is identical with that of the parent rock, the simplest explanation is that all the lead in the soil results from the parent rock material. If, however, the isotopic character of the lead differs from that of the parent material, the lead has probably been added to the soil. As an illustrative example, Ma et al. (2014) completed an investigation in Pennsylvania where lead was enriched in soil relative to the parent bedrock. The isotopic signature of the lead varied significantly and consistently upward from the bedrock to the land surface (Figure 4-2). Using the lead isotopic signature, concentration–depth profiles, knowledge of the history of anthropogenic practices in the area, and models, the researchers attributed the added lead to atmospheric deposition between the 1850s and 1920s, when lead was emitted to the atmosphere from coal-burning and ore-smelting in the area (Ma et al. 2014).

Similarly, Steinnes et al. (2005) examined lead concentrations and sources throughout Norway. Their findings illustrate a similar $^{206}Pb/^{207}Pb$ ratio for C-horizons (unconsolidated parent rock material) throughout the country and are indicative of the undisturbed soil baseline lead signature. Using known $^{206}Pb/^{207}Pb$ ratios in atmospheric deposition, they were able to determine the fraction of the lead attributed to atmospheric inputs for lead-enriched surface soils. Gulson et al. (1981) provide another illustrative example. They examined lead sources

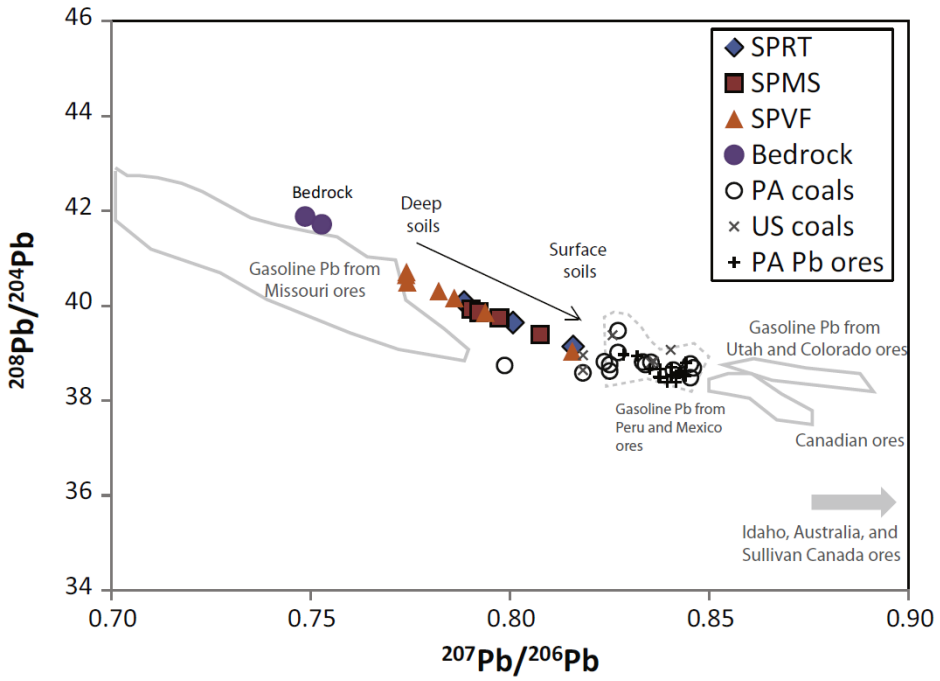

FIGURE 4-2 Isotopic signatures of soil samples from the pristine Shale Hills site in central Pennsylvania compared with various sources of lead. The gray circled areas represent lead-isotope ratios for leaded gasoline *if* the lead were derived from the ores indicated. Solid-colored symbols represent soil or bedrock samples, open symbols represent samples of coal from Pennsylvania, and crosses represent lead ore mined in nearby parts of Pennsylvania. Dashed gray lines indicate the isotopic values of Peruvian and Mexican lead ores that were generally not used in the Great Lakes region (Graney et al. 1995). Soil lead is attributed to a mixture of bedrock and atmospherically deposited lead from local coal-burning and iron or lead ore-smelting; deeper soils contain more bedrock-derived lead, and topsoils contain more coal- or ore-derived lead. Abbreviations: SPRT, southern planar ridge top; SPMS, southern planar middle slope; SPVF, southern planar valley floor. Source: Ma et al. (2014). Reprinted with permission; copyright 2014, *Anthropocene*.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

in soils near Adelaide, South Australia, by comparing concentrations and isotopic signatures between surface (upper 10 cm) and subsoil (30-40 cm) collected along a path that included urban and rural land use. Subsoil isotopic values were similar throughout the traversed sampling path and were consistent with parent rock; lead in the subsoil was therefore attributed almost entirely to that derived from the parent rock. In contrast, lead from parent rock made up a minor fraction of the total lead in surface soils. Using the isotopic signatures along the transect with the depth comparison, the authors were able to eliminate pesticides, power stations, and smelters as major sources of soil lead; instead, they attributed the lead to gasoline.

Rabinowitz and Wetherill (1972) used isotopic signatures, lead concentrations, and general mineralogic observations to assess sources of soil lead in shallow soil samples (0–2.5 cm and 12.5 cm) in Southeast Missouri and Benicia, California; their work illustrates the benefits and limitations of isotopic analysis for source attribution. In the majority of sites examined from St. Louis to rural areas away from any known ore bodies and sites near ore-processing or gasoline-refining, lead enrichment in surface soil layers could be attributed to specific sources on the basis of comparison with deeper soil layers and measured isotopic values of potential sources. However, a slight enrichment of 25-ppm lead in a surface soil layer near the ore-crushing and beneficiation plant in Indian Creek Mill, Missouri, provided an equivocal isotopic signature. In that case, mineralogy, particle-size distribution, and lead isotopic signature were not sufficient to resolve the source of high lead concentrations in the surface soil. In the other 11 sites examined in Southeast Missouri and Benicia, California, the combination of lead isotopic signature, concentration profiles, and mineralogic analysis allowed source attribution of lead enrichment in surface soil layers.

Using spatially resolved depth variation in lead concentration and lead isotopic signatures, Prapaipong et al. (2008) determined lead sources for soils potentially affected by smelting in Southeast Missouri. Lead isotopes of the smelting ore, which originated from the Viburnum Trend, were distinct from those of the parent materials of soils developed on Bonneterre dolomite or St. Francois rhyolite, and they also differed from the isotopic signature of lead derived from burning of leaded gasoline. The unique signature of each potential lead source allowed apportionment across the study area and with sampling depth. Lead concentrations attributed to smelting decreased with depth to a consistent value (typically 10–30 ppm) and decreased with distance from the smelter. However, within 2 km of the smelter, up to 90% of the lead was derived from smelting operations to depths of 25 cm. Over 4 km away from the smelter, smelter emissions accounted for 10–50% of the soil lead in the upper 15–25 cm. Isotopic analysis revealed that aerially deposited lead (from smelting and automotive exhaust) was present even at depths where concentrations were consistent with natural background. That finding suggests that the naturally occurring lead was displaced from the soil and that a maximum retention capacity was reached; any new lead that entered the soil would therefore either move through the soil or displace lead already present in the soil. To establish temporal trends in soil lead inputs, Prapaipong et al. (2008) examined lead concentrations and isotopic signatures of White Oak tree cores by using tree rings to provide concentration–time profiles. Lead concentration rose sharply 7 years after onset of smelting operations, increased within the tree rings over the following 25 years, and increased by a factor of 10 in trees within 1 km of the smelter. Isotopic analysis substantiated that the rise in lead concentrations was from the uptake of smelter-derived lead. The combined use of tree cores to determine temporal trends with spatial and depth profiles of soils to determine lead concentrations and isotopic signatures provides a powerful means of identifying lead sources.

Thus, if the lead isotopic compositions of the potential sources are unique and the lead isotopic values in the soil of concern fall within the range of the source materials, the contribution of each source to lead contamination can be determined. Given the robust nature of the technique, it might obviate additional analyses for source attribution, and this would greatly reduce the time, effort, and costs involved in determining lead sources. If the lead isotopic compositions of the source materials are similar (that is, they overlap), the method cannot unequivocally assess lead sources, and additional techniques are required.

Mineralogic Analysis and Particle Morphology

Mineralogic analysis of soils, such as optical microscopic identification of sand particles and x-ray diffraction (XRD) analysis of silts and clays, might provide signatures that allow source attribution. Minerals unique to specific sources can help with source attribution. The presence of galena, PbS, and other heavy minerals, for example, might be a clear signature of lead source (Ettler et al. 2005; Cabala and Teper 2007), whereas hydrocerussite, $Pb_3(CO_3)_2(OH)_2(s)$, might precipitate as a soil mineral after weathering of the original lead mineral. As lead disperses in the environment, soil concentrations tend to decrease as distance from the source increases, and lead is more likely to be adsorbed to other soil minerals or to be present as a minor substituent in secondary phases in soils and sediments. As a result, source attribution through mineralogic analyses, although often effective, can be inconclusive in other cases.

XRD has been used extensively for clay mineral identification (see Whittig and Allardice 1986) and to elucidate soil and sediment sources (Eberl 2004; Benedetti et al. 2006). It is often used in conjunction with particle-size

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

or density separation to identify minerals specific to a lead source (Olson and Skogerboe 1975). The mineralogy and particle structure determined with optical microscopy and scanning electron microscopy (SEM) of sand particles has been used extensively on alluvial and dust deposits to track sediment source (Arribas et al. 2000; Abu-Zeid et al. 2001; Cardona et al. 2005; Benedetti et al. 2006) and might serve to attribute lead sources in soil.

SEM coupled with elemental analysis—conducted with energy dispersive x-ray spectroscopy (EDS) or wave-length dispersive x-ray spectroscopy—is an additional means of obtaining chemical information and information on particle structure and texture. A description of the attributes and limitations of SEM and elemental analysis for identifying particle sources is provided in Pye (2004). Specific elemental ratios and morphologic characteristics of particles can be used to infer mineral identity, and combining mineralogy, particle size, and elemental composition has proved successful in source attribution (de Boer and Crosby 1995; Sterling et al. 1998). For example, Linton et al (1980) used specific particle structure and chemical composition to distinguish lead sources between automotive exhaust and paint chips, and Sobanska et al. (1999) used spherical particle structure and elemental composition to identify lead originating from smelters. Demonstrative features, such as spherical structure associated with smelters, can provide definitive source identification, and more subtle etching of sand grains might provide important clues to particle source (Abu-Zeid et al. 2001; Cardona et al. 2005). Figure 4-3 illustrates the use of SEM and EDS to distinguish between spherical lead-containing particles that are indicative of high-temperature processing, such as smelting, and particles that are more characteristic of airborne dust originating from vehicle activity or wind. Transmission electron microscopy (TEM) coupled with EDS and electron diffraction might also be useful for source identification. Mineralogy and particle-surface morphology can be deduced for isolated particles with TEM, which might be particularly useful for small, well-crystallized particles that have a propensity for deposition via wind-borne transport (Buseck and Posfai 1999).

Lead concentrations also tend to depend on particle size in material deposited as dust, with larger particles deposited closer to the source (NEPC 1998). Thus, particle-size analyses that include dividing particles into fine and coarse fractions can help to determine source. Size separation is typically conducted with wire-mesh sieves for particles larger than about 0.05 mm; finer particles are measured by sediment rate separation, suspension density (hydrometer), or laser light scattering. An example of particle-size variation is illustrated by Taylor et al. (2010), who found that lead concentrations within 2 km of mining and smelting activities in Mount Isa, Queensland, Australia, were higher above more distant soils and depended on particle size. High lead concentrations associated within finer particles (<180 μm) extended further from the site. Such geographic concentration data are often combined with dispersion models that predict the downwind deposition and surface concentrations of atmospheric lead from known sources (see, for example, Small et al. 1995).

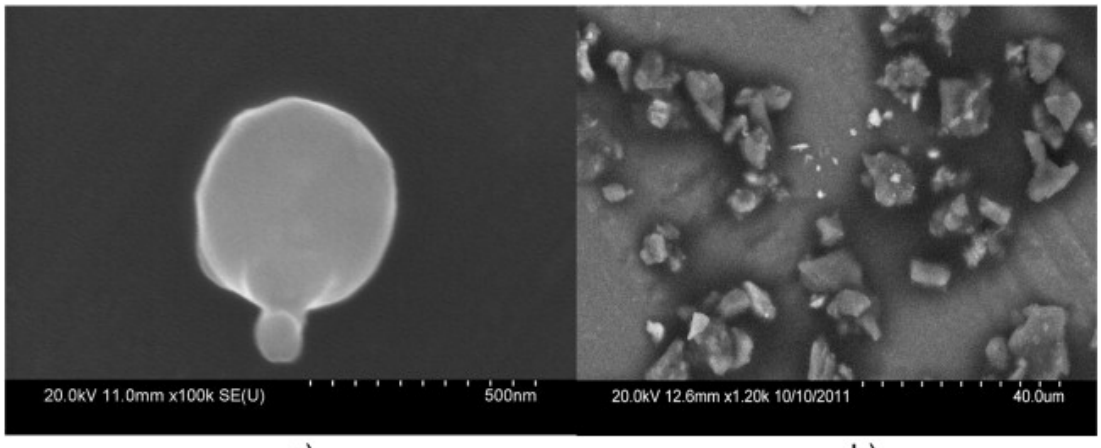

FIGURE 4-3 Representative SEM images of particles with aerodynamic diameters of (a) 0.32 μm and (b) 6.2 μm collected from a micro-orifice uniform deposit impactor at an active copper-smelting site (Hayden, AZ). Particle depicted in (a) was found with EDS to contain 10.88 ± 1.00% lead by weight. Source: Csavina et al. (2014). Reprinted with permission; copyright 2014, *Science of the Total Environment*.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Heavy minerals—such as pyrite, galena, cerussite, anglesite, and sphalerite—can be separated from soils by using fluids of different density. Such fractionated samples (separates) can often be used to associate soil grains with sources of lead contamination. Heavy minerals are particularly effective in tracing airborne lead and other metals derived from smelting and mining operations (see review by Ettler et al. 2016). Heavy mineral assemblages are often examined in combination with particle structure for attribution purposes. For example, the combination of ilmenite, $FeTiO_3$, and particle structure allowed successful determination of particle origin (Basu and Molinaroli 1991), and heavy minerals with quartz stress fractures provided evidence on wind-transported particles (Abu-Zeid et al. 2001).

If heavy minerals are isolated with density separation methods that rely on high-viscosity fluids, the assemblages can be characterized by using mineralogic tools noted above, such as XRD (Burt et al. 2003; Ettler et al. 2005) and SEM–EDS (Cabala and Teper 2007). Density separation has been used extensively for the analysis of minerals in both consolidated and unconsolidated rocks (see, for example, Morton 1985), but it has not been applied much to source attribution of anthropogenic lead in soils. Nevertheless, the method holds promise in that it allows additional mineralogic, geochemical, or isotopic analysis (described above) to be performed directly on heavy minerals.

The attribution of airborne lead and other metals to mining and smelting operations by using heavy minerals has generally been based on spatial variations in the quantity with which they are found in soils relative to the source and the area's predominant wind directions. Calaba and Teper (2007), for example, found that the proportion of heavy minerals, particularly iron sulfides associated with ore minerals, reached concentrations as high as 6–8% within several kilometers of ore-processing sites in southern Poland. Similarly, Ettler et al. (2005) found that anglesite occurred commonly in the dust and fly ash of lead-smelting operations in the Příbram district of the Czech Republic. Thus, they were able to argue that their presence in local soils was a clear indicator of airborne contamination from the nearby lead smelters.

Lead Chemical Speciation

Lead speciation can provide additional means for source attribution, but chemical speciation of lead in soils can be challenging because lead can be dispersed or poorly crystallized or be associated with small particles, all of which makes it difficult to conduct XRD or SEM analyses. Furthermore, weathering, alteration, and dissolution of primary lead compounds can change lead speciation and often result in adsorption of lead on mineral or organic-matter surfaces or its substitution as a minor element in newly precipitated phases. To overcome those challenges, selective extractions have been used commonly to assess the chemical speciation of lead.[2] Most series of selective extractions are based on a method developed by Tessier et al. (1979); various methods are reviewed and summarized by Ure et al. (1993). One potential problem is that although the extracting medium might target lead associated with specific materials (such as organic matter, carbonates, or iron or manganese oxide), it might also capture other material; that is, the separation is not clean. Coupling that problem with changes in the lead species leads to imprecision in the method. The accuracy of a series of selective extractions has been assessed by comparing them with direct spectroscopic analyses—such as x-ray absorption spectroscopy, x-ray fluorescence, Raman spectroscopy, and other advanced analytic methods (Scheckel et al. 2005; Hayes et al. 2009; Hayes et al. 2012)—that provide information on chemical bonding of lead. In a study of mine tailings from Leadville, CO, coupling of direct characterization of lead speciation that used x-ray absorption spectroscopy with a series of selective extractions revealed discrepancies between lead fractions targeted in extractions and lead speciation determined spectroscopically and demonstrated substantial redistribution of lead after extraction treatment (Ostergren et al. 1999). However, despite their limitations, selective extractions are useful for assessing the relative reactivity of lead in different soil fractions that can then be compared with other soil layers or other sites and sources. For example, particle-size separations and selective extractions were used with x-ray absorption spectroscopy and x-ray fluorescence to determine lead speciation and mineral phases in core samples from weathered mine tailings to assess the potential for wind transport of particles and their relative bioaccessibility (Hayes et al. 2012). More advanced spectroscopic methods for chemical speciation might also be useful but can be difficult to access or can require specific expertise for data acquisition or analysis; a comprehensive summary of potential techniques is provided in D'Amore et al. (2005).

Source-Associated Tracers

The final source-attribution approach for soils encompasses a wide array of methods, including multielement analysis and methods that involve stable isotopes other than lead; they have been used to determine the contribution of lead from multiple sources on the basis of composition of the geologic materials with which lead is associated. The methods hold considerable promise but have not been extensively applied to the specific problem of lead-source attribution. For example, cadmium and zinc are commonly associated with and recovered during the

[2]Selective extraction is an analytic process in which lead is leached from a sample with a solution to recover only a specific form of lead.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

processing of lead ores (Rehkämper et al. 2011). As the ore is smelted, light isotopes of zinc and cadmium preferentially exit with the exhaust; heavy isotopes of zinc and cadmium are preferentially retained in the smelting residue (Sivry et al. 2008; Mattielli et al. 2009; Miller et al. 2015). The differences might then be used to track the deposition of emitted smelter particles, including lead-containing particles, over the region by analyzing the zinc and cadmium isotopic composition of the soils (see, for example, Cloquet et al. 2006; Mattielli et al. 2006, 2009; Shiel et al. 2010; Thapalia et al. 2010). Similarly, stable zinc and copper isotopes were used by Thapalia et al. (2010) to identify smelter emissions in lake sediments and thus trace lead to the smelter emissions.

In other cases, elemental ratios have been an easy means of tracing lead sources. Zota et al. (2011) used the association of lead, zinc, cadmium, and arsenic to identify particles originating from chat, and manganese was used to identify particles from uncontaminated soil. To elucidate whether pesticides or paints were responsible for enriched soil lead, Nezat et al. (2017) used the As/Pb ratio in particles to denote pesticide contributions and Pb/Ba/Zn ratios for paint contributions. Given the use of antimony in alloying processes at specific smelters, Eckel et al. (2002) found Sb/Pb ratios, as opposed to As/Pb or Zn/Cd ratios, to correlate with soil lead contributions from smelting operations.

Analytic methods have also been paired with modeling to attribute sources, and the following discussion provides several examples of such approaches for source attribution. An example of combined analysis and modeling is the use of SEM–EDS to develop a hierarchical cluster analysis for household-dust apportionment based on particle size and element ratio (Hunt et al. 1992). A combination of multiple analytic methods, extractions, and geospatial modeling was used to characterize iron oxide phases, fine-grained mine waste, and organic material that adsorbed lead (and other metals) and to distinguish relative contributions from two geochemically distinct sources, mine drainage and mine-waste pile runoff (Schaider et al. 2014). Simple mass-balance models—an example of which is provided in Chapter 5—can also help to constrain potential source contribution and aid in source attribution. More sophisticated predictive statistical models can also be useful in lead-source attribution. Contributions of soil lead from an automotive-battery recycling facility were compared with lead-based house paint and other background sources by Small et al. (1995); they used scaled deposition estimates from atmospheric dispersion to develop a statistical model that characterized observed soil-lead concentrations and attributed sources relative to the urban background. Multielement models noted in the next section on sediments might also be applicable to lead-source attribution in soils.

SEDIMENTS

The committee's investigative strategy for sediment is shown in Figure 4-4 and provides a guide to the effective determination of the natural and anthropogenic sources of lead found in river sediments. Similar analytic methods can be applied to nearly any type of sediment, such as those associated with lakes, wetlands, peat bogs, and coastal or estuarine environments. In fact, it is common to analyze sediments from different types of settings to provide a more holistic assessment of inputs of lead to the environment. Nonetheless, the focus here is on rivers and river sediments.

The sequence of analytic methods is intended only as a guide and might need to be adjusted to fit the site or operable unit of interest given specific site conditions, availability of instrumentation, and considerations of cost and time (see Box 4-2). The discussion that follows provides a general description of the methods shown in the figure and highlights some advantages, disadvantages, and sources of uncertainty. Additional information on each method can be obtained from the references provided.

Site Characterization and History

As applied here, site characterization is the process of collecting data to describe the river basin in terms of its physical, hydrologic, physiographic, and biotic characteristics at the time of the analysis and in the past. The exact list of measures to be used will depend on the site conditions but should include the identification of all natural and anthropogenic lead sources in the site and in the basin upstream of the site. The objective is to document the location and spatial distribution of each source, the form of the lead and associated materials in each source, the pathways and processes through which lead could enter a river from each source, and, for anthropogenic sources, the history and methods of lead use or processing. Most of the data required for site characterization will probably have been collected through the Superfund remedial investigation and feasibility study.

Fluvial Geomorphic Analysis and Sampling

Rivers can be viewed, simplistically, as networks of channels that transport water and sediment from upstream areas to downstream areas of a basin. Rather than being simple conduits, however, they are highly dynamic features in which water is continuously eroding and depositing sediment in the river channel and on the floodplain during floods. Erosion and deposition of sediment can incorporate sediment-associated lead that enters the drainage network into riverbed and floodplain (bank) deposits. The deposits vary widely along the river valley in their areal extent, age, and sedimentologic characteristics, such

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

BOX 4-2 Examples of Modifications of Investigative Strategy

Figure 4-4 is provided as a guide to the effective attribution of lead in river sediments in or adjacent to Superfund sites. The investigative strategy will ultimately depend on a host of factors, including the nature of the lead sources, the size of the area under investigation, the available analytic capabilities, and constraints on time and money. Thus, the strategy will probably need to be modified by selecting methods that possess a high probability of being effective for a specific site or operable unit. For example, the Maritsa River in Bulgaria is highly contaminated by lead and other trace metals. Contamination of the river is related to the inflow of mining and smelting waste from multiple mining districts in its tributaries. Bird et al. (2010a) demonstrated that the various ore bodies in the basin and the mine wastes associated with the ore bodies exhibit a distinct lead isotopic signature. As a result, lead-isotope data could be used to apportion lead between the mine or smelting wastes and the local bedrock. Lead isotopes could not, however, be used to apportion lead in riverbed sediments of the larger Maritsa River because lead was derived from many more sources, including multiple ore bodies and bedrock types. The occurrence of multiple lead sources precluded the use of simple mixing models. Bird et al. (2010a) circumvented the problem by determining the relative percentage of sediment in the Maritsa River derived from each tributary and using multi-element fingerprinting. By treating, the tributaries, including those contaminated by mining operations, as distinct sources of sediment and sediment-associated metals, the authors were able to estimate the relative quantity of sediment and, by association, metals contributed to the Maritsa River by each tributary. They were also able to estimate changes in tributary contributions downstream along the river.

The Rio Loa, which is in the Atacama Desert of northern Chile, provides another methodologic example (Miller et al. 2013a). The Rio Loa is highly contaminated by lead and other metals and metalloids. The predominant sources of metal contamination include large copper mines and their tailings piles in the Rio Loa basin and the El Tatio geyser basin. Lead isotopes could not be used to differentiate between lead from the mines and the geyser basin, although they could be used to distinguish between lead from the mines or geysers and non-mineralized rocks in the area. Current studies suggest that the most effective method for sediment and sediment-associated metal apportionment is the ratio of copper (which is high in mining wastes) to antimony (which is high in sediments of the geyser basin). The abundance of heavy minerals also appears useful.

as particle size, shape, lithology, and color. The sources of sediment and lead in the deposits also vary along the river and on a local (stream segment) scale.

The primary objective of analyzing a river's erosional and depositional history is to identify, characterize, and map the distribution of distinct, time-correlated sedimentary deposits along the river valley. The analysis provides an understanding of the transport pathways through which sediment-associated lead is dispersed from suspected lead sources and the potential sites where lead might have accumulated along the river during specific times. It also provides a framework that is essential for developing a sound sampling program for which the physical and chemical analyses described below can be effectively conducted. For example, sediments deposited before European settlement might provide information on natural concentrations of lead associated with the sediments in the river basin.

Lead Isotopic Analysis

When applied to river sediments, the assumption is that lead in riverbed, floodplain, or terrace deposits represents a mixture of lead from all the sources that contribute lead to the river at the time of sediment deposition. Comparison of the lead isotopic composition of the sediment mixture with the isotopic composition of the suspected sources allows an estimation of the relative contribution of lead to the sediments from each potential source. The analysis is often complicated because the lead in river sediment is derived partly from the bedrock that underlies the basin. Depending on the basin's geology, the lead isotopic composition of the underlying bedrock might vary substantially between rock units. Thus, in addition to the suspected anthropogenic sources of lead, it might be necessary to consider multiple bedrock lead sources.

Nonetheless, many studies have used lead isotopic methods effectively to identify the source of lead in river deposits directly (Church et al. 2004; Miller et al. 2007; Shepherd et al. 2009; Bird et al. 2010a,b; Ayrault et al. 2012). Lead isotopic methods have also been applied to various other sediment types, such as those associated with reservoirs and lakes (Shirahata et al. 1980; Petit et al. 1984; Graney et al. 1995; Chiaradia et al. 1997; Foster et al. 2002; Callender 2005), wetlands, and peat bogs (Shotyk et al. 1998; Weiss et al. 1999; Marcantonio et al.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

2000; Cloy et al. 2008). Lead isotopes have been particularly useful in deciphering the contributions of lead from nonmineralized rocks and mining and milling wastes and contributions of lead from distinct mining districts when the lead isotopic characteristics vary between ores (see, for example, Bird et al. 2010a,b). However, when the isotopic characteristics of the mining wastes are similar to those found in the local, mineralized, but unmined bedrock, it will not be possible to attribute lead to those sources by using lead isotopes.

The analysis of river deposits differs from the analysis of upland soils (described in the previous section) in two ways. First, the isotopic composition of river deposits of known age can be determined and compared with suspected lead sources in the basin for that time. In doing so, it might be possible to construct a history of the changes in lead source contributions to the river over periods of decades to centuries. Second, spatial variations in lead concentration and isotopic data can be combined to assess changes in lead source longitudinally along the river valley. For example, Shepherd et al. (2009) analyzed a variety of geologic materials along an 86.5-km segment of the River Wear in northeast England (Figure 4-5). At Site 1, the $^{208}Pb/^{206}Pb$ ratio in riverbed sediment was comparable with that in geologic materials found in a mineralized ore body and was therefore interpreted as reflecting the relatively high lead concentrations associated with historical mining operations. The decline in downstream concentrations between Sites 1 and 5 was thought to result from dilution and the deposition of dense, finely milled lead particles in the riverbed. Farther downstream, $^{208}Pb/^{206}Pb$ ratios continue to decline until reaching Site 9, whereas lead concentrations increased. The decrease in $^{208}Pb/^{206}Pb$ ratios presumably reflected the influx of mine waste from two tributary valleys where lead ore was derived from a second mineralized zone in the ore body; this second mineralized zone was characterized by a lower $^{208}Pb/^{206}Pb$ ratio. Shepherd et al. (2009) used changes in lead concentration and $^{208}Pb/^{206}Pb$ ratios between Sites 10 and 27 to assess the influx and importance of additional sources of

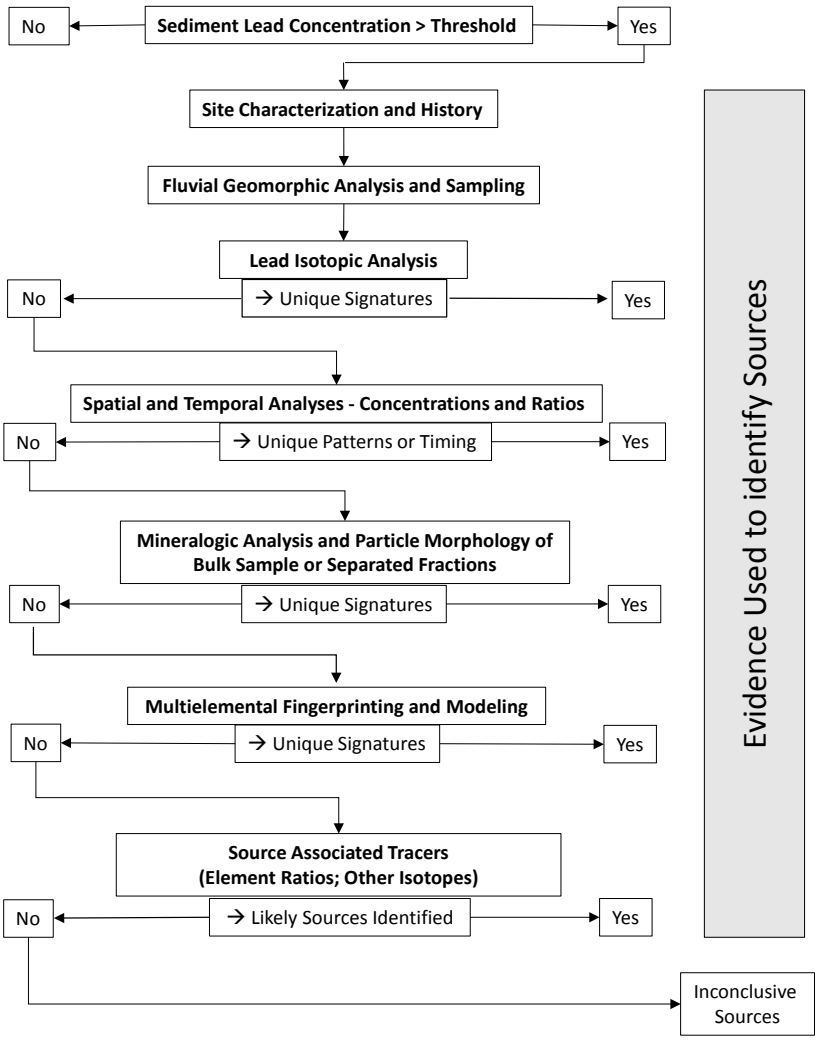

FIGURE 4-4 Example of an investigative strategy for attributing sources of lead in river (alluvial) sediments. The optimal sequence will depend on site-specific conditions, availability of analytic techniques, and cost and time considerations.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

lead to the river. The key point is that combined spatial analysis of lead concentration and lead isotopic composition of the river sediments might provide a more detailed understanding of source contributions of lead to a river than is possible by using lead concentration data alone.

Spatial and Temporal Analyses

If the use of lead isotopes fails to determine the source of lead in river sediments completely, it will be necessary to apply one or more additional methods. Spatial and temporal analyses have been effective in determining lead sources qualitatively in many river basins and are described below.

Spatial Analysis

One of the most extensively used methods for determining sources of lead in rivers is examination of the spatial distribution of lead concentrations or elemental ratios, such as Pb/Zn, in alluvial deposits. The initial interpretation is that an abrupt downstream increase in lead concentration or the ratio of lead to another element will correspond geographically to a predominant source. There are several advantages to the approach, including that it can be applied to both riverbed and floodplain deposits, it can be completed relatively rapidly by using samples collected during a single sampling campaign, it relies on standard analytic procedures for the analysis of total lead concentrations, and the data are relatively easy to interpret.

An example was provided in Chapter 3 (Figure 3-3) for lead, zinc, and antimony concentrations along the Rio Chilco–Rio Tupiza drainage system of southern Bolivia (Villarroel et al. 2006). In the United States, Integral (2014) and Pavlowsky et al. (2010) used spatial variations in lead concentrations in channel sediments along the Big River to assess lead sources. Figure 4-6A shows that lead concentrations increase abruptly downstream of river mile 110, presumably in response to the influx of mining-related waste materials as the river passes through the St. Francois County Mining Area. Lead concentrations decrease downstream until reaching the Meramec River. However, the general decrease in concentration is disrupted locally by minor increases in lead concentrations (Figure 4-6A). Integral (2014) argued that those minor increases in lead

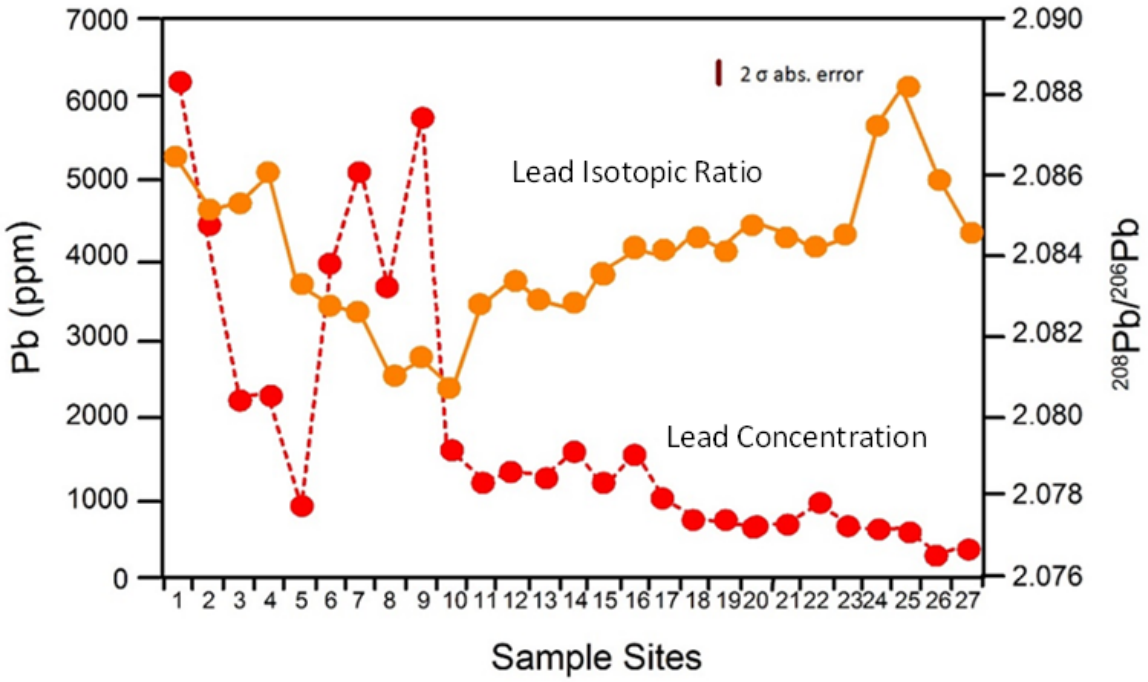

FIGURE 4-5 Downstream variations in total lead concentrations and $^{208}Pb/^{206}Pb$ ratios along the Wear River in northern England. Total distance is about 86.5 km. Error bar refers to isotopic measurement. Source: Shepherd et al. (2009). Reprinted with permission; copyright 2009, *Science of the Total Environment*.

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concentration downstream of river mile 85 reflect less important additions of lead from other mining operations, including lead from the Barite Mining District.

Although the analysis of spatial patterns in lead concentrations and elemental ratios provides insights into the sources of lead in river sediments in the drainage basin, it has several limitations as described below.

- Multiple sources might exist in a specific area, and it might not be possible to differentiate inputs between multiple overlapping sources by using lead concentration data alone. For example, the input of mining wastes might spatially correspond to areas of mineralized rock where relatively large quantities of natural lead might also enter the channel. Exploration geochemists have applied similar spatial analyses to rivers to identify the location and grade of ore deposits. To help alleviate the problem, downstream variations in other elements or in lead ratios (such as Pb/Zn) might be used to gain additional insights into the source of the lead if the concentrations of such elements differ between the overlapping sources. Figure 4-6A, for example, shows that barium concentrations increase substantially downstream of river mile 85; a trend that Integral (2014) argues is related to the influx of barite from mining operations in the Barite Mining District. Alternatively, the analysis of downstream trends in elemental concentration might focus on a specific sediment size fraction, as shown in Figure 4-6B, which is associated with a known lead source, such as tailings.
- The resolution of the downstream trends in lead concentrations reflects the number of samples that are collected along the river and the location from which the samples were obtained. Differences in sampling frequencies and locations can yield differing results. For example, Figure 4-6 shows the downstream trends in lead concentrations developed by Intergral (2014) (Figure 4-6A) and Pavlowsky et al. (2010) (Figure 4-6B). Differences in the trends in lead concentration are related primarily to differences in the sampling scheme and approach used, which lead to differences in interpretation of the primary source of lead to the Big River.

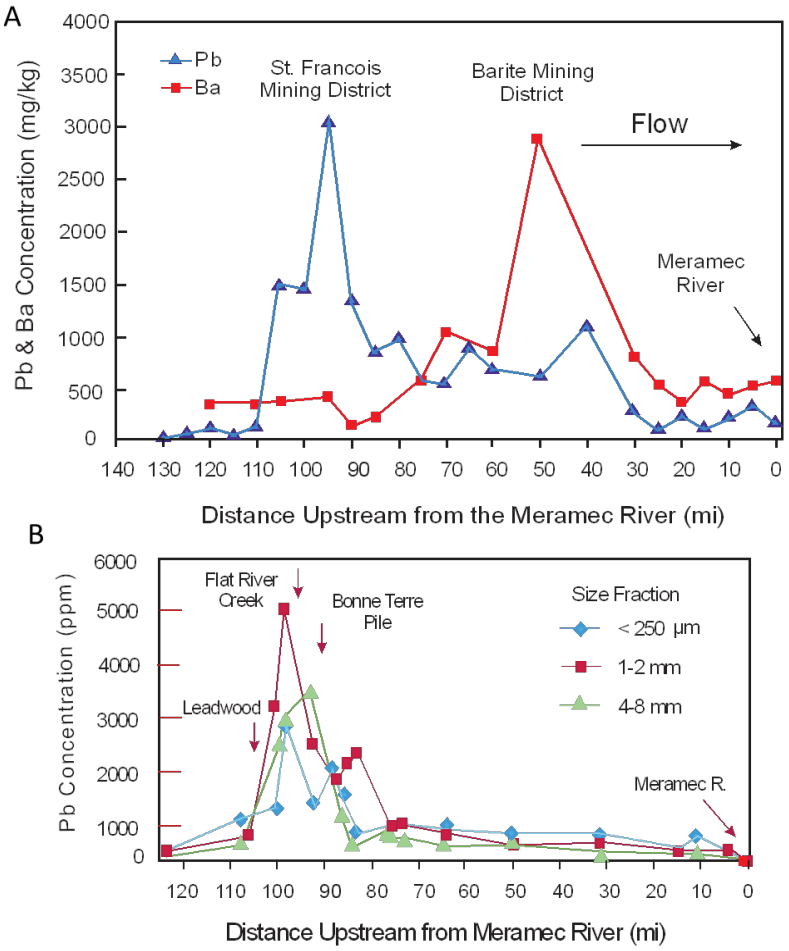

FIGURE 4-6 (A) Changes in lead and barium concentration along the Big River as determined by Integral (2014). Abrupt downstream increase in lead concentration has been interpreted as reflecting the input of mine-associated lead in the St. Francois Mining District. Increased barium and minor increases in lead presumably reflect the input of sediment from mining wastes in the Barite Mining District. Source: Adapted from Integral (2014). (B) Changes in lead concentration along the Big River as determined by Pavlowsky et al. (2010); data are stratified by grain size. Source: Adapted from Pavlowsky et al. (2010). Differences in developed trends partly reflect differences in sampling frequency and location.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

• Abrupt downstream variations in lead concentrations might reflect erosional and depositional patterns along the river rather than a location of lead influx. Stream segments that are characterized, for example, by relatively wide valleys, low gradients, and gentle flows are often areas of sediment-associated lead deposition. That deposition can lead to zones of high lead concentrations; thus, abrupt increases in lead concentration are not always a perfect indicator of a lead source.

• The method cannot be used to determine the quantity of lead inputs into a system from a specific source. Rather, it provides a means of assessing the relative importance of lead inputs from a given source.

Temporal Analysis

Floodplains and terraces are composed of sediments that are deposited directly by the river adjacent to the channel (Figure 3-4). In contrast with upland areas, anthropogenic lead in floodplains and terraces often extends to depths measured in meters. The spatial distribution of sediment-associated lead in these alluvial deposits reflects the depositional processes responsible for floodplain formation and the sources and concentrations of lead in the river at the time of deposition. The floodplain and terrace deposits therefore contain a historical record of lead inputs (Macklin et al. 1999, 2006). Once deciphered, this stratigraphic record can be compared with documented variations in lead-related human activities to help to determine the potential role of anthropogenic lead sources in contaminating the river environment. The lead-related human activities should be described in terms of their time of operation, spatial extent and location, quantity of potential lead inputs into the river, and the geochemical and physical character of the contaminated sediments (Heim and Schwarzbauer 2013), all of which are to be collected as part of the site characterization described above.

The methods, assumptions, and uncertainties inherent in developing a chronology of trace-metal inputs (including lead) into a river are outlined in Macklin and Klimek (1992), Hudson-Edwards et al. (1997), Tobin et al. (2000), Miller and Orbock Miller (2007), Pease et al. (2007), Du Laing et al. (2009), Bábek et al. (2011), Matys Grygar et al. (2011, 2012, 2013), and Ferrand et al. (2012). In general, it involves documenting the physical characteristics of the river deposits, sampling and analyzing the deposits for lead and other substances, and applying absolute dating methods to estimate the age of the deposits in calendar years. Absolute dating methods include a wide array of techniques, such as measurement of radioactive isotopes (such as ^{137}Cs, ^{210}Pb, and ^{14}C), optically stimulated luminescence, dendrochronology, and identification of historical artifacts; see Stokes and Walling (2003) for a more detailed discussion of these and other dating methods.

The most detailed assessment of lead and trace-metal attribution is based on the analysis of overbank deposits. Overbank floodplain deposits—also referred to as vertical accretion deposits—are produced by the deposition of suspended sediments from floodwaters that inundate the floodplain surface (Figure 3-4). The process results in layers of younger materials that bury older sediments; thus, the sediment age varies systematically with depth. Because deposition occurs only during floods, there are temporal gaps in the depositional record, and the relationship between depth and unit age is not perfect. Nonetheless, such depositional sequences often result in the construction of a relatively high-resolution history of lead loadings into the river.

The distance of a specific stream segment from a source and the number of potential upstream lead sources vary along the river valley (Figure 4-7). Therefore, it is important to develop a chronology of lead inputs into the river at multiple locations. Sites should be selected to ensure that all potential lead sources will be reflected in the constructed chronology and to minimize the number of locations needed to differentiate inputs between all potential lead sources. The historical record should also extend back hundreds to a few thousand years, if possible, to ensure that natural variations in lead loadings (those characteristic of the basin before substantial human activities) are adequately characterized.

A potential disadvantage of the approach is that multiple human activities that have the potential to increase lead influx in a river can overlap temporally. For example, early mining operations in Southeast Missouri during the late 1800s and early 1900s correlate temporally with regional land-use change, which allowed large quantities of eroded upland soil to enter the drainage network. Increases in sediment-associated lead during that time might therefore have been associated with both mining operations and regional erosion of mineralized soil that contained natural lead. In some cases, it might be possible to separate the significance of lead from such diffuse sources from that of point sources by examining spatial trends in the data.

The method also assumes that lead in the sedimentary deposits is immobile, an assumption that is typically met (Hudson-Edwards et al. 2001). Provided that the migration of lead after deposition is negligible, the resolution of the record depends on the degree to which the sediments can be dated; when the ages of the sediments are poorly constrained, only general statements about lead sources and contributions can be made. Other causes of uncertainty are associated with spatial differences in the deposition of overbank sediments across the floodplain, variations in concentration related to flow conditions at the time of sediment deposition, and variations in the grain-size distribution and organic matter content of the sediment

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

(both of which influence lead concentrations). In some areas, such as sites located downwind of smelters and tailings piles, the atmospheric deposition of lead might also complicate vertical trends in lead concentrations. Various methods have been developed to reduce those uncertainties, such as analyzing multiple floodplain cores at a site and normalizing metal concentrations on the basis of a specific grain size, organic matter content, or conservative element[3] (Horowitz 1991; Harrison et al. 2003; Bonotto and de Lima 2006; Miller and Orbock Miller 2007).

In addition to analyzing floodplain deposits, the approach has often been applied to sediments in the bed of a reservoir (Von Gunten et al. 1997; Kähkönen et al. 1998; Müller et al. 2000; Audry et al. 2004; Miller and Mackin 2013). The disruption of stream flow and sediment transport by a dam typically results in higher rates of nearly continuous sediment accumulation in a reservoir (Müller et al. 2000; Arnason and Fletcher 2003) and makes it easier to create a high-resolution record of historical changes in sediment and sediment-associated metal loadings into a river. In addition, thicker depositional units reduce the potential influences of the postdeposition migration of lead in the deposits (Callender 2000; Audry et al. 2004). In other cases, other types of sediments might be examined to complement the historical sedimentary record (Box 4-3).

[3]A *conservative element* is one that is uniformly distributed throughout the sampled core. If the ratio of another element to a conservative element changes with depth in the core, the change is a signal that the other element is being depleted from or being supplied to the system.

Mineralogic and Morphologic Analyses of Bulk Samples

It is not uncommon for the geologic materials associated with a lead source to contain a unique set of miner-

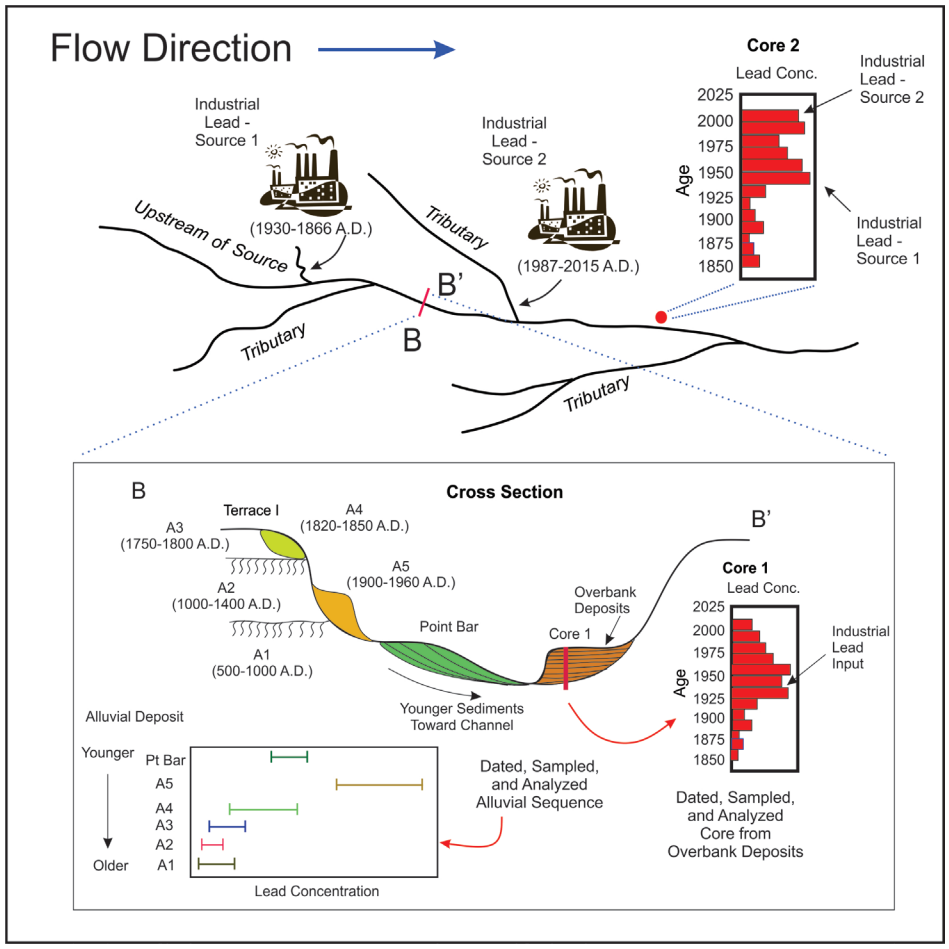

FIGURE 4-7 Schematic diagram illustrating how the age of a sedimentary deposit can be combined with lead-concentration data to determine the source of lead in river sediments. Sources are determined by linking temporal peaks in lead concentration to known anthropogenic inputs at the time of sediment deposition. Variations associated with natural inputs of lead can be assessed by examining prehistoric deposits (not shown).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

als. Unique minerals or mineral assemblages have been used effectively to determine the origin of sediment from point and nonpoint (diffuse) sources along contaminated and uncontaminated rivers. Two of the most common analyses focus on clay minerals or heavy-mineral assemblages (Jeong and McDowell 2003; Eberl 2004; Gingele and DeDeckker 2005; Benedetti et al. 2006; Chen et al. 2009; Hardy et al. 2010; Bernárdez et al. 2012), although other mineral groups might also be useful depending on the nature of the source.

The effectiveness of the use of clay minerals stems from the fact that they reflect the composition and weathering characteristics of rock types that underlie the basin. Different rock types generally yield different clay minerals on weathering. Of importance to lead attribution in and around Superfund sites, the use of clay minerals has the potential to differentiate between sediments derived from nonmineralized rocks and mineralized or mined rock units. For example, differences in clay mineralogy were used by Jeong and McDowell (2003) to differentiate between mine tailings (enriched in the clay mineral chlorite), Ontonagon River sediments (with low chlorite and high illite), and a Wisconsin red-clay deposit (with low illite and high expandable-clay content) along the south-central coast of Lake Superior.

Heavy minerals, particularly sulfide minerals, have also been used to assess the origin of sediment and sediment-associated trace metals (including lead) in mining districts (Schreck et al. 2005; Bernárdez et al. 2012). Schreck et al. (2005), for example, found that minerals as-

BOX 4-3 Historical Analysis of Lake, Bog, and Coastal Sediments

In addition to the analysis of river sediments, sedimentary records from lakes, peat bogs, and coastal areas can provide valuable insights into the sources and magnitude of lead loadings into the environment. The analysis is similar to the methods applied to overbank floodplain and reservoir deposits in that the sediments are sampled, analyzed, and dated, and this allows the development of a record of the temporal variations in lead influx into the water body. The temporal record can then be compared with an understanding of the history of anthropogenic lead use in the region, including timeframe and extent of activity, changes in regulatory measures, and location of sources.

The input of lead and other trace metals into lakes occurs by a combination of wet and dry atmospheric deposition and the inflow of water and sediment from the surrounding drainage basin (Norton et al. 2004; Aebischer et al. 2015). It follows that the sedimentary deposits produced record changes in metal inputs from both atmospheric and basin sources. The analysis of lake sediments to determine atmospheric sources of lead deposition has been complemented by the analysis of peat bogs (Weiss et al. 1999, 2002; Bindler 2006; Kylander et al. 2009; Shotyk and Krachler 2010). Some peat bogs receive water, nutrients, and lead almost exclusively from the atmosphere; their sedimentary records are particularly useful because they are not substantially affected by either surface-water or groundwater inputs (Damman 1986; Shotyk 1988).

Assessment of lead sources in and adjacent to Superfund sites necessarily requires distinguishing local from global or regional atmospheric lead sources. Two approaches are commonly used to differentiate the two. First, multiple lakes are cored and analyzed; some receive runoff and lead from local sources, and others receive lead only from atmospheric sources. Norton et al. (2004), for example, analyzed the sedimentary records contained in three lakes in Massachusetts that were adjacent to a Superfund site. Two of the lakes received lead from their drainage basins. The third lake was in a relatively undisturbed basin and therefore received lead primarily from atmospheric sources. Comparison of data on the three lakes provided insights into the magnitude and timing of contamination of the environment by local sources.

The second, and more common, approach is to combine lead-concentration data with lead isotopic data (see, for example, Shirahata et al. 1980; Petit et al. 1984; Graney et al. 1995; Callender 2005; Aebischer et al. 2015). As presented earlier, comparison of the changes in the lead isotopic composition of the sediments can often be linked to suspected lead sources. A more recent, and potentially useful, approach is to analyze the cores for lead, lead isotopes, and other isotopes (such as zinc and iron isotopes) to assess source. For example, Aebischer et al. (2015) used lake sediments in Schefferville, Quebec, to assess the effect of mining on aquatic ecosystems. Combining lead-concentration data with lead, zinc, and iron isotopic data allowed the identification of multiple sediment sources of lead in the lake. A number of recent studies have focused on zinc isotopic records in lakes to assess the input of metals into the environment from smelting and other atmospheric sources (Sonke et al. 2002, 2008; Cloquet et al. 2006; Weiss et al. 2007; Mattielli et al. 2009; Thapalia et al. 2010).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

sociated with the Kupferschiefer ores, which outcropped in the Mansfeld mining district of central Germany, were dominated by covellite, chalcopyrite, and sphalerite. The mineral assemblage differed from the waste materials that were associated with metalliferous flue dust and smelter wastes, which were dominated by slag particles; the differences allowed their contributions to the river to be determined. However, mineral assemblages were similar between mining wastes composed of low-grade ore and natural outcrops of the ore deposits. Determining the importance of the latter sources depended on spatial variations in the waste piles in the basin. A potential shortcoming associated with the use of heavy minerals is that weathering of the particles after deposition might alter the mineralogic characteristics of the source sediments.

Other minerals might also be used to assess sediment contributions from mining operations. In Southeast Missouri, mineral analyses showed that chat particles sampled from the Leadwood, Federal, and National tailings piles were composed almost exclusively of dolomite, whereas sediments sampled from selected control sites were composed of greater than 95% chert and feldspar. Pavlowsky et al. (2010) argued that the quantity of dolomite in the Big River was an indicator of the relative contribution of mine tailings to the river.

The structure of fine-grained sediment is often examined to help to identify minerals. In other cases, the shape of such fine-grained sediments might provide direct insights into sediment and sediment-associated lead sources. As noted above, particles emitted from smelters are often spherical; that knowledge combined with an understanding of their composition can determine their source.

The structure of larger particles in rivers is typically the product of their degree of weathering at their source, abrasion during transport, and modifications after deposition. In general, the farther a particle has been moved along the river, the more rounded (smooth) it is. Thus, particle shape provides information on transport distance and the potential source in the basin (de Boer and Crosby 1995; Cardona et al. 2005). In mining areas, the mechanical grinding and crushing processes associated with the production of mill tailings might create particles characterized by a broken, jagged appearance that can differ from that of sediment derived from natural sources in the basin and allow their identification.

Mineralogic and Morphologic Analysis of Particle Separates

Because of the processes involved in the erosion, transport, and deposition of sediment in river systems, it is possible that sand-sized or dense particles will be derived from a source different from that of the light and fine-grained particles, such as silt and clay (see, for example, Miller et al. 2013b). Thus, the identification of lead source by using mineralogic, chemical, or isotopic methods might be complicated by analyzing mixed population of particles that differ in size or density. It might be possible to alleviate the problem by collecting and analyzing separates of the bulk sediment, which are characterized by a narrow range of particle size or density.

Multielement Fingerprinting and Modeling

The use of multielement geochemical fingerprinting techniques has increased in recent years (Franks and Rowan 2000; Collins et al. 2012, 2013; Rowan et al. 2012; Miller et al. 2015). For example, multielement methods have been applied to suspended sediments (Walling and Woodward 1995; Collins et al. 1997, 2001; Massoudieh et al. 2013), riverbed sediments (Collins et al. 2013; Evrard et al. 2013), floodplain deposits (Collins et al. 2012), and sediments in lakes, reservoirs, and wetlands (Miller et al. 2005, 2013b; Pittam et al. 2009; Rowan et al. 2012). The increased use has been promoted by recent advances in analytic techniques, such as inductively coupled plasma–mass spectrometry, that allow the rapid analysis of large numbers of elements at a reduced cost and by the ability to determine the source of contemporary and historic sediments and sediment-associated lead.

Conceptually, it is assumed that as sediments (and their associated lead) are eroded and transported from a source or source area they are combined with sediments from all other sources in the basin to form a mixture. The geochemical composition of the mixture depends on the composition of the source materials and the relative proportions of sediment derived from each source, provided that the physical and chemical characteristics of the sediment are not altered during transport, as might occur by elemental leaching or changes in the sediment grain size. If the compositions of the source materials and the mixture in question are determined (measured), it is possible to estimate the relative proportions that each source contributed to the mixture (Box 4-1).

Single and multielement geochemical fingerprinting in rivers has been used most extensively to determine nonpoint sources of sediment and sediment-associated contaminants in a river, whose sources might be defined by soil type, underlying geologic units, land-use categories, or tributaries (Russell et al. 2001; Douglas et al. 2003; Miller et al. 2005, 2015; Collins et al. 2009). In mining areas, the approach might provide insights into the quantity of lead eroded from mineralized upland soils. Multielement fingerprinting has not often been applied to point sources of contamination, such as a tailings pile, but it has been shown to be effective when it has been applied (Bird et al. 2010a,b).

The application of statistically based mixing models to river sediments has been criticized because the models can generate vastly different results that have similar

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levels of uncertainty, particularly when contributions from a source approach 0 or 100 % (Collins et al. 2010; Rowan et al. 2012). Much of the uncertainty is associated with variability inherent in the physical and geochemical characteristics of the source materials and the river sediment. To reduce and quantify uncertainty inherent in the modeling results, recent studies have explored the use of an increasing suite of statistical approaches, including the use of Monte Carlo sampling frameworks and Bayesian methods (Franks and Rowan 2000; Small et al. 2002, 2004; Collins et al. 2010, 2012, 2013; Rowan et al. 2012; Cooper et al. 2014; Nosrati et al. 2014; Miller et al. 2015; Palazón et al. 2015). The analyses have led to a general agreement that current attempts to apportion sediment and sediment-associated metals that use inverse (unmixing) models should include a sensitivity analysis for the input parameters and a detailed assessment of model uncertainty.

Other Source-Associated Tracers

In addition to the methods described above, a number of other characteristics have been used effectively to attribute sediment and sediment-associated metals in river sediments. They include magnetic properties (Yu and Oldfield 1993; Maher et al. 2009; Armstrong et al. 2010; Guzmán et al. 2010), particle color (Croft and Pye 2004; Martinez-Carreras et al. 2010), chemical speciation (Macklin and Dowsett 1989; Shikazono et al. 2012), and isotopic analyses, such as analyses of isotopes of strontium and neodymium (Weldeab et al. 2002; Padoan et al. 2011; Rosenbauer et al. 2013), copper (El Azzi et al. 2013), mercury (Blum and Bergquist 2007; Foucher et al. 2009; Sonke et al. 2010; Mil-Homens et al. 2013; Blum et al. 2014) and zinc (Sivry et al. 2008; Chen et al. 2009). Although the latter isotopes have not been applied extensively to the problem of lead-source attribution, their application holds considerable promise. Elements that have unique isotopic characteristics as a result of smelting, such as cadmium and zinc, might be particularly useful.

Modeling of Upland Erosion, Sediment Yields, and Transport

A wide array of surface-water modeling routines of varied degrees of complexity have been developed and applied to rivers to understand and predict sediment and sediment-associated contaminant-dispersal processes from both point and nonpoint sources. In general, the models are not designed specifically to determine the source of lead in river basins, and their successful application often depends on the availability and quality of topographic, hydrologic, geologic, and other forms of data. Given those constraints, the wide array of models available, and the ability to combine different models for specific purposes, the committee chose to exclude them from its investigative strategy. Nonetheless, such models might provide important insights into the source of sediment-associated lead. For example, in addition to known point sources of lead in and around a Superfund site, diffuse sources of natural lead exist in a river basin. The occurrence of lead in mineralized soils, which are eroded and delivered to a river during runoff events, might be particularly important in Superfund sites associated with mining districts. It might therefore be important to assess the contributions of lead derived from diffuse upland sources by erosion and mobilization processes. That objective might be addressed partly through the application of spatially distributed models that determine the location and magnitude of upland erosion and the amount of sediment that leaves the basin mouth. The distributed models typically partition the drainage basin into small parcels, each characterized by its own conditions, such as soil type, slope, and vegetation. Those data can then be used to assess soil mobilization and delivery to the river from specific parcel types, such as a specific type of soil or bedrock unit.

GROUNDWATER AND SURFACE WATERS

As noted in Chapter 3, concentrations of dissolved lead are typically low in surface waters or groundwater with a pH of 6-8. Thus, concentrations of dissolved lead tend to be relatively low in areas characterized by carbonate rocks (limestone and dolomite), such as in Southeast Missouri, that buffer pH near neutral and limit acid generation associated with the weathering of sulfide minerals, such as pyrite and galena, found in lead-bearing ores. The concentrations can be high in acidic water in other mining areas where limestone and other rock types that can neutralize acid water are generally not present. Here, the committee presents its investigative strategy for groundwater and surface waters (see Figure 4-8) and provides a brief discussion of the methods. The analysis of lead associated with water particles has been discussed in previous sections on soils and sediments.

Site Characterization and Hydrologic Conceptual Model

A first step in determining lead sources in water is to identify and characterize possible sources in and adjacent to the site. For example, if the focus is on river water, potential sources upstream of the site should be identified with potential on-site sources. Once possible sources are located, a conceptual model of the potential dispersal pathways via surface waters and groundwater can be developed by using existing data and standard hydrologic and hydrogeologic approaches. The conceptual model should address questions whose answers might depend on whether lead was found in groundwater from a well,

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in surface water from a river, stream, lake, or pond, or in both. Possible questions to consider include, What surface-water bodies are downgradient of the potential lead sources and thus might receive dissolved lead from the source? Do the adjacent streams receive groundwater that originates from the vicinity of the lead source? Is river water derived primarily from surface-water runoff, tributaries, or groundwater, and do these contain lead sources? What geologic materials come into contact with the groundwater and its flow path, and how do they influence flow (for example, limestone vs sandstone)? What are the depth to groundwater and the slope of the groundwater surface, and what are the sources of groundwater recharge? What are the vertical and lateral directions and rates of groundwater flow? Are there important anthropogenic sources of lead, such as lead-containing paint or plumbing, at the site that might dissolve and contribute to lead in water?

Once the conceptual model has been developed, it should be possible to define which sources can contribute lead to groundwater and surface waters. In some cases, such a hydrogeologic assessment might lead to a confident conclusion about the source of the dissolved lead that obviates further study. For example, a suspected lead source might be downgradient of a water-sampling location and be eliminated as a possible source, whereas an obvious upgradient source might be implicated if other lead sources are eliminated.

Groundwater and Surface-Water Sampling

If the conceptual hydrogeologic analysis does not elucidate the source with sufficient confidence, additional investigations are necessary. The sampling of groundwater should reflect the directions, depths, and rates of flow relative to the suspected lead sources and use accepted sampling protocols (see, for example, USGS 2006). Wells selected for sampling should accurately reflect the water chemistry of the hydrogeologic system under investigation and yield samples suitable for water analysis. At a given site, a sufficient number of appropriate wells for sampling or sufficient historical sampling data might not be available. Various factors can influence the integrity of a groundwater sample, and such characteristics as well

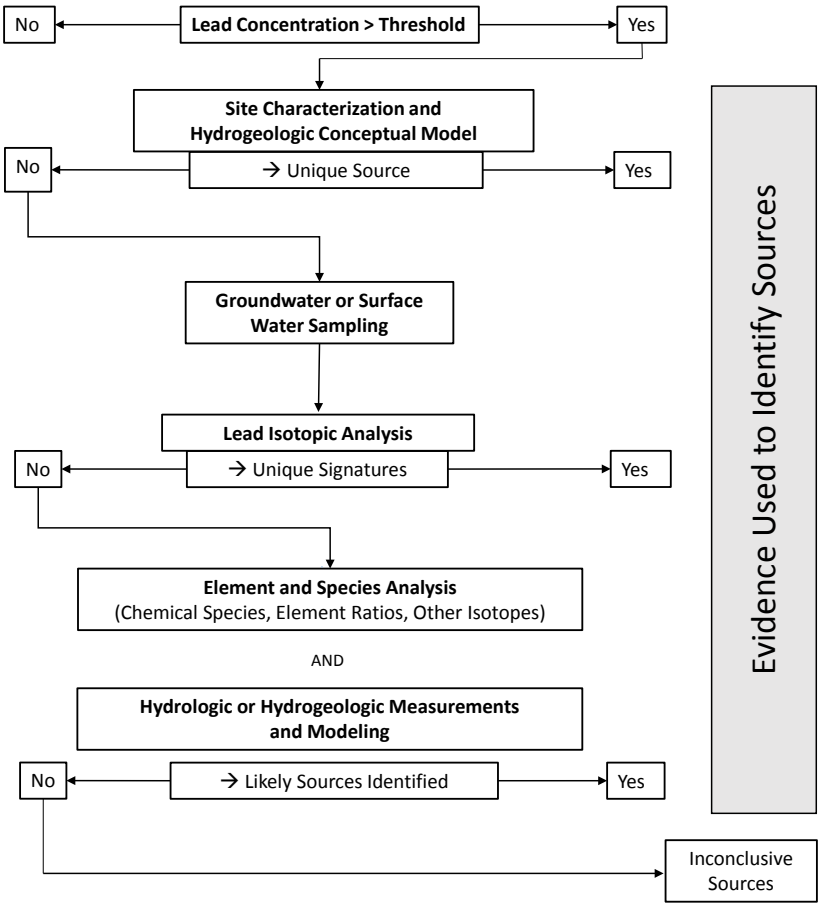

FIGURE 4-8 Example of an investigative strategy for attributing sources of lead in water at a Superfund site. The optimal sequence will depend on site-specific conditions, availability of analytic techniques, and cost and time considerations.

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type, depth to groundwater, water-sampling depth based on the location of the well screen, pumping rate, water yield, temperature, pressure, and amount of suspended particulate matter (PM) should be considered in the sampling strategy. Wells that are not frequently pumped, such as monitoring wells, should be purged of standing water by pumping before sampling. If dissolved concentrations are of interest, water samples are filtered through a 0.45-μm pore-size membrane and analyzed for lead and other constituents. If total concentrations are desired, unfiltered and acid-digested samples are analyzed. Given the generally low lead concentrations in surface waters and groundwater, all sampling and filtration equipment should be lead-free. All water-sample handling, preservation methods, and storage before analysis should follow standard protocols for trace metals to avoid changes after sampling that might affect measured concentrations (EPA 1996a; Lurry and Kolbe 2000).

In rivers, two approaches to sampling are often used to characterize concentrations and sources of dissolved lead. First, samples are collected at multiple times at fixed locations to characterize temporal variations in lead inputs into the river, particularly during changes in flow or flood events. A monitoring station established along a river has the potential to collect multiple samples as water levels rise and fall during a flood event. Second, one or more synoptic sampling campaigns might be conducted along river segments of interest; synoptic sampling is sampling of a river at many locations at the same time. The samples are obtained from the main channel and all known inflow points—such as tributaries, culverts, irrigation ditches, and urban sewer systems—along the river during a relatively short period of stable flow. River flow (discharge) is also measured so that the amount of lead (mass/time) that passes any point along the river can be calculated from the product of lead concentration (mass/m^3) in the river and flow (m^3/time). Thus, the analysis provides a snapshot of the variations in elemental concentrations and load along the river that can then be interpreted by using mass balances and inferred or observed lead inputs.

Methods for sampling standing bodies of water, such as lakes and ponds, are generally similar to those used for rivers although strategies for the timing and location of sample collection might differ. The number of samples to collect, the distribution of sampling locations, and the interval between sampling events should be determined on the basis of the size, depth, inflow and outflow points, water residence time, seasonal variations, and study objectives for the particular water body. For example, samples collected at the inflows and outflows of the lake or pond might be compared with representative samples collected from the interior. Sampling as a function of depth in different locations might provide information about water mixing or settling of PM that might affect concentrations. Depth sampling is usually done with a sampling device that is dropped on a weight to a desired depth and opened or closed with an activator. If it is important to assess changes in water chemistry as a function of time, time between samplings of lakes or ponds might be much longer than times between samplings of rivers and will depend on the residence time of the water and possibly on seasonal variations.

Lead Isotopic Analysis

As discussed above, lead isotopic abundances have been used extensively to determine the potential sources of lead in a wide array of media, including water. Specifically, a quantitative comparison is conducted between the isotopic signature of lead in water and possible sources, such as ores, tailings, nonmineralized rocks, and other lead-containing materials in the area. Some lead isotopic data might be available in the published literature. As noted, the method requires that the isotopic signatures of the possible lead sources be sufficiently different to warrant measurement of lead isotopes in water samples. That is, if all the possible sources of lead have the same isotopic signature, an expensive time-intensive isotopic analysis might not be appropriate (Aberg 2001; Komárek et al. 2008; Norrström and Knutsson 2012). If the known isotopic signatures of sources show that isotopic analysis might be useful, an unfiltered water sample could be digested for analysis of lead concentration and isotope ratios to determine the sources of lead in the water. The investigation might include application of a mixing model or other computational analysis. There might not be a unique isotopic signature, but the analytic results could add to the body of evidence and help to eliminate some sources. A total lead measurement includes dissolved lead and lead associated with suspended particles (Graham et al. 2006). A more in-depth analysis of lead isotopes in a filtered water sample (0.45 μm or smaller filter pore size) vs the particles retained on the filter might provide additional source information if the two fractions differ in their lead isotopic signatures.

Element and Species Analysis

If the isotopic signatures of the total, dissolved, or particulate lead do not yield a unique match to one or more of the lead sources or if more data are desired to build confidence in the lead-source attribution, further analysis of constituents in water will need to be undertaken. A first-order assumption is that high lead concentrations will occur at or immediately adjacent to a source and decrease with distance from the source as a result of dilution and a variety of attenuation processes. As noted in the soil and sediment sections, spatial variations in element concentrations and concentration ratios can provide qualitative insights into lead sources by identifying characteristic

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associations or ratios. Single-element and multielement analyses and measurement of dissolved chemical species and water-quality characteristics can be undertaken on surface waters and groundwater. For example, total, dissolved, and particulate samples could be analyzed for major, minor, and trace elements; for species, such as sulfate or phosphate; and for total dissolved carbon and organic carbon content. Standard measurements of water include temperature, conductivity, pH, dissolved oxygen, oxidation–reduction potential, and alkalinity (acid-neutralizing capacity) or acidity (base-neutralizing capacity). Stable isotopes of water (^{18}O, ^{16}O, ^{1}H, and ^{2}H), dissolved noble gases (^{4}He, ^{20}Ne, and ^{40}Ar), tritium (^{3}H), sulfur hexafluoride (SF_6), and radiocarbon (^{14}C) are among the tracers used to determine groundwater sources, flow paths, and water age (Clark and Fritz 1997; Cook and Bohlke 2000). Measurements of elements, species, isotopes, and water characteristics help to bound geochemical and hydrologic models that can predict water sources, flow paths, mixing, and reactions.

The chemical composition of particulate samples can be determined directly as discussed above or calculated on the basis of the difference between the measured total concentration and the dissolved concentration. Element ratios and element associations can then be compared with possible sources. Lead that is associated with particulate organic matter, for example, might point to an organic-rich water-body source. If filtered particles can be recovered, the particle size, structure, mineralogy, and composition could be investigated with SEM, XRD, or other techniques discussed above to provide insight into suspended-particle sources.

Hydrologic and Hydrogeologic Measurements and Modeling

Modeling of River Samples

Analysis of synoptic samples and temporal variations in lead concentrations can help to identify sources along rivers (Kimball 1997; Boughton 2001; Nimick and Cleasby 2001; Wirt et al. 2001; Walton-Day et al. 2005; Kimball et al. 2002, 2005, 2006, 2007, 2010; Church et al. 2007; Kimball and Runkel 2009). In most cases, the samples are obtained from the river channel and all known inflow points—such as tributaries, culverts, irrigation ditches, and urban sewer systems—during relatively short intervals of stable flows, which are also measured. The analysis provides a snapshot of the variations in elemental concentrations and loads along the river that reflect points of substantive elemental (lead) inputs. Instantaneous load is calculated as the product of constituent (lead) concentrations and river discharge at the sample point at the time of collection. Downstream variations in the loads in the river channel are used to determine the importance of each inflow point as a lead source and to determine the attenuation of lead along the river. Sources are identified by using a mass-balance approach that compares the cumulative load within the river channel with the cumulative load that enters the channel from upstream inflows (see, for example, Kimball et al. 2002). In many cases, the approach is combined with the use of elemental tracers, such as lead isotopes, to quantify more fully the contributions of a pollutant from a specific source.

An advantage of the synoptic approach is that the location and importance of unsampled, diffuse sources of lead from groundwater, which are often poorly documented, can be determined. A disadvantage of synoptic sampling is that it is difficult to apply during some periods of high river flow, but methods are being developed to overcome such issues (see, for example, Kimball et al. 2010). In some cases, the data collected during synoptic sampling can be used for in-stream modeling of solute transport, such as that of dissolved lead (Gooseff et al. 2008). An understanding of temporal variations in lead concentration at a site during a flood event can provide insights into the primary sources of contaminants (McDiffett et al. 1989; Evans and Davies 1998; House and Warwick 1998; Lloyd et al. 2016).

Geochemical, Hydrologic, and Hydrogeologic Models

Developing an overall assessment of sources of lead in water at a given site requires integration of multiple lines of evidence from isotopic and chemical measurements with hydrologic or hydrogeologic data. The data are typically analyzed and evaluated by using various statistical, numerical, and modeling approaches of varied complexity. Multivariate statistical methods, such as principal-components analysis or factor analysis, might be used to identify correlations or characteristic patterns among elements or species. Mixing models use differences in chemical or isotopic composition among the potential sources to determine whether the composition of a specific water can be represented by a mixture of the potential water-source compositions. Inverse mass-balance models compare differences in mass composition to deduce whether a specific water was derived from another along a flow path in contact with minerals and gases (Zhu and Anderson 2002). That model approach assumes a chemical steady state (no net change in chemical species) and is based strictly on mass differences and mass transfer between water and the minerals and gases that are assumed to be in contact with it. Mass-balance models also typically ignore hydrodynamic dispersion or diffusion processes that might affect solute concentrations (Zhu and Anderson 2002). Although potentially informative, mass-balance models consider net chemical mass differences and do not produce a unique solution; that is, multiple combinations of water types, minerals, and gases

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might fit the water composition in question and depend on the water, mineral, and gas phases assumed in the model.

Models that rely solely on mass differences are distinguished from chemical-speciation models that rely on mass balances and thermodynamics to establish the dominant chemical reactions and chemical species that are present. On the basis of thermodynamic equilibrium constants and kinetic parameter estimates, chemical-speciation models are able to calculate the dominant aqueous species and complexes, the amount of dissolution and precipitation of minerals, the solubility of gases in water, and the extent of surface sorption reactions. Several programs are available and include free packages, such as PHREEQC (Parkhurst and Appelo 1999) and MINTEQA2 (EPA 1999a). Chemical equilibrium calculations, particularly ones that include sorption reactions, can help to elucidate possible chemical reactions that lead to mobilization of lead from sources or how lead might be attenuated along a flow path. For example, streams contaminated by lead, zinc, and cadmium from mine waste runoff and mine-drainage discharge in the Tri-State district in Oklahoma, Missouri, and Kansas were studied with a combination of runoff and discharge measurements by using a conservative tracer, statistical analyses, mass-balance calculations, and equilibrium chemical modeling to evaluate lead sources, metal fluxes, and chemical reactions that mobilize or attenuate lead downstream of waste piles and mine-drainage input (Carroll et al. 1998; Schaider et al. 2014).

A variety of water-quality modeling routines might be applied to rivers, such as the Water Quality Assessment Simulation (Ambrose et al. 1988), which includes methods to model advection, dispersion, and point and diffuse mass loading processes and can be linked to hydrodynamic and sediment transport models to assess flow and particulate transport. For groundwater, hydrologic gradients, pump tests to calculate aquifer storage and characteristics, tracer studies to map flow paths and determine residence time, and geologic and hydraulic information are used to support aquifer and groundwater basin models. A widely used package is MODFLOW, the US Geological Survey three-dimensional finite-difference groundwater model (Harbaugh 2005). Originally developed solely as a groundwater-flow simulation code, MODFLOW has been greatly expanded to include simulation of coupled groundwater and "surface-water systems, solute transport, variable-density flow (including saltwater), aquifer-system compaction and land subsidence, parameter estimation, and groundwater management" (Brovelli and Moreno 2014). Surface-water or groundwater models are increasingly used in conjunction with analysis and modeling of chemical and isotopic data to provide a comprehensive evaluation of contaminant sources, transport, and transformation at a study site (Appelo and Postma 2005; Bedekar et al. 2016).

AIR

Like the investigative approaches presented for soils, sediments, and water, attribution of sources of airborne lead typically requires field assessment, laboratory analysis, and modeling. The laboratory analysis of lead-containing PM that might be collected by air monitors is similar to the laboratory analysis of soils described above. Therefore, the committee focuses here on field assessment and modeling approaches that are used to distinguish sources of airborne lead. The committee's investigative strategy is a tiered approach illustrated in Figure 4-9; each tier increases in complexity to achieve source attribution. Tier I begins by conducting chemical speciation on archived filter remnants after lead analysis has been conducted, Tier II includes field sampling to develop site-specific source signatures for input into receptor modeling, and Tier III includes more complete ambient and source sampling to provide additional evidence via a combination of source-dispersion and receptor modeling. Although the focus here is on traditional particle analysis, other approaches are possible. As noted above, Prapaipong et al. (2008) used oak trees to determine dispersion of lead emissions from a smelter, and other researchers have used lichen, rainfall, and snowpack sampling to understand spatial gradients of emissions from smelters and other sources (see, for example, Carignan and Gariepy 1995; Simonetti et al. 2000; Spiro et al. 2004; Telmer et al. 2004; Aznar et al. 2008; Graney et al. 2012; Graney and Landis 2013; Sherman et al. 2015).

Two types of models are used in the committee's investigative strategy. First, receptor models start with pollutant concentrations measured at receptors and attempt to identify and quantify contributions of different sources on the basis of source characteristics (Watson et al. 2016). Specifically, receptor models analyze patterns of chemical composition, particle size, temporal variability, and spatial gradients that are related to specific sources and take into consideration measurement uncertainty and source variability to determine contributions from specific sources that reach the receptors (Watson et al. 2002; Watson and Chow 2005, 2013, 2015; Watson et al. 2016). Second, source-dispersion models start with emission estimates related to potential sources—such as surface soils, road dust, and mine tailings—and calculate meteorologic transport of pollutants to receptors. The receptors are usually neighborhood, urban, or regional air-quality monitoring sites that are established to determine compliance with ambient air-quality standards. The US Environmental Protection Agency (EPA) maintains the Web site Support Center for Regulatory Atmospheric Modeling (SCRAM), which describes EPA-accepted air-quality models in great detail and provides free downloads for the accepted model software.[4]

[4]See https://www.epa.gov/scram.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Tier I: Analyze Composition of Archived Filters

The first tier in the committee's investigative strategy involves further analysis of samples that have already been collected from air-monitoring stations. As noted in Chapter 3, high airborne lead concentrations in total suspended particles (TSP) at monitoring sites of the Missouri Department of Natural Resources (see Figure 3-6) indicate the presence of lead-contaminated resuspended dust in the Southeast Missouri Lead Mining District (MO DNR 2016). Archived filter-sample remnants for which 24-hour TSP lead concentrations exceeded 0.15 $\mu g/m^3$ could be submitted for PM composition analyses, which could include multielement analysis (Watson et al. 1999) with XRF, inductively coupled plasma–atomic emission spectroscopy, and inductively coupled plasma–mass spectrometry; analysis of anions (such as chloride, nitrate, and sulfate) and cations (such as water-soluble sodium, magnesium, potassium, calcium, and ammonium) with ion chromatography; and thermal-optical carbon analysis of organic and elemental-carbon and thermal-carbon fractions. Lead concentrations should be compared with those reported by the Missouri Department of Natural Resources for quality assurance. Material balances of measured species should be performed to ensure that all major PM components are measured, that is, that the sum of the measured chemical species adequately explains the gravimetric mass (Chow et al. 2015).

High ambient PM lead concentrations might have various sources. Watson et al. (2016) recommend that additional indicators be obtained from archived filter-sample remnants to reduce source apportionment uncertainties. Such indicators include commonly found mineral-related elements (aluminum, silicon, potassium, calcium, and iron), elements related to mining activities (such as lead, zinc, copper, arsenic, and silver), stable lead isotopes (^{204}Pb, ^{206}Pb, ^{207}Pb, and ^{208}Pb) that can be analyzed after hot-block acid digestion procedures (with a combination of nitric, hydrochloride, and hydrofluoric acids) established by EPA for lead analysis with inductively coupled plasma-mass spectrometry (EPA 1996b, 1999b). Contaminated fugitive dust might be the main contributor to atmospheric lead concentrations, and additional measurements—such as the carbonate carbon and rare earth elements (such as cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, terbium, thulium, and ytterbium) and particle structure—can also be considered.

Descriptive data analysis can be conducted to understand PM composition and to examine temporal and spatial variations. Comparison of similarities and differences between lead-isotope ratios and abundances of rare earth elements among sites serves as the starting point for examining site-to-site and month-to-month variations (Felix et al. 2015). Because chemical composition varies with geologic source as illustrated in Figure 4-10, that information can be used in source attribution to define source categories. Receptor modeling of about 200–300 samples with the Effective Variance Positive Matrix Factorization and UNMIX solutions to the chemical-mass balance equations can be conducted to identify and quantify major source contributions of PM and lead (EPA 2016).

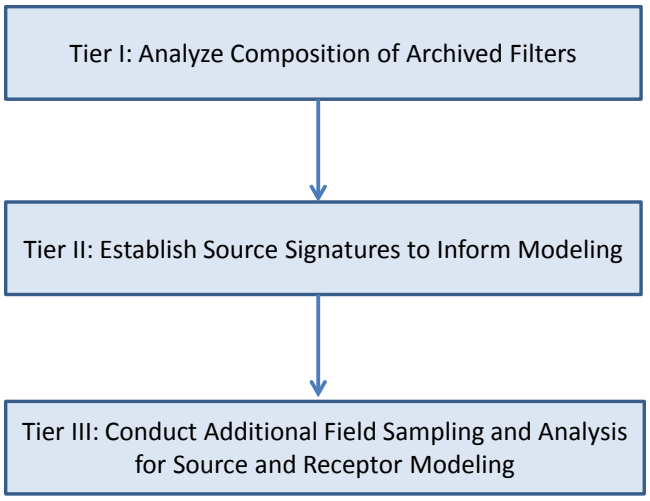

FIGURE 4-9 Investigative strategy for identifying sources of lead in air. The progression from one tier to the next represents increasing complexity.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Preliminary source contributions can serve as a guide in determining the type of source signatures that need to be acquired in Tier II and the extent of field sampling needed for Tier III.

Tier II: Establish Source Signatures for Receptor Model Input

Figure 4-11 illustrates the strategy for establishing source signatures. Source signatures of major source types—such as vehicle exhaust, aircraft fuel combustion, lead smelting, and glass manufacturing—from the EPA source-profile library (SPECIATE; EPA 2017a) can be compiled with the available local source signatures to evaluate the adequacy of signatures for receptor modeling. Geological materials are often a major source of PM mass, so site-specific source signatures probably need to be defined. Surface-soil and paved-road dust surrounding sampling sites that are not in compliance with air-quality standards for lead should be collected, processed, and resuspended in a laboratory resuspension chamber into TSP, PM_{10}, $PM_{2.5}$, and PM_1 size fractions by using multiple filter substrates that will accommodate the same chemical speciation as that of archived filter-sample remnants for Tier I identification. For residential areas that have high lead concentrations, soil samples and house lead-based paint chips should also be collected, processed, and resuspended. Additional bulk-material sampling and analysis of storage piles, tailings piles, and mine haul roads that are near sites that have high lead concentration should also be considered. The source signatures identified here in Tier II serve as model input and verification for receptor modeling and as the basis of development of a speciated PM emission inventory for source-dispersion modeling (EPA 2016).

Tier III: Conduct Additional Field Sampling and Analysis for Source-Dispersion and Receptor Modeling

EPA's National Emissions Inventory (EPA 2017b) shows that lead from mining constitutes only 10% of Missouri emissions, but processes or activities that result in resuspended dust emissions are not well represented in current emission factors (EPA 1998). Because source-dispersion models use emission factors to translate emissions into ambient concentrations, the modeling results can be variable. To improve the accuracy of receptor and source-

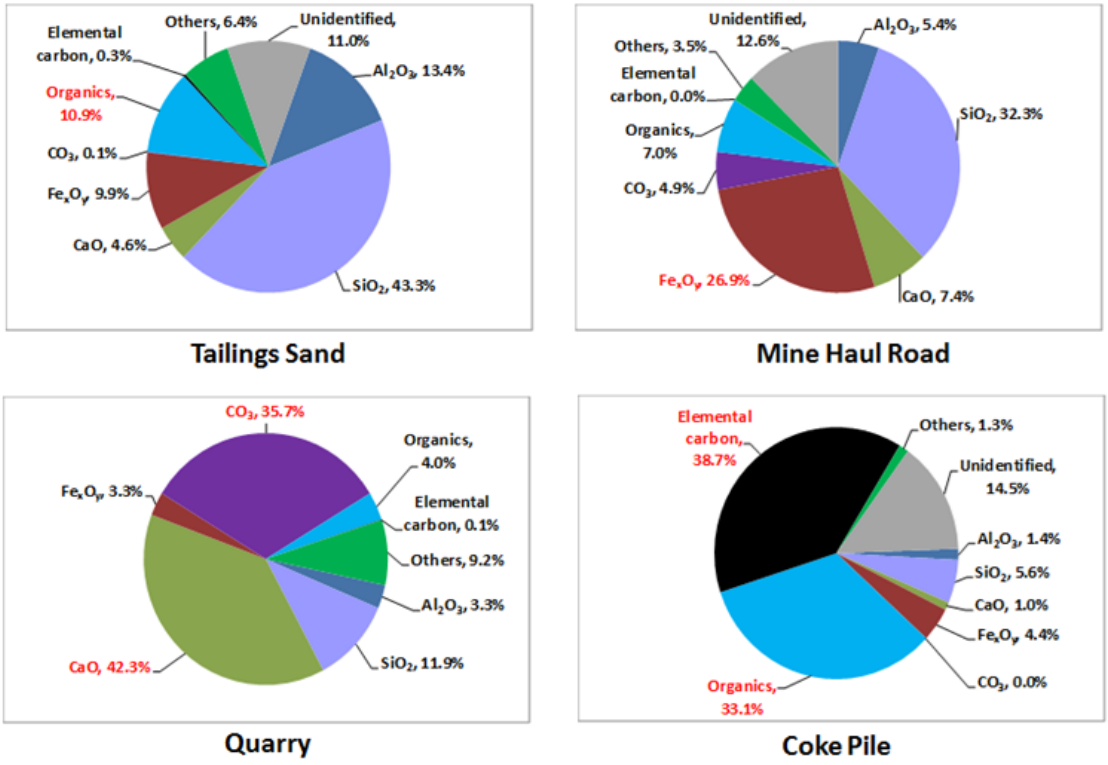

FIGURE 4-10 Chemical compositions differ among dust sources in the Canadian Oil Sands Regions. Source: Watson et al. (2014a,b). Reprinted with permission; copyright 2014, Desert Research Institute.

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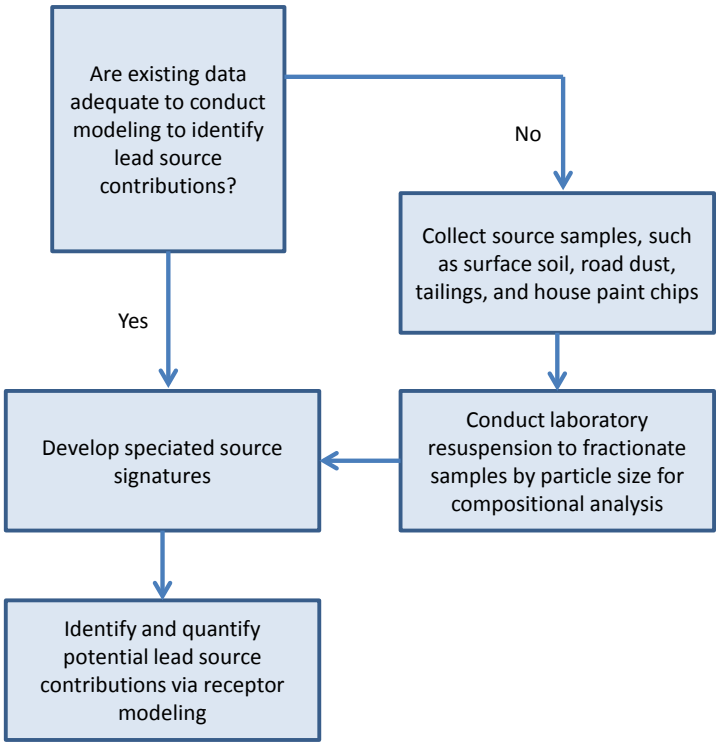

FIGURE 4-11 Expansion of the committee's Tier II strategy for establishing source signatures to inform receptor modeling that can help to identify and quantify potential lead sources.

dispersion models, field sampling is necessary to provide site-specific inputs. Thus, the committee's strategy for Tier III that is illustrated in Figure 4-12 includes varied field sampling to improve model inputs. For source-dispersion models, sensors that are mounted on-board a moving vehicle can be used to determine mechanical suspension and surface loadings (Kuhns et al. 2001), and portable wind tunnels can be used to measure wind erosion potential in various PM size fractions (Etyemezian et al. 2007; Sweeney et al. 2008; Wang et al. 2015). Source-dispersion and receptor models can both benefit from use of site-specific meteorologic variables, such as wind speed and direction, temperature, and relative humidity. Particle-size distributions illustrated in Figure 4-13 vary by geologic source categories and can be obtained by using an optical particle counter that provides particle-number concentrations in several size ranges, such as 0.01–10 μm. Finally, particle mass and chemical composition of lead and other geologically abundant elements (such as aluminum, silicon, potassium, calcium, iron, zinc, and titanium) can be determined by using a cascade impactor.

As indicated in Figure 4-12, model reconciliation can be used to identify uncertainties and limitations in receptor and source-dispersion modeling results and to improve model input datasets (EPA 2007). The goal here is to establish how well the receptor concentrations predicted by a source-dispersion model agree with the measurements collected at receptors and to assess whether receptor-model output compares favorably with the available information on source locations and signatures. Another approach is to use source-dispersion models in a parametric mode to predict chemical patterns at a receptor and then to use receptor models to identify the patterns that best reproduce the ambient measurements (Watson and Chow 2014).

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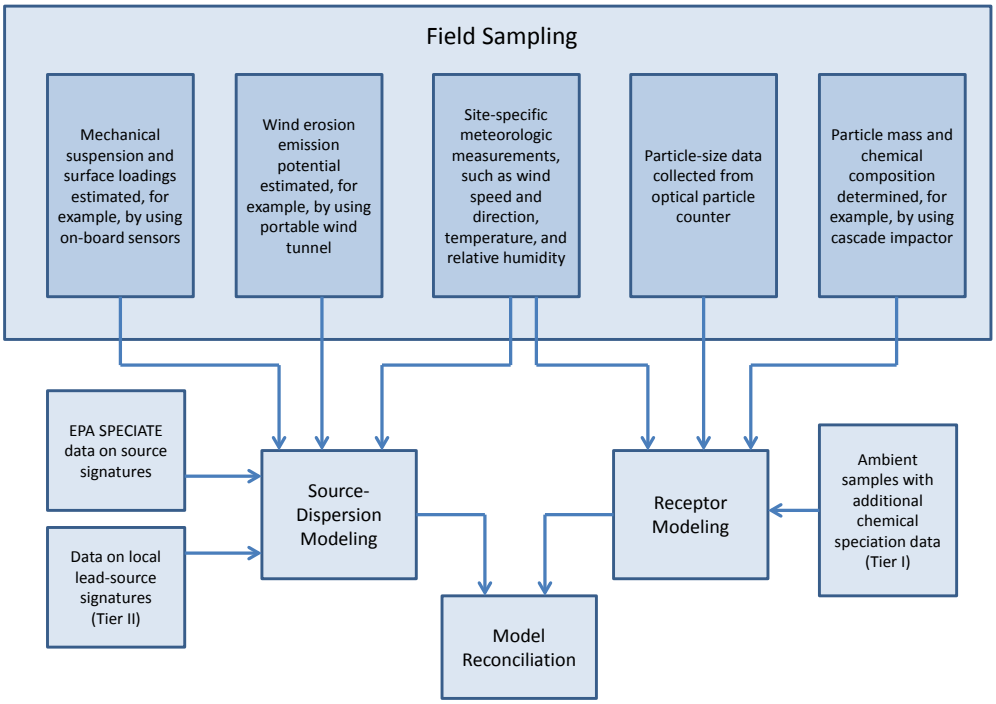

FIGURE 4-12 Expansion of the committee's Tier III strategy for estimating emission potential and particle-size distribution to provide inputs to modeling for source attribution.

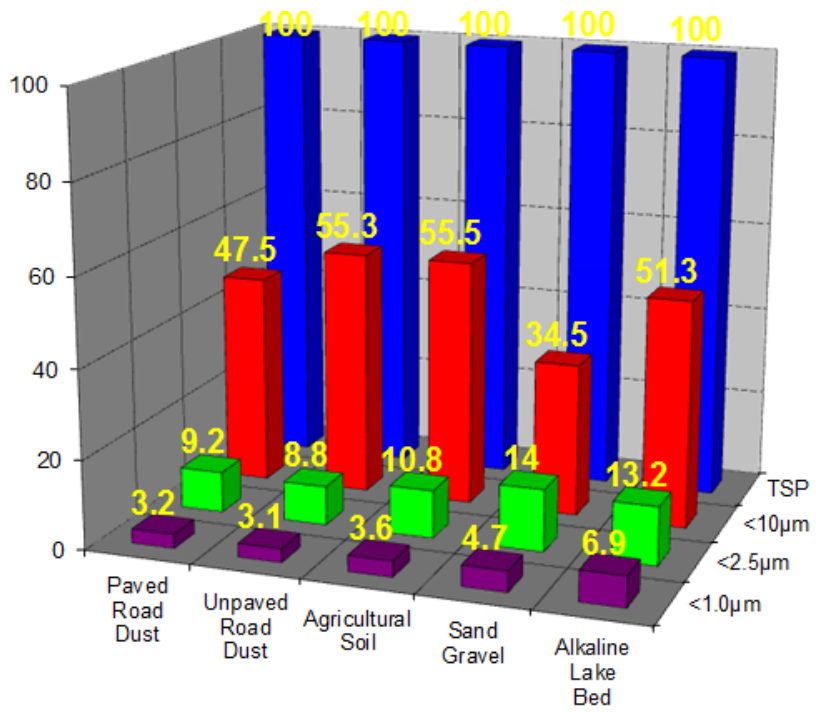

FIGURE 4-13 Comparison of size distribution of particles from Fresno (CA) paved-road dust, Bakersfield (CA) unpaved-road dust, Stockton (CA) agricultural soil, Visalia (CA) sand and gravel, and Owens Lake (CA) alkaline lake-bed sediments. Vertical axis and numbers above bars are percentages. Source: Chow et al. (1994). Reprinted with permission; copyright 1994, *Atmospheric Environment*.

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5

Implications for Southeast Missouri and Research Needs

In this report, the committee has described potential sources of lead contamination, transport mechanisms for environmental dispersal of lead, and investigative strategies for determining the sources of lead in environmental media. Here, the committee addresses specifically the implications of that information for the Southeast Missouri Lead Mining District, provides some research recommendations for optimizing approaches, and considers other opportunities for using some of the analytic techniques or methods for identifying potential sources of environmental lead contamination.

IMPLICATIONS FOR SOUTHEAST MISSOURI

Given the extensive mining history of Southeast Missouri, determining the sources of lead at sites in this region is complex. The presence of lead-ore deposits at or near the surface means that there are natural sources of lead at sites. Mining activities have produced waste materials, and the materials have been dispersed over wide areas, have been deposited many miles from their sources, and have come into contact with residential areas. A further complication is that lead can come from consumer products, including lead paint, gasoline, agricultural chemicals, batteries, and plumbing materials. In Chapter 4, the committee described various analytic methods and approaches for identifying sources of lead at a site and presented investigative strategies for implementing the various methods and approaches for soil, sediments, water, and air. As noted, the steps undertaken can depend on site characteristics and available resources. In the pages that follow, the committee first presents its overall conclusions regarding implementation of its strategies for Southeast Missouri and then provides two case studies that use data from the area to support its conclusions.

Overall Conclusions

Isotopic analytic techniques hold great potential to distinguish commercially processed lead or non-native ores from natural or locally mined materials in Southeast Missouri.[1] For example, compilation of published $^{206}Pb/^{207}Pb$ ratios in North American ore deposits, gasoline, and paints is described in the next section. On the basis of those results, it is likely that lead-isotope ratios will be able to be used to apportion the sources of lead in soils, sediments, or house dust between those commercial sources and natural or mined materials in the case of Southeast Missouri. One strength of using isotopic analysis is that it can pinpoint a source with high accuracy if there is a unique signature, as is the case, for example, in the lead-paint data described in the next section.

The use of the analytic methods in the investigative approaches to distinguish natural sources of lead from mined material is much more challenging and might not be possible, particularly for soil, in the absence of a unique isotopic signature. The natural and mined material often contains lead that exhibits similar isotopic values, and this inhibits the use of lead isotopes to determine source. It might therefore be necessary to use other methods alone or in combination as shown in the committee's investigative strategies to make a judgment about potential sources. Accordingly, determining the grain size, structure, and composition of soil particles might link them to a source. For example, analyzing structure and chemical composition could link soil particles to a smelting operation inasmuch as smelter-derived soil particles often contain spherical grains composed of sulfides, oxides, or glassy particles (Ettler 2016). The spatial distribution of the particles is also likely to vary as a function of wind direction and distance from the smelter; sulfides are relatively dense, and their concentration in soil is therefore likely to be higher closer to the smelter. Furthermore, differences in particles from tailings and chat piles might be determined partly on the basis of grain size; the former consists of relatively small grains (less than 74 μm), and the latter

[1]The committee uses the term *natural materials* to refer to the geologic background that includes the mineral deposits that have not been mined.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

much larger grains (often 4–8 mm). In addition, concentrations of barium and barite might distinguish lead from the Southeast Missouri Barite District and the St. Francois County Mining Area. With time, however, weathering of soil minerals derived from primary ore or smelter sources might alter or dissolve them and potentially disperse lead as a sorbed species or substituted in minor amounts in new precipitated phases. The point is that the selection of specific characteristics for attribution must be based on physical, compositional, mineralogic, or geochemical differences in the various source materials, and it might be necessary to use multiple methods to differentiate between all sources present. Even when multiple analyses are used, however, source identification might not be definitive.

It might be possible to estimate the relative contributions of lead from sources by using data analysis. *Data analysis* is a catchall term for mathematical manipulations designed to extract useful patterns and narratives from empirically derived collections of numbers, or data sets. The assessment activities undertaken early in the Superfund process described in Chapter 1 typically generate substantial collections of such data. The field collection and laboratory analysis of samples follow quality-assurance protocols; consequently, the consistent quality of the resulting data makes them well suited to systematic analyses.

A concrete example of data analysis to help to establish the extent to which lead-based paint contributes to environmental lead contamination in the Southeast Missouri Lead Mining District is described as the second case study. The mass-balance analysis revealed that much less total lead is likely to reside in exterior paint on older houses than in the top 1 inch of soil in many Southeast Missouri residential yards. Consequently, the contribution of exterior paint is expected to be a small fraction of the average lead content measured in typical Southeast Missouri residential yards. Such data analysis can be used to determine the dominant contributors to the mass balance of lead at a given site. However, the committee emphasizes that lead paint could still be the most important source for human exposure. The committee did not examine exposure pathways to determine the most important source for human exposure.

Lead-Isotope Techniques: A Southeast Missouri Case Study

To use lead-isotope ratios effectively for source attribution, one must first determine the lead isotopic composition of the various potential sources. The technique works well if there is an isotopic contrast between the sources that one wishes to distinguish but can yield equivocal results if there are overlapping isotopic compositions in the various potential sources. In most cases, some potential sources can be eliminated, and the investigation can focus on fewer possible sources. Thus, the lead-isotope method should work for source attribution of lead in soil near residences in mining or smelting areas if the isotopic composition of the ores and tailings is distinct from that of other possible sources.

For this case study, the committee selected lead paint and gasoline as possible sources because widespread environmental contamination has resulted from their use. The committee assessed whether they could be distinguished from natural ores or tailings from Southeast Missouri. It is well known that the lead isotopic composition differs between various ore deposits (Stanton and Russel 1959) and between lead ingots and slags and contaminated soils associated with different mines (Rabinowitz 2002). Different gasoline producers and paint manufacturers used lead mined from different ore bodies and in some cases changed their sources through time (Rabinowitz and Hall 2002). Therefore, it is expected that in some specific cases the lead isotopic composition of gasoline and paint might differ from that of local ore bodies but in other cases might be the same and therefore not useful for source attribution. The lead ores from Southeast Missouri have an extremely unusual lead isotopic composition (Rabinowitz and Wetherill 1972; Goldhaber et al. 1995). Thus, the isotopic composition of lead mined from Southeast Missouri (and adjacent areas in the tristate region) appears to be distinct from lead mined in nearly all other major mines (and products made with that lead) in North America (Doe 1970). However, the local geologic background lead in Southeast Missouri also contains unusual lead, so it might not be possible to differentiate between background and mine-derived lead in Southeast Missouri on the basis of isotopes alone.

The committee compiled $^{206}Pb/^{207}Pb$ ratios for North American lead ores, gasoline, and paints from around the world. The compilation is shown in Figure 5-1. All the data are from peer-reviewed published articles except those from the Herculaneum smelter and nearby houses, which come from an exposure-investigation report prepared by the Agency for Toxic Substances and Disease Registry (Orloff 2002). In that report, two houses that were within 1 mile of the smelter were studied. The upper panel in the figure shows that Southeast Missouri ores, especially those from the Old Lead Belt, have considerably higher $^{206}Pb/^{207}Pb$ ratios than nearly all other North American ores that are plotted; only ores from the Upper Mississippi Valley District have overlapping lead-isotope ratios. In addition, 11 of the 12 samples of paint from the two houses sampled near the Herculaneum smelter in Southeast Missouri had $^{206}Pb/^{207}Pb$ ratios lower than dust, ore, and slag sampled at the nearby smelter, and one had a higher ratio. Thirty-one samples of paint pigment produced by six major US lead-paint manufacturers had ratios lower than dust, ore, and slag sampled at the

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

smelter. The single high-ratio paint sample was from the exterior of the back door of a house within 1 mile of the Herculaneum smelter. Either that paint contained lead that was produced from Southeast Missouri ores or the back door was contaminated by lead emitted from the smelter. Lead concentrations of the paint were not given in Orloff (2002), so the possibility that the back-door paint had low lead concentration and that the isotopic composition reflects the addition of lead from the nearby smelter cannot be eliminated.

The lead-isotope ratio measurements of materials from near the Southeast Missouri smelter suggest that the source of lead in most or possibly all lead paint was not Southeast Missouri lead. The middle panel in Figure 5-1 shows the $^{206}Pb/^{207}Pb$ ratios for six studies of lead in paint sampled from houses in other US locations, including Massachusetts, California, and New Jersey. All the samples have $^{206}Pb/^{207}Pb$ ratios lower than those of Southeast Missouri ores; this supports the suggestion that most lead paint manufactured in the United States used lead from ore deposits that did not include Southeast Missouri ores. Finally, the lower panel of Figure 5-1 shows the $^{206}Pb/^{207}Pb$ ratios of house paint from France and Brazil, road paint from New York City, bridge paint from Australia, and gasoline; these samples have $^{206}Pb/^{207}Pb$ ratios below those of Southeast Missouri ores.

Figure 5-1 shows that the Southeast Missouri ores, especially Old Lead Belt ores, have higher $^{206}Pb/^{207}Pb$ ratios than other ore deposits, gasoline, or paints compiled for North America. As noted, the only exceptions are the ores from the Upper Mississippi Valley District, which were probably not produced in large quantities in the 20th century compared with those from Southeast Missouri, and the single paint sample from the house near the Herculaneum smelter. Thus, in the case of the Southeast Missouri Lead Mining District, lead-isotope ratios will likely be able to attribute the sources of lead in soils between mined materials and paints and gasoline in most cases. As discussed below, additional analyses of lead concentrations and isotopic compositions of exterior paints in older houses in Southeast Missouri will be needed to verify the range of lead isotopic composition of paints in the area and the origin of the single back-door paint that had a high $^{206}Pb/^{207}Pb$ ratio.

The committee emphasizes that Figure 5-1 contains $^{206}Pb/^{207}Pb$ ratios from a variety of sources that were measured with a variety of mass spectrometry methods. Thus, the accuracy of the measurements varies considerably between about 0.01% and 0.5%. However, the highest estimated error is still smaller than the symbol sizes on the diagram; thus, it is clear that even without high-precision measurements, lead in most paints should be easily distinguishable from Southeast Missouri ores. High-precision lead-isotope analyses have uncertainties that are about one-fiftieth of the value reflected by the size of the symbols in Figure 5-1; thus, it is likely that at specific sites near other ore bodies, there will be measurable differences in lead-isotope ratios between paint and ore materials. In Figure 5-1, the committee showed only $^{206}Pb/^{207}Pb$ ratios because only they were available in some data sets. However, it is well known that if plots of $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ are included, there can be greater resolving power for determining isotopic source contributions.

The committee notes that lead-isotope ratio measurements can be classified into three categories according to their precision: low-precision analyses of digests without chromatographic separation using quadrupole inductively coupled plasma mass spectrometry (ICP–MS), medium-precision analyses of digests without chromatographic separation using magnetic-sector ICP–MS, and high-precision analyses of digests after chromatographic separation using either multicollector magnetic-sector ICP–MS or thermal ionization mass spectrometry. Analysis costs vary widely among laboratories but increase from low to medium to high precision. The estimated cost per analysis is $50–500 and depends on the sample type and the analytic method. In the case of the Old Lead Belt in Southeast Missouri, low- and medium-precision analyses are likely to be adequate because of the large difference in $^{206}Pb/^{207}Pb$ between paint and ore. However, high-precision analyses might in some cases allow differentiation between ores from the various different mineral deposits in the mining district. Furthermore, measurement of ^{204}Pb with high precision might be helpful for source apportionment in some cases. In general, the committee suggests that preliminary studies with medium precision should be conducted first to determine where there would be a benefit from high-precision analyses.

The committee notes that the utility of the lead isotopic methods in other mining and smelting regions in the United States has not been evaluated adequately and will depend on the lead isotopic composition of individual ore deposits and the isotopic contrast between the ores and other exposure sources, including paint. Ores from the Coeur d'Alene Idaho mining district have an unusually low $^{206}Pb/^{207}Pb$ ratio of about 1.06, which is lower than any of the paint or gasoline $^{206}Pb/^{207}Pb$ ratios that the committee compiled from the literature (Figure 5-1). Thus, in addition to the Southeast Missouri ores, Coeur d'Alene ores have $^{206}Pb/^{207}Pb$ ratios that contrast with those of paint and gasoline and should allow source-attribution studies. Furthermore, Vázquez Bahéna et al. (2017) found that in the Taxco mining district of southern Mexico the lead isotopic composition could be used to differentiate between local ores, glazed pottery, and paints. They concluded that women of childbearing age who had high blood lead and lived in the area had acquired lead predominantly from a mixture of local ores and pottery glaze.

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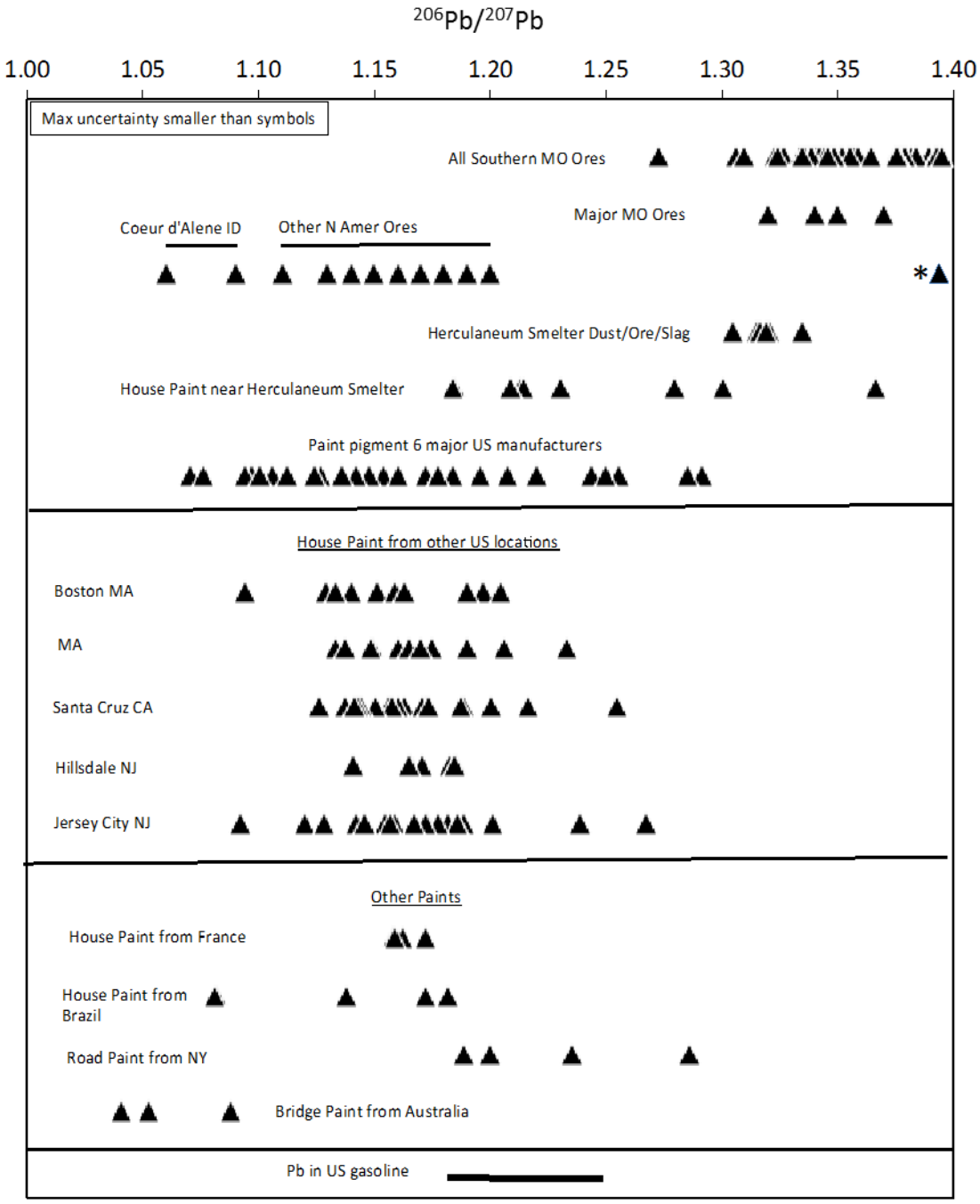

FIGURE 5-1 Compilation of $^{206}Pb/^{207}Pb$ ratios in North American ore deposits, gasoline, and all paints that have been published. Data are from the following sources: Southeast Missouri ores (Goldhaber et al. 1995); major Missouri ores and major North American mining districts (Rabinowitz 2005); dust, ore, and slag from the Herculaneum smelter and paint from a house near the Herculaneum smelter (Orloff 2002); paint pigments from six major US paint manufacturers (Rabinowitz and Hall 2002; in this study, only $^{206}Pb/^{204}Pb$ ratios were reported and were converted to $^{206}Pb/^{207}Pb$ ratios by using the linear relationship between $^{206}Pb/^{204}Pb$ and $^{206}Pb/^{207}Pb$ ratios for ingots, slags, and contaminated soils from a wide array of US lead ores and reported by Rabinowitz 2002); house paint from two houses within 1 mile of the Herculaneum smelter (Orloff 2001, 2002); Boston, MA, house paint (Rabinowitz (1995); Massachusetts (city not designated) house paint (Viczián et al.1990); Santa Cruz, CA, house paint (Gwiazda and Smith 2000); Hillsdale, NJ, house paint (Jaeger et al. 1998); Jersey City, NJ, house paint (Adgate et al. 1998); house paint from France (Glorennec et al. 2010); house paint from Brazil (Mirlean et al. 2005), road paint from New York City, NY (Duzgoren-Aydin and Weiss 2008), and bridge paint from Australia (Gulson et al. 2016); gasoline (Sherrell et al. 1992). The asterisked triangle represents the average $^{206}Pb/^{207}Pb$ ratios in ores from the Upper Mississippi Valley District (Heyl et al. 1974).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Data Analysis to Estimate Lead-Based Paint Contribution to Environmental Lead Contamination: A Southeast Missouri Case Study

As noted in Chapter 2, lead-based paints were heavily used in the early decades of the previous century (Mielke 1999), particularly to protect the exterior surfaces of houses and other structures from the effects of weathering. Detritus from lead-based paints is well recognized as a potential contaminant of soils in older neighborhoods, and protocols for the collection of residential soil samples distinguish drip zones where such debris is likely to collect adjacent to painted surfaces (see Figure 5-2). In addition to paint flakes and residues, drip zones can be enriched in airborne lead-containing particles deposited initially on roofs and walls and then washed off by precipitation. As Figure 5-2 indicates, samples collected in quadrants of the larger yard are intended to represent average concentrations in soils free from those influences.

Lead is considered to be relatively immobile as a constituent of soil in Southeast Missouri. Consequently, the spatial distribution of soil lead concentrations offers some indication of where exogenous lead might have been introduced and provides a strategy for attributing soil lead to point sources where releases are concentrated at fixed locations. The contributions of removal of lead-based paint in preparation for repainting and of weathering and wear of lead-based exterior paint are expected to manifest themselves as differentials in soil lead concentrations between the drip zone and the outer yard.

Figure 5-3 directly compares drip-zone with yard-average soil lead concentrations measured at 145 Southeast Missouri lots in the Focused Residential Sampling program described by Integral Consulting Inc. (2014). Drip-zone concentrations were found to be higher than yard concentrations at about 75% of homes (48 of 65) built before 1940, when lead content in house paint started to decline (Mielke 1999). The observation of higher drip-zone concentrations at older houses provides evidence that lead-based paint contributes to environmental contamination. Many other homes of all ages showed yard-average lead concentrations well above those in their drip zones, and these data indicate the presence of sources other than house paint. The mixture of positive and negative spatial concentration gradients near homes suggests that exterior paint does not generally overwhelm other sources of soil lead in the sampled neighborhoods.

A different kind of gradient that is evident in Figure 5-3 is the tendency of older houses to have higher soil lead concentrations outside their drip zones. Of the 60 residences built after 1979, 35 (58%) have yard lead concentrations below 400 mg/kg, whereas only six of 65 built

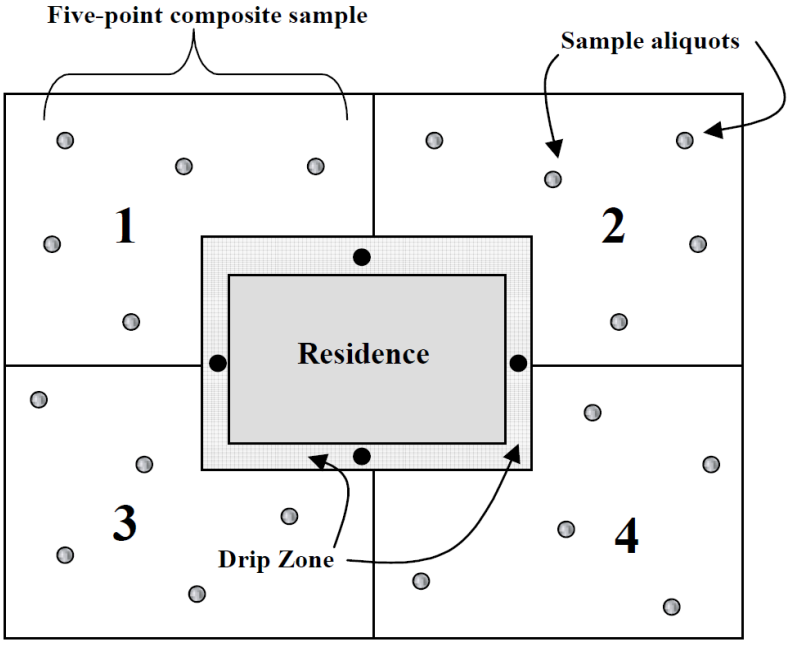

FIGURE 5-2 Recommended minimum soil sampling in yards greater than one-eighth acre. A five-point composite sample is collected 0–1 inch below the soil surface in each quadrant, outside the drip zone considered as extending 30 inches from the exterior walls of the house. Source: EPA (2003).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

before 1940 (9%) are below this threshold. The differential could represent nothing more than the circumstance that construction at different times took place in different neighborhoods with different levels of prior contamination. Alternatively, it can be interpreted as evidence that lead-based paint debris is not confined to the drip zones of exterior walls. The higher lead concentrations recorded in older yards might be attributable in some part to the lead-based exterior paint used on the older houses, as suggested by Integral Consulting Inc. (2014, pp. 3-2, 4-1).

A mass balance can place bounds on source contributions of lead. Figure 5-3 compared *concentrations* in the outer yard with *concentrations* in the drip zone. The average lead concentration in the outer yard represents a much greater *total quantity* of lead, however, than would a similar concentration in the narrow drip zone. To assess the possibility raised above that lead-based paint is a major contributor to lead in the outer yard and not just to lead in the drip zone, the committee first considered the total lead contained in a yard's surface soil.

The total lead content of a yard's surface soil can be estimated from the average mass concentration and an estimate of soil volume and density. An arithmetic mean lead concentration of 677 mg/kg of soil was reported outside the drip zone for all Southeast Missouri yards sampled in 2013 (Integral Consulting Inc. 2014, Figure 3-8). The committee used the bulk soil density for the relevant density (Timm et al. 2005), which accounts for the volume contributed by interstitial air spaces. Surface soils vary in their composition and compaction; reported residential bulk soil densities typically are 1.2–1.6 g/cm^3. The committee took 1.5 g/cm^3 as a representative value, and this converts the mean lead concentration of 677 mg/kg reported for sampled Southeast Missouri yards to about 1 mg/cm^3 of soil. The committee assumed conservative values (lower bounds) of one quarter-acre for Southeast Missouri residential lot sizes, and 40% as an estimate of the portion covered with soil. A quarter-acre is about 107 cm^2, and the 40% soil-cover factor is offset by the sampling depth of 1 in (2.54 cm) rather than 1 cm. Those order-of-magnitude calculations yield average amounts of lead in the top inch of yard soil in a quarter-acre of at least 10 kg ([107 cm^3][1 mg/cm^3]). The 10-kg total lead burden estimated to reside in the top inch of an average Southeast Missouri yard serves as a meaningful benchmark with which the contents of other potential lead reservoirs can be compared. In the case of lead-based exterior paint, three methods described below can be used to estimate a house's total lead burden.

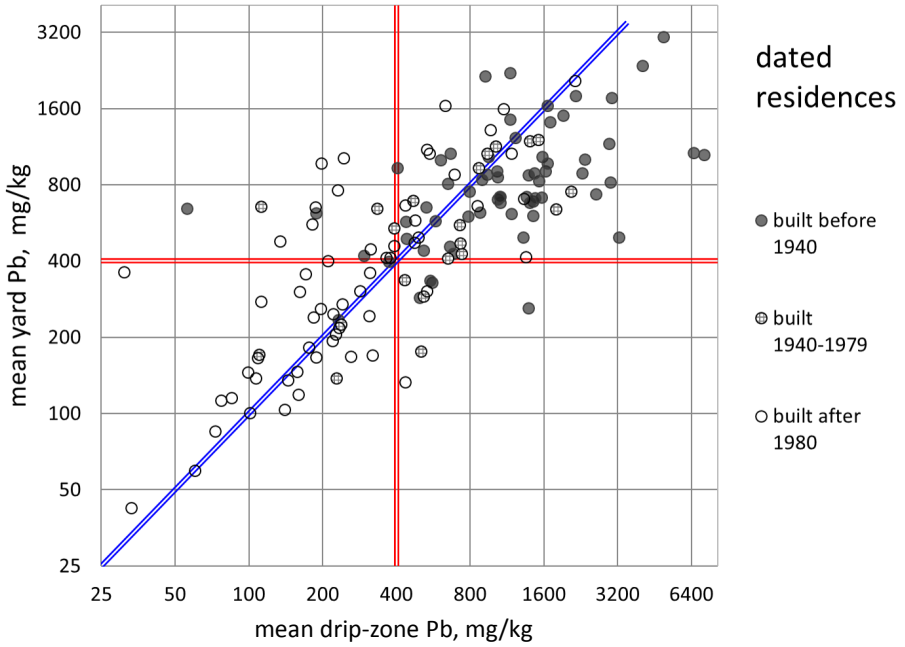

FIGURE 5-3 Results from 2013 soil sampling in Southeast Missouri. Each point represents one residential lot; its coordinates indicate drip-zone concentration (horizontal axis) and the arithmetic mean concentration of the four yard quadrants (vertical axis). The red lines indicate a typical action level for soil clean-up. Scales are logarithmic and marked at regular geometric intervals. The double blue line represents the yard concentrations equal to the drip-zone concentration. Soil lead concentrations are from Integral Consulting Inc. (2014). Only sampled residences (145 of 165) of which construction dates could be found on line from the real-estate data aggregator Zillow were plotted. Source: Generated from Zillow (2017).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

• The lead content of house paints has varied, but a representative formulation might be the following (HUD 2012, Appendix A): 12% Pb × 50% solids × 12 lb/gal = lead at 0.7 lb/gal. A square house 40 ft on a side with walls that extend 9 ft above the foundation would have at most 1,440 ft^2 of paintable exterior surface. At coverages of 350–400 ft^2/gal, this house would take about 4 gal of paint, containing 2.8 lb = 1.3 kg. The 10-kg estimated in the surface yard soil would correspond to seven or eight full-coverage coats of lead-based paint.

• Mielke et al. (2001) studied a two-story wood frame house that was built in the 1920s and had deteriorating lead-based paint. The investigators oversaw an exterior restoration in which care was taken to collect and quantify all removed paint and reported 41 kg of paint scrapings that contained 3.7 kg of lead. They estimated that a similar amount remained bound intact to the wood, for a total of 7.4 kg of lead accumulated in paint layers over many decades.

• A third set of estimates comes from systematic national surveys undertaken for the Department of Housing and Urban Development and the US Environmental Protection Agency (EPA) by field inspectors using portable x-ray fluorescence analyzers (EPA 1995a). Table 5-1 summarizes the survey for exterior surfaces of occupied and privately owned housing units grouped into three construction periods. The historical decline of lead-based paint use is clear in the survey results. For the maximally leaded "pre-war" houses, the committee estimated total lead contents of

$$1{,}441 ft^2 \left(\frac{12\ in}{ft}\right)^2 \left(\frac{2.54\ cm}{in}\right)^2 4.6 \frac{mg}{cm^2} = 6.2\ kg,$$

which is close to the value that Mielke et al. (2001) obtained by collecting paint scrapings.

The three estimates indicate that less total lead is likely to reside in exterior paint, even on an older house, than the 10-kg average lead burden that sampling indicates now sits in the top inch of sampled Southeast Missouri yards. Table 5-1 shows that the high-lead-content paints applied before 1940 were largely still in place when inspectors visited them more than 50 years later; that finding suggests that most of the paint ever applied to the exterior remains there. Some portion of the applied paint is lost to weathering, maintenance, and wear, but most of this debris is expected to accumulate in the drip zone, as discussed earlier.

The committee's mass-balance findings imply that the great majority of the surface lead in a randomly selected sample of surface yard soil outside the drip zone cannot reasonably be attributed to contamination by paint debris in typical Southeast Missouri yards. However, they do not preclude that paint debris might be primarily responsible for the soil lead content in some areas of some yards or that the paint debris is the primary source of human exposure. Again, the committee emphasizes that one must examine exposure pathways to identify the sources important for human exposure.

RESEARCH NEEDS

Additional research provides an opportunity to enhance the performance of the analytic methods incorporated into the investigative strategies proposed by the committee and to reduce uncertainty during implementation. The committee concluded that high research priority should be given to further characterizing potential sources but notes that the research described below is not essential for implementation of its investigative strategies. The research needs are not listed in order of priority.

Characterizing Lead Isotopic Composition of Historical Paints

The committee has discussed the use of lead-isotope ratios for attributing sources of lead in contaminated soils to mining and smelting activities. The committee pointed to examples of previous studies that showed an isotopic contrast between lead from paint and lead from mining and smelting activities in Southeast Missouri and suggested that the two sources of lead in soils could be identified by using lead isotopes. However, to evaluate the utility

TABLE 5-1 Selected Characteristics of Exterior Surfaces of Privately Owned Occupied Housing Units Built before 1980 with Lead-Based Paint

	Construction Era		
	Before 1940	1940–1959	1960–1979
Number of sampled units	77	87	120
Area of lead-based paint per unit (ft^2)	1,441	758	482
Mean lead-based paint loading (Pb in mg /cm^2)	4.6	1.5	0.6

Source: Extracted from EPA (1995b), Appendix II, Tables 2-1, 2-12, 2-13.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

of the approach fully, additional study of lead isotopes should be conducted. In particular, knowledge of the lead isotopic composition of house paint in Southeast Missouri is limited to 11 analyses related to a single house and one analysis related to a second house, and lead concentrations in these samples were not reported. The committee recommends systematic sampling and lead isotopic analysis of paint in houses built before 1980 throughout the Southeast Missouri Lead Mining District. A broad sampling and analysis of paint in houses of various ages and locations should be conducted with at least five interior and five exterior paint samples collected from each house. That approach would give a much clearer indication of the range in lead isotopic composition of paint used in Southeast Missouri and would clarify the degree to which lead isotopes can be used in attributing lead in soil to paint vs mining and smelting sources. If there are other lead-containing consumer products at the site—such as plumbing materials, batteries, and pesticides—studies of their lead isotopic composition could establish or refute their role as a source of lead contamination at a site.

Characterizing Lead-Bearing Geologic Materials and Mining Wastes

The distribution, concentration, and geologic context of potentially key elements need to be better characterized to provide a baseline for interpretation of natural contributions to surface lead. There is a need to move away from just making bulk lead measurements and to provide greater detail on the materials and characteristics of the lead in the geologic and mining sources. Characterization would include chemical data, such as concentrations and isotopic ratios, mineralogy, grain size and texture, and host rock types. Spatial characterization would include vertical distribution, particularly in weathering (soil) profiles, and the lateral (areal) distribution over appropriate areas. Such information will improve confidence in investigative strategies for source attribution introduced in Chapter 4.

Recent advances in analytic chemistry, such as multicollector ICP–MS, have opened the possibility that a wide array of nontraditional stable isotopes can be used to determine the source of trace metals in the environment. Many metals—such as cadmium, copper, iron, mercury, and zinc—occur as sulfides and are associated with lead in geologic materials. Thus, they can potentially be used to attribute lead from geologic and mining sources in the Southeast Missouri Lead Mining District.

Variations in lead isotopic abundance in geologic materials are due mainly to radioactive decay over geologic timescales in that lead undergoes little change in isotopic ratios during other types of physical, chemical, and biologic processes. In contrast, shifts in the isotopic abundances of nontraditional stable isotopes[2] are small but are due entirely to physical, chemical, or biologic processes, including ones that occur during industrial processing or during metal dispersal at the Earth's surface (Wombacher et al. 2004; Cloquet et al. 2006; Shiel et al. 2010; Rehkämper et al. 2011; Blum et al 2014). It is that shift in the isotopic ratio that allows those isotopes to be of use in studies of source attribution. However, their effective use requires a detailed understanding of the processes that cause changes in the isotopic ratios in the environment of interest. They are more likely to change because of chemical reactions in the environment and are therefore more complicated to use for source attribution than lead isotopes. However, several such isotopes—including cadmium, mercury, and zinc—have proved useful as tracers of particles in soils and river sediments. Their application to the Southeast Missouri situation will require additional investigation but might prove to be highly useful, particularly for distinguishing between particles derived from ore deposits and smelter emissions.

Developing Capabilities to Model Metal Concentrations in Soils as a Function of Depth

As described in Chapter 4, the science of modeling sediment distributions in river floodplains is relatively advanced. Advantages of multielement, geochemical fingerprinting for attribution of sources of sediment and sediment-associated metals in rivers include (1) the ability to incorporate a wide array of elements into the analysis, thereby increasing the probability that the sources of sediment (and particulate lead) can be uniquely distinguished; (2) the establishment of widely accepted sampling and statistical analysis protocols; and (3) the increasing ability to quantify uncertainty in the attribution results (see, for example, Collins et al. 2012; Miller et al. 2015). The approach might prove applicable for determining particulate lead in sediments of the Big River with little modification of existing methods. Modeling of metal movement through soils is less developed. The application of multielemental, geochemical fingerprinting to determine sources of particulate lead in soils is more challenging because of potential alteration and dissolution of particulate lead. Theoretically, the approach is applicable to soils and might yield highly useful results, but the method will require additional testing when applied to soils. Studies could be completed on soils near known metal-emitting sources to map and model how the metals, especially lead, have moved through soils as a function of time.

[2]Nontraditional stable isotopes include elements other than carbon, hydrogen, oxygen, nitrogen, and sulfur. Examples are zinc, copper, molybdenum, mercury, iron, lithium, and cadmium.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

Characterizing Size Distribution of Suspended Particles in Air Samples

Tailings impoundments, chat piles, and smelting emissions are important sources of airborne lead in a mining district; however, little is known about the size of suspended particles and their mobility. Knowledge of the size distribution of lead-containing airborne particulate matter is important for controlling particle transport and deposition. The largest particles have high terminal velocities and can settle within a few minutes to a few hours whereas particles whose diameters are a few micrometers can remain suspended for several days and can therefore be transported long distances. Size-selective sampling of air samples in the mining district should be conducted to determine the particle-size distribution and establish the $PM_{2.5}$ and PM_{10} levels. Size-selective sampling can be conducted upwind or downwind of a source, such as smelter or tailings pile, to evaluate contributions from the source. In addition to particle-size measurements, particle analysis by elemental, mineralogic, isotopic, and microscopic methods can be used to help to relate airborne and deposited particles to their sources.

Characterizing Rates of Emission of Airborne Particles from Mining Wastes

Little is known about rates of emission of airborne lead from stockpiles of mining wastes. Portable wind tunnels can be used to estimate the airborne particle emission rates and dust production from stockpiles of mining wastes, such as chat piles and tailings impoundments. Portable wind tunnels can also be useful in measuring the threshold wind velocity at a specific site that results in particle suspension and later transport downwind. This information can help to establish whether airborne lead from mining wastes is an important source of lead contamination downwind.

Identifying Sources with Investigative Tools in Industrial Archeology and Affiliated Disciplines

Industrial archeology is the systematic study of material evidence associated with historical industrial activities, such as resource extraction and raw-material processing; refining and manufacturing; storage, transport, and distribution; uses throughout product and byproduct life cycles; and waste disposal. Although historical industrial processes were generally on a smaller scale than modern industry, they operated less efficiently, were more likely to use processes and materials that produced hazardous byproducts, and lacked pollution controls. Thus, the relative pollution effect of historical industrial activities can be highly disproportionate relative to the scale of production. Understanding historical practices sheds light on their relative importance as a source of legacy pollution that persists long after the industries have disappeared.

Industrial archeology provides scientific methods for investigating the industrial life cycle of lead and drawing objective conclusions about how past practices throughout the industrial life cycle contributed to the present abundance, distribution, and forms of lead in the built and natural environments. Those investigative tools could help to identify sources of lead contamination, especially at large Superfund sites, including the Southeast Missouri Lead Mining District, and involving industrial archeologists and historians at the earliest stages of a remedial investigation could provide valuable insight on sources, transport, and fate of contaminants. The committee notes that the investigative tools of industrial archeology evolve as do the tools of any other discipline. A good resource is *IA*, the Journal of the Society for Industrial Archeology, which publishes on industrial archeology of industrial waste.

OTHER APPLICATIONS OF RECOMMENDED ANALYTIC TECHNIQUES: A CASE STUDY OF BLOOD LEAD AND ISOTOPIC ANALYSIS

The analytic techniques and methods incorporated into the committee's investigative strategies can be used for applications other than simply soil, sediments, water, and air. For example, isotopic analysis can be used for assessing sources of lead in biologic samples, such as blood and urine. When humans are exposed to lead, the lead isotopic composition in their blood and urine reflects the sources of lead exposure. Lead isotope investigations to determine the sources of lead in residents near the Herculaneum Lead Smelter in Southeast Missouri were reported by the Agency for Toxic Substances and Disease Registry and published as two exposure investigations (Orloff 2001, 2002). The committee summarized and interpreted the data in those reports as a case study to demonstrate both the power and the complexity of the use of lead isotopes for source attribution.

Two houses within 1 mile of the Herculaneum Lead Smelter in Southeast Missouri and their occupants were sampled, and the samples were analyzed for lead isotopic composition (Orloff 2001, 2002). The various environmental media and human specimens that were sampled and their lead isotopic compositions are shown in Figure 5-4. The committee focused on the data from house 1 because the sampling included 11 paint samples, compared with only one at house 2. The patterns in lead isotopic composition and the general conclusions are similar for the two houses.

As discussed above, lead ores and mining waste from the Southeast Missouri Lead Mining District have unusually high $^{206}Pb/^{207}Pb$ ratios compared with most other mining districts and therefore most commercial

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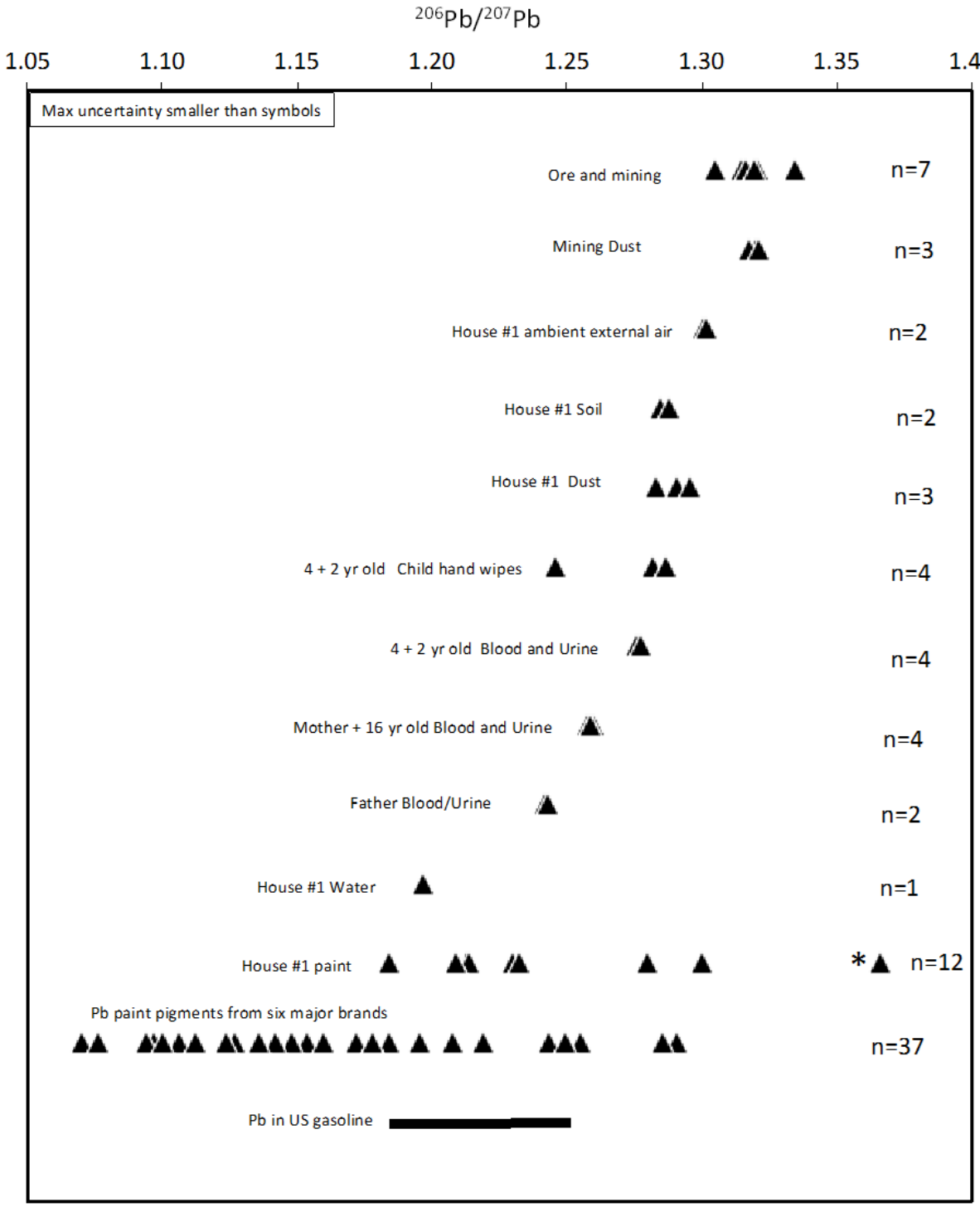

FIGURE 5-4 Compilation of $^{206}Pb/^{207}Pb$ ratios for one house within 1 mile of the Herculaneum Lead Smelter. House and its occupants were sampled, and the results were analyzed for lead isotopic composition (Orloff 2001, 2002). Also shown are $^{206}Pb/^{207}Pb$ ratios for ore and mined materials, mining dust, lead in paints and pigments of six major brands, and lead in gasoline.

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products that contain lead. Ore, mining waste, and dust generated from ore-processing at the Herculaneum lead smelter have the highest $^{206}Pb/^{207}Pb$ ratios measured (Orloff 2001, 2002), 1.31–1.34. Ambient exterior-air particles larger than 0.8 μm sampled 4–5 ft above the ground in the house 1 yard have similar but slightly lower $^{206}Pb/^{207}Pb$ ratios, 1.30, and this suggests that the lead in atmospheric dust is generated mainly from the smelter but with the addition of some lower $^{206}Pb/^{207}Pb$ lead. Lead from leaded gasoline is a ubiquitous component of soils throughout North America. Although lead was phased out of automobile gasoline by the middle 1990s, it remains in soils, especially near roadways. As discussed in Chapter 2, leaded gasoline is still used in aviation fuel, which is currently the largest source of lead emitted to the atmosphere in the United States (Wolfe et al. 2016). The $^{206}Pb/^{207}Pb$ ratio of lead in gasoline in the United States has been estimated at 1.19–1.25 (Sherrell et al. 1992; Teutsch et al. 2001). The lead-isotope ratio of a mixture of sources whose lead-isotope ratios are known scales linearly with the proportion of lead from each source. As an example of how mixing calculations can be done, the committee used data from Figure 5-1 and applied a mixing calculation to explore the origin of the atmospheric dust samples analyzed by Orloff (2001). Using average $^{206}Pb/^{207}Pb$ ratios for each sample type, the committee found that the $^{206}Pb/^{207}Pb$ ratio can be explained by a mixture of about three-fourths smelter emissions and one-fourth lead from gasoline. However, the proportion of lead derived from gasoline could be much lower if the $^{206}Pb/^{207}Pb$ ratio of smelter emissions during the period of atmospheric sampling was at the lower end of the range of ratios of Southeast Missouri ores.

Soil from the yard and dust from the interior of house 1 have lower $^{206}Pb/^{207}Pb$ ratios than atmospheric dust, 1.28–1.30. The lower values could be produced by mixing smelter lead with lead from house paint. Eleven samples of interior and exterior house paint from house 1 were analyzed. Ten had values that overlap the previously reported range of ratios of commercial paint pigments (Rabinowitz and Hall 2002), 1.19–1.30. One paint sample has a $^{206}Pb/^{207}Pb$ ratio above the range of major lead ores; it is an exterior sample, and its lead concentration was not reported, so its lead isotopic composition is difficult to interpret.

As expected from other studies, blood and urine samples from each family member yielded nearly identical $^{206}Pb/^{207}Pb$ ratios. The 2- and 4-year-old children have $^{206}Pb/^{207}Pb$ ratios of 1.28—at the lower range of soil, dust, and hand-wipe values—except for the one hand-wipe outlier that might be related to paint exposure, perhaps from a windowsill. That result suggests that the 2-year-old and 4-year-old are exposed to lead mainly via ingestion of soil and dust; this result has been found to be the case in many other studies (see, for example, Gulson et al. 1994; Gwiazda and Smith 2000; Manton et al. 2000; Laidlaw et al. 2016). The 16-year-old and the mother have lower $^{206}Pb/^{207}Pb$ ratios, 1.26, and the father has a still lower ratio, 1.24. Those results are not unexpected in that even in an adolescent blood lead can reflect a mixture of past and present lead exposure. That is, lead is stored in bone material, and blood lead can be derived partly from lead mobilization from bone over year-long timescales (Manton 1985; Manton et al. 2000).

This case study demonstrates the power of lead isotopes in differentiating between lead sources in several types of environmental and biologic media. The identification of the lead sources for a particular sample is sometimes equivocal, but some sources can be eliminated in most cases, thus narrowing the possible combination of sources that need to be considered. In the Southeast Missouri Lead Mining District examined here, the largest source of lead isotopic uncertainty is the multiple values in paint at different locations in house 1. Many paint samples analyzed in Orloff (2002) were from locations where a child would not typically be exposed to them, including above a ceiling, on a baseboard molding, and in a parent's bedroom closet. By limiting paint sampling to areas where children have access and to where paint dust is generated by friction on door jambs or window sashes, the $^{206}Pb/^{207}Pb$ ratio of paint in a given house can be estimated more narrowly. Peeling or flaking paint that can be ingested by a child presents a different problem: the amount ingested can lead to frank lead poisoning or, in a worst-case scenario, encephalopathy that results in permanent brain damage or death. Even with the uncertainties and imperfect sampling strategy, Orloff (2001, 2002) demonstrates systematic differences of lead sources from different environmental sources and allows the testing and narrowing of hypotheses for the sources of human lead exposure.

Other studies that have used lead-isotope ratios to determine potential sources of lead in children in the United States (Viczián et al. 1990; Rabinowitz 1995; Gwiazda and Smith 2000; Manton et al. 2000; Glorennec et al. 2010) have been conducted in urban areas, not near mining or smelter sites. Researchers measured lead isotopes in children's blood and then sought to distinguish between potential sources, including house paints, household dust, and soils. Most of the studies involved some individual houses where children's blood-lead isotopes match with paint or soil and some other houses where there is such a large range in paint lead-isotope ratios that no single source can be identified. One such study was carried out in Santa Cruz, CA, by Gwiazda and Smith (2000). They measured the lead isotopic composition of children's blood, household dust, exterior soil, and interior and exterior paints. In one house, paint could be eliminated as a major source of lead exposure, and exterior dust and soil were implicated. In two other houses, paint from some areas could be eliminated as possible sources, but vari-

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

ous mixtures of paints from other areas with dust and soil could explain the children's blood-lead isotope values, and no single source could be identified.

If EPA or others want to pursue blood-lead isotopic investigations for the Southeast Missouri Lead Mining District, the type of investigation described in this case study would need to be replicated in houses of different ages and at different locations in Southeast Missouri to determine where and under what conditions the lead isotope method can provide unambiguous attribution of lead sources for children who have high blood lead concentrations. The approach is promising in Southeast Missouri because the lead associated with mining and smelting has an unusually high $^{206}Pb/^{207}Pb$ ratio, about 1.34, which in most cases is distinct from lead used to make paint in the United States.

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A

Challenges to Obtaining Information about Lead Sources at Superfund Sites Associated with Lead-Mining Districts

Source identification is not typically problematic for sites that have concentrated waste materials, but challenges arise when sites have large volumes of low-concentration wastes, such as large municipal landfills and mining sites. Such sites are sometimes referred to as *special sites*, and the US Environmental Protection Agency (EPA) remedial investigation and feasibility study (RI/FS) guidance "does not specifically state how… such sites should be addressed" (EPA 1988a, Section 1.5).

Lack of clear RI/FS guidance creates later challenges for assigning response costs at special sites among responsible parties and challenges to obtaining information about lead-source identification. Response costs at Superfund sites are divided among responsible parties by apportionment or allocation. Apportionment applies only when the liability of responsible parties can be separated; it would apply, for example, at a site where two parties are responsible for separate types of pollution that can be clearly distinguished qualitatively and quantitatively. Allocation applies at most Superfund sites because it is the default process and because separate liability is difficult to establish. At sites where allocation is used, equitable factors are used to assign liability for response costs. Although the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, Superfund) does not prescribe the equitable factors to be used, Gore factors[1] are often applied and include the following:

- Ability of the parties to demonstrate that their contributions to a discharge, release, or disposal of a hazardous waste can be distinguished.
- Amount of hazardous waste involved.
- Degree of toxicity of hazardous waste involved.
- Degree of involvement by the parties in generation, transportation, treatment, storage, or disposal.
- Degree of care exercised by the parties with respect to the hazardous wastes concerned.
- Degree of cooperation with public officials to prevent harm to public health or to the environment.

Other equitable factors that have been used include contractual provisions, years of and economic benefit from ownership or operation, knowledge of and responsibility for waste handling and disposal practices, ability to pay, and strength of evidence that identifies responsible parties (Allen 2006).

EPA's orphan-share policies and guidance (EPA 1996a,b, 1997) and mixed-funding guidance (EPA 1987, 1988b) create additional challenges to identifying the sources of lead associated with Superfund sites. Orphan-share policies, such as the work policy (EPA 1996a) and the cost-recovery policy (EPA 1997), attempt to address the liability for a Superfund site that is attributed to insolvent or defunct parties that cannot pay their share of a site's cleanup cost. Here, EPA agrees to pay a portion of the orphan share allocated to insolvent or defunct parties; this can accelerate settlement with the viable responsible parties (EPA 2001). Mixed-funding is another mechanism whereby the federal government can accept settlement offers for less than the full response cost at a site. Mixed funding is appropriate under two circumstances: when pursuit of a fully funded settlement might cost the federal government more than accepting a mixed-fund settlement and when a substantial portion of the waste at a site cannot be attributed to known and financially viable parties. By creating opportunities to shift responsibility for response costs, the orphan-share policies and mixed-funding guidance create disincentives to objective disclosure of information about sources of lead at Superfund sites that are associated with lead-mining districts.

Liability for response costs at special sites, including Superfund sites associated with lead-mining districts, can range from hundreds of millions to billions of dollars. A party's ability or inability to demonstrate its contributions to a discharge, release, or disposal of a hazardous waste can substantially alter the outcome of the allocation process, orphan-share settlement, and mixed-fund settlement. The magnitude of the costs that are subject to allocation creates powerful incentives for potentially responsible parties and the federal government to think and

[1] H.R. 7020, 96th Cong., 2d Sess. (1980).

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

act strategically when it comes to gathering and sharing information about the sources of contamination at Superfund sites, particularly special sites. That situation creates impediments to open development and sharing of source-identification methods and results.

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B

Biographic Information on the Committee on Sources of Lead Contamination at or near Superfund Sites

Edward J. Bouwer (*Chair*) is Abel Wolman Professor of Environmental Engineering in the newly formed Department of Environmental Health and Engineering at Johns Hopkins University. He is also director of the Center for Contaminant Transport, Fate and Remediation. Dr. Bouwer has extensive experience with drinking water and wastewater treatment processes, microbial process engineering, and contaminant transport and fate. His research interests encompass factors that influence biotransformation of contaminants; bioremediation for control of contaminated soils and groundwater; biofilm kinetics; biologic process design in wastewater, industrial, and drinking-water treatment; transport and fate of micro-organisms in porous media; behavior of metals in contaminated sediments; and defining and managing environmental risks. He serves as the editor-in-chief for *Biodegradation* and on the editorial boards for the *Journal of Contaminant Hydrology and Environmental Engineering Science*. Dr. Bouwer received his BS in civil engineering with a minor in nuclear engineering from Arizona State University, and an MS and a PhD in environmental engineering and science from Stanford University.

Mark D. Barton is a professor of geosciences at the University of Arizona. He serves as associate director of the Lowell Institute for Mineral Resources. He has been instrumental in driving innovative research applied to ore deposits in North America and South America for nearly 30 years. Collaborative research in which he has a leading role includes porphyry copper life cycles in the American Southwest and its broader crustal context, the regional geologic framework and origin of Carlin-type gold deposits, the characteristics and origin of iron oxide mineralization, granite petrogenesis and lithophile element mineralization in the Great Basin, and metallogenic synthesis in Mexico and adjoining regions. He is a winner of the Society of Economic Geology Lindgren Award and of the Mineralogical Society of America award and the author of numerous papers, including landmark reviews on ore deposits and metallogeny. He served on the National Research Council Committee on Basic Research Opportunities in the Earth Sciences. Dr. Barton earned his PhD in geology from the University of Chicago.

Eric A. Betterton is a University Distinguished Professor and head of the Department of Hydrology and Atmospheric Sciences at the University of Arizona. He also has appointments in the Department of Chemical and Environmental Engineering and the College of Public Health. His research focuses on air pollution, especially atmospheric aerosols and dust associated with mining operations; solar energy; rain, snow, and ice chemistry; remediation of polluted groundwater; and environmental fate of various compounds. He received a PhD in chemical kinetics from The University of Witwatersrand, South Africa.

Joel D. Blum holds the JD MacArthur Professorship and is the GJ Keeler Distinguished University Professor in the Department of Earth and Environmental Sciences of the University of Michigan. He obtained his BA from Case Western Reserve University, his MS from the University of Alaska, and his PhD from the California Institute of Technology. He was a professor of earth sciences at Dartmouth College for 9 years before moving to the University of Michigan in 1999. Dr. Blum's research focuses on the sources, fate and cycling of metals in the environment. Most recently, he has focused on understanding the biogeochemistry of mercury in aquatic, terrestrial, and atmospheric systems, in many cases using mercury stable isotopes. Dr. Blum has published over 200 research papers. He has served on numerous advisory panels for the National Science Foundation, the National Institutes of Health, the Environmental Law and Policy Center, and the Department of Energy. He is a past editor of *Chemical Geology* and current editor of *ACS Earth and Space Chemistry*. He is a fellow of the Geochemical Society, the

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

American Geophysical Union, the Geological Society of America, and the American Association for the Advancement of Science. In 2013, he won the Patterson Medal of the Geochemical Society for his work on metals in the environment.

Susan L. Brantley is Distinguished Professor of Geosciences and director of the Earth and Environmental Systems Institute at Pennsylvania State University. Dr. Brantley investigates chemical and physical processes associated with the circulation of aqueous fluids in shallow hydrogeologic settings. Her investigations incorporate field and laboratory work and theoretical modeling of observations. Particular interests are the measurement and prediction of the rates of natural processes, including chemical weathering and natural degassing. Her recent work has focused on measuring and modeling how rock turns into regolith and on water-quality issues in areas with hydraulic fracturing. Dr. Brantley has served on numerous National Research Council committees and is a member of the National Academy of Sciences. She is a recipient of the Wollaston Medal of the Geological Society, the Arthur L. Day Medal of the Geological Society of America, and the Presidential Award of the Soil Science Society of America. She received her PhD in geologic and geophysical sciences from Princeton University.

Judith C. Chow holds the Nazir and Mary Ansari Chair in Science and Entrepreneurialism and is a research professor in the Division of Atmospheric Sciences of the Desert Research Institute of the Nevada System of Higher Education in Reno, Nevada. For more than 39 years, she has conducted air-quality studies and performed data analysis to improve understanding of effects of air quality on human health, visibility, historical treasures, ecosystems, and climate. She has been principal investigator or a major collaborator in more than 50 large air-quality studies and many smaller ones in the United States and other countries. Dr. Chow is a charter member of EPA's Clean Air Scientific Advisory Committee (CASAC) and a member of CASAC's Particulate Matter Review Panel (2015–2018). She is the principal author or co-author of more than 400 peer-reviewed journal articles and book. She was chair of the Publications Committee for the *Journal of the Air & Waste Management Association* and serves on editorial boards or as thematic editor for several international journals, including the *Air Quality, Atmosphere, & Health, Aerosol* and *Air Quality Research, Atmospheric Pollution Research,* and *Particuology*. Dr. Chow has received the California Air Resources Board's 2011 Haagen-Smit Clean Air Award for her contributions to air-quality science and technology, the Air & Waste Management Association's 2016 Arthur C. Stern Distinguished Paper Award and 2002 Frank A. Chambers Excellence in Air Pollution Control Award, and the 2001 Nevada System of Higher Education's Nevada Regents' Researcher Award. Dr. Chow earned her ScD in environmental science and physiology from Harvard University.

Scott E. Fendorf is the Huffington Family Professor in Earth Sciences at Stanford University and a senior fellow at the Stanford Woods Institute for the Environment. Dr. Fendorf is interested in the chemical and biologic processes that govern the fate and transport of contaminants and nutrients in soils, sediments, and surface waters. His research group examines the chemical environments that develop as a result of biotic and abiotic processes and strives to account for the physical complexity in natural settings. Dr. Fendorf served on the National Research Council Committee on Bioavailability of Contaminants in Soils and Sediments. He received his PhD in soil and environmental chemistry from the University of Delaware.

Robert E. Hazen is a research scientist at the New Jersey Department of Environmental Protection in the Division of Science Research and Environmental Health. His research activities have focused on human health risk assessment and natural-resource management with the goal of assisting with department procedures and regulations. He has served on numerous national technical committees, including the US Environmental Protection Agency Science Advisory Board and the National Research Council Committee on Remedial Action Priorities for Hazardous Waste Sites. He received his PhD in biology and environmental health from New York University.

Chris E. Johnson is a professor in the Department of Civil and Environmental Engineering at Syracuse University. Dr. Johnson's research focuses on the chemistry of natural organic matter, which plays an important role in soil fertility, trace-metal transport, and the acid–base status of soils and natural waters. He is also involved in the interdisciplinary study of biogeochemical cycles at the Hubbard Brook Experimental Forest in the United States. He has research interests in the fate of trace metals (lead, zinc, copper, and nickel) in forest soils and landscapes; the effects of clear-cut logging on soils and drainage waters; and the changing acid–base chemistry of soils historically affected by acid rain. He served on the US Environmental Protection Agency's Clean Air Scientific Advisory Committee Lead Review Panel in 2011-2013, which established the National Ambient Air Quality Standard for lead. He has been an associate editor for the *Soil Science Society of America Journal* and the *Journal of Soils and Sediments*. Dr. Johnson has a BSE in civil and urban engineering, an MA in statistics, and a PhD in geology from the University of Pennsylvania.

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Investigative Strategies for Lead-Source Attribution at Superfund Sites Associated with Mining Activities

William I. Manton is a professor of geology at the University of Texas at Dallas. His early work focused on the contribution of lead from gasoline to lead in blood. He continued working in the fields of toxicology and environmental medicine using stable-isotope dilution to measure concentrations of zinc in the brain and spinal cord and lead in blood serum and cerebrospinal fluid. He has used variations in lead-isotope ratios to determine how children acquire lead and exploited the long residence of lead in bone to study conditions, such as pregnancy, under which the skeleton might be resorbed. He has also been involved in studies in which animals have been dosed with stable lead isotopes, including investigations of lead poisoning from retained bullets and the mobilization of lead from the skeleton during pregnancy and after ovariectomy to stimulate menopause. He has also published on lead in the US diet and its unexpectedly high concentrations in cocoa and chocolate. He received his PhD in geochronology from the University of Witwatersrand, South Africa.

Jerry R. Miller is the Whitmire Professor of Environmental Science in the Department of Geosciences and Natural Resources at Western Carolina University. His research interests include assessment of the transport and fate of heavy metals in rivers and lakes, sediment geochemical fingerprinting with multivariate and isotopic methods, documentation of the effects of natural and anthropogenic disturbances on sediment yields and river processes, and restoration of riparian ecosystems. He received his PhD in geology from Southern Illinois University, Carbondale.

Peggy A. O'Day is professor of life and environmental sciences at the University of California, Merced. Dr. O'Day studies the chemistry, reaction, and transport of inorganic contaminants and species, primarily metal and metalloid elements, in surface and subsurface systems. She specializes in the use of spectroscopic and microscopic methods, especially synchrotron x-ray techniques, to determine element speciation and molecular-scale mechanisms of biogeochemical reactions in natural systems and laboratory analogues. She develops and applies thermodynamic, kinetic, and reactive transport models for synthesis and quantitative description of biogeochemical cycling, reactivity, transport, and bioavailability. She received a PhD in applied earth sciences from Stanford University.

John Toll is a partner at Windward Environmental LLC. He is recognized for his work in ecologic modeling, risk assessment, uncertainty analysis, and environmental decision analysis. He works primarily on complex contaminated sediment sites and leads teams that conduct remedial investigations and feasibility studies, ecologic risk assessments, and bioaccumulation modeling. He is the author or a co-author of numerous scientific papers on ecologic modeling and risk assessment and environmental decision analysis. Dr. Toll is a senior editor of the journal *Integrated Environmental Assessment and Management* and is a member of the board of directors of the Society of Environmental Toxicology and Chemistry (SETAC) North America. He earned his BS in chemical engineering from the University of Iowa and his PhD in engineering and public policy from Carnegie Mellon University.

Warren White is a researcher at the Crocker Nuclear Laboratory of the University of California, Davis. His research focuses on airborne particles and visibility impairment. He served on the review panel for the Air Quality Criteria for Particulate Matter Document and was a member of the US Environmental Protection Agency Clean Air Science Advisory Committee and its particulate-matter monitoring subcommittee. He has served on several National Research Council committees. He received his PhD in mathematics from the University of Wisconsin.

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C

Open Session Meeting Agendas

COMMITTEE ON SOURCES OF LEAD CONTAMINATION AT OR NEAR SUPERFUND SITES

FIRST MEETING
Open Session: November 21, 2016
National Academies Keck Center, Room 100
500 Fifth Street, NW, Washington, DC 20001

PUBLIC AGENDA

1:00 **Purpose of Open Session and Introduction of Committee Members**
Edward Bouwer
Chair, Committee on Sources of Lead Contamination at or near Superfund Sites

1:15 **EPA Perspective on Study Objectives and Background**
Michele Burgess
Senior Biologist
Office of Land and Emergency Management
Office of Superfund Remediation and Technology Innovation
US Environmental Protection Agency

2:15 **Natural and Anthropogenic Sources of Lead in the Big River Watershed**
Teresa Bowers
President, Gradient
Michael Montgomery
Senior Attorney, The Doe Run Company

3:15 **Open Microphone – Opportunity for Public Comment**

4:00 ***End of Open Session***

SECOND MEETING
Open Sessions: January 18, 2017
Southeast Missouri Lead-Mining District

OPEN-SESSION AGENDA I: TOUR OF SOUTHEAST MISSOURI LEAD MINING DISTRICT

9:00 **Historical Perspective of Mining and Milling**
Art Hebrank, Site Administrator of Missouri Mines State Historic Site
Location: Missouri Mines State Historic Site, located southeast of the intersection of Highway 32 and Business 32/67 in Park Hills, MO

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10:30 **Example of Residential Park Remediation**
Location: Haney Park, Located at the 500 Block of Crane Street (Near Intersection of Crane and Kelly Street), Park Hills, MO

11:00 **National Mine Tailings Site**
Location: Park Hills Industrial Park (near the intersection of Parkway Drive and S. Chamber Street), Park Hills, MO

11:45 ***Lunch Break***

1:00 **Mine Tailings Site Adjacent to Big River**
Location: Desloge Mine Tailings Site (Located between Landfill Road and W. Oak Street, Desloge, MO) and Bone Hole County Access Point (located off of Landfill Road, Desloge, MO)

2:00 **Example of State Park Remediation**
Bill Bonnell, Site Administrator
Location: St Joe State Park (located on Pimville Road about 2.4 miles southeast of the intersection of Highway 32 and Pimville Road from Park Hills, MO or about 4.25 miles northwest of the intersection of Bray Road and Pimville Road from Farmington, MO)

3:00 ***Tour Concludes***

OPEN-SESSION AGENDA II: PRESENTATIONS ON GEOLOGY AND MINING
Mineral Area College
North College Room, College Park
112 Dixie Kohn Drive, Park Hills, MO 63601

3:30 **Purpose of Open Session and Introduction of Committee Members**
Edward Bouwer
Chair, Committee on Sources of Lead Contamination at or near Superfund Sites

3:45 **Southeastern Missouri Geology and Mining in the Old and New Lead Belts**
Cheryl M. Seeger
Geologist
Missouri Geological Survey

4:30 **Mining, Milling, and Waste Handling Procedures at Active Lead-Mining Sites**
Mark Yingling
Vice President, Environmental, Health & Safety
Doe Run

5:15 ***Dinner Break***

OPEN-SESSION AGENDA III: PRESENTATIONS ON LEAD CONTAMINATION AND OPPORTUNITY FOR PUBLIC COMMENT
Mineral Area College
North College Room, College Park
112 Dixie Kohn Drive, Park Hills, MO 63601

6:45 **Purpose of Open Session and Introduction of Committee Members**
Edward Bouwer
Chair, Committee on Sources of Lead Contamination at or near Superfund Sites

7:00 **Environmental Transport and Deposition of Lead in Southeastern Missouri**
Emitt Witt
Hydrogeologist
US Geological Survey

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7:45 **Lead Contamination Associated with Various Sources**
Valerie Wilder
Chief, Site Assessment Unit, Superfund Section, MO Department of Natural Resources Hazardous Waste Program
Jonathan D. Garoutte
Chief, Bureau of Environmental Epidemiology, Department of Health and Senior Services

8:30 **Open Microphone – Opportunity for Public Comment**
NOTE: Those who want to make a public comment must register by 8 p.m. Each speaker has a maximum time limit of 5 minutes. Speakers are invited to submit relevant written materials.

9:30 ***End of Open Session***

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Heavy Metals Toxicity and the Environment

Paul B Tchounwou,* Clement G Yedjou, Anita K Patlolla, and Dwayne J Sutton

Abstract

Heavy metals are naturally occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Their multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment; raising concerns over their potential effects on human health and the environment. Their toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals. Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority metals that are of public health significance. These metallic elements are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. They are also classified as human carcinogens (known or probable) according to the U.S. Environmental Protection Agency, and the International Agency for Research on Cancer. This review provides an analysis of their environmental occurrence, production and use, potential for human exposure, and molecular mechanisms of toxicity, genotoxicity, and carcinogenicity.

Feedback

Keywords: Heavy metals, production and use, human exposure, toxicity, genotoxicity, carcinogenicity

Introduction

Heavy metals are defined as metallic elements that have a relatively high density compared to water [1]. With the assumption that heaviness and toxicity are inter-related, heavy metals also include metalloids, such as arsenic, that are able to induce toxicity at low level of exposure [2]. In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by these metals. Also, human exposure has risen dramatically as a result of an exponential increase of their use in several industrial, agricultural, domestic and technological applications [3]. Reported sources of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources [4]. Environmental pollution is very prominent in point source areas such as mining, foundries and smelters, and other metal-based industrial operations [1, 3, 4].

Although heavy metals are naturally occurring elements that are found throughout the earth's crust, most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds [4–7]. Environmental contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water [8]. Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution [1, 3, 4, 7, 8]. Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high tension lines, plastics, textiles, microelectronics, wood preservation and paper processing plants [9–11].

It has been reported that metals such as cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se) and zinc (Zn) are essential nutrients that are required for various biochemical and physiological functions [12]. Inadequate supply of these micro-nutrients results in a variety of deficiency diseases or syndromes [12].

Heavy metals are also considered as trace elements because of their presence in trace concentrations (ppb range to less than 10ppm) in various environmental matrices [13]. Their bioavailability is influenced by physical factors such as temperature, phase association, adsorption and sequestration. It is also affected by chemical factors that influence speciation at thermodynamic equilibrium, complexation kinetics, lipid solubility and octanol/water partition coefficients [14]. Biological factors such as species characteristics, trophic interactions, and biochemical/physiological adaptation, also play an important role [15].

The essential heavy metals exert biochemical and physiological functions in plants and animals. They are important constituents of several key enzymes and play important roles in various oxidation-reduction reactions [12]. Copper for example serves as an essential co-factor for several oxidative stress-related enzymes including catalase, superoxide dismutase, peroxidase, cytochrome c oxidases, ferroxidases, monoamine oxidase, and dopamine β-monooxygenase [16–18]. Hence, it is an essential nutrient that is incorporated into a number of metalloenzymes involved in hemoglobin formation, carbohydrate metabolism, catecholamine biosynthesis, and cross-linking of collagen, elastin, and hair keratin. The ability of copper to cycle between an oxidized state, Cu(II), and reduced state, Cu(I), is used by cuproenzymes involved in redox reactions [16–18]. However, it is this property of copper that also makes it potentially toxic because the transitions between Cu(II) and Cu(I) can result in the generation of superoxide and hydroxyl radicals [16–19]. Also, excessive exposure to copper has been linked to cellular damage leading to Wilson disease in humans [18, 19]. Similar to copper, several other essential elements are required for biologic functioning, however, an excess amount of such metals produces cellular and tissue damage leading to a variety of adverse effects and human diseases. For some including chromium and copper, there is a very narrow range of concentrations between beneficial and toxic effects [19, 20]. Other metals such as aluminium (Al), antinomy (Sb), arsenic (As), barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), gallium (Ga), germanium (Ge), gold (Au), indium (In), lead (Pb), lithium (Li), mercury (Hg), nickel (Ni), platinum (Pt), silver (Ag), strontium (Sr), tellurium (Te), thallium (Tl), tin (Sn), titanium (Ti), vanadium (V) and uranium (U) have no established biological functions and are considered as non-essential metals [20].

In biological systems, heavy metals have been reported to affect cellular organelles and components such as cell membrane, mitochondrial, lysosome, endoplasmic reticulum, nuclei, and some enzymes involved in metabolism, detoxification, and damage repair [21]. Metal ions have been found to interact with cell components such as DNA and nuclear proteins, causing DNA damage and conformational changes that may lead to cell cycle modulation, carcinogenesis or apoptosis [20–22]. Several studies from our laboratory have demonstrated that reactive oxygen species (ROS) production and oxidative stress play a key role in the toxicity and carcinogenicity of metals such as arsenic [23, 24, 25], cadmium [26], chromium [27, 28], lead [29, 30], and mercury [31, 32]. Because of their high degree of toxicity, these five elements rank among the priority metals that are of great public health significance. They are all systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. According to the United States Environmental Protection Agency (U.S. EPA), and the International Agency for Research on Cancer (IARC), these metals are also classified as either “known” or “probable” human carcinogens based on epidemiological and experimental studies showing an association between exposure and cancer incidence in humans and animals.

Heavy metal-induced toxicity and carcinogenicity involves many mechanistic aspects, some of which are not clearly elucidated or understood. However, each metal is known to have unique features and physic-chemical properties that confer to its specific toxicological mechanisms of action. This review provides an analysis of the environmental occurrence, production and use, potential for human exposure, and molecular mechanisms of toxicity, genotoxicity, and carcinogenicity of arsenic, cadmium, chromium, lead, and mercury.

Arsenic

Environmental Occurrence, Industrial Production and Use

Arsenic is a ubiquitous element that is detected at low concentrations in virtually all environmental matrices [33]. The major inorganic forms of arsenic include the trivalent arsenite and the pentavalent arsenate. The organic forms are the methylated metabolites – monomethylarsonic acid (MMA), dimethylarsinic acid (DMA) and trimethylarsine oxide. Environmental pollution by arsenic occurs as a result of natural phenomena such as volcanic eruptions and soil erosion, and anthropogenic activities [33]. Several arsenic-containing compounds are produced industrially, and have been used to manufacture products with agricultural applications such as insecticides, herbicides, fungicides, algicides, sheep dips, wood preservatives, and dye-stuffs. They have also been used in veterinary medicine for the eradication of tapeworms in sheep and cattle [34]. Arsenic compounds have also been used in the medical field for at least a century in the treatment of syphilis, yaws, amoebic dysentery, and trypanosomaiasis [34,35]. Arsenic-based drugs are still used in treating certain tropical diseases such as African sleeping sickness and amoebic dysentery, and in veterinary medicine to treat parasitic diseases, including filariasis in dogs and black head in turkeys and chickens [35]. Recently, arsenic trioxide has been approved by the Food and Drug Administration as an anticancer agent in the treatment of acute promeylocytic leukemia [36]. Its therapeutic action has been attributed to the induction of programmed cell death (apoptosis) in leukemia cells [24].

Potential for Human Exposure

It is estimated that several million people are exposed to arsenic chronically throughout the world, especially in countries like Bangladesh, India, Chile, Uruguay, Mexico, Taiwan, where the ground water is contaminated with high concentrations of arsenic. Exposure to arsenic occurs via the oral route (ingestion), inhalation, dermal contact, and the parenteral route to some extent [33,34,37]. Arsenic concentrations in air range from 1 to 3 ng/m^3 in remote locations (away from human releases), and from 20 to 100 ng/m^3 in cities. Its water concentration is usually less than 10μg/L, although higher levels can occur near natural mineral deposits or mining sites. Its concentration in various foods ranges from 20 to 140 ng/kg [38]. Natural levels of arsenic in soil usually range from 1 to 40 mg/kg, but pesticide application or waste disposal can produce much higher values [25].

Diet, for most individuals, is the largest source of exposure, with an average intake of about 50 μg per day. Intake from air, water and soil are usually much smaller, but exposure from these media may become significant in areas of arsenic contamination. Workers who produce or use arsenic compounds in such occupations as vineyards, ceramics, glass-making, smelting, refining of metallic ores, pesticide manufacturing and application, wood preservation, semiconductor manufacturing can be exposed to substantially higher

levels of arsenic [39]. Arsenic has also been identified at 781 sites of the 1,300 hazardous waste sites that have been proposed by the U.S. EPA for inclusion on the national priority list [33,39]. Human exposure at these sites may occur by a variety of pathways, including inhalation of dusts in air, ingestion of contaminated water or soil, or through the food chain [40].

Contamination with high levels of arsenic is of concern because arsenic can cause a number of human health effects. Several epidemiological studies have reported a strong association between arsenic exposure and increased risks of both carcinogenic and systemic health effects [41]. Interest in the toxicity of arsenic has been heightened by recent reports of large populations in West Bengal, Bangladesh, Thailand, Inner Mongolia, Taiwan, China, Mexico, Argentina, Chile, Finland and Hungary that have been exposed to high concentrations of arsenic in their drinking water and are displaying various clinico-pathological conditions including cardiovascular and peripheral vascular disease, developmental anomalies, neurologic and neurobehavioural disorders, diabetes, hearing loss, portal fibrosis, hematologic disorders (anemia, leukopenia and eosinophilia) and carcinoma [25, 33, 35, 39]. Arsenic exposure affects virtually all organ systems including the cardiovascular, dermatologic, nervous, hepatobilliary, renal, gastro-intestinal, and respiratory systems [41]. Research has also pointed to significantly higher standardized mortality rates for cancers of the bladder, kidney, skin, and liver in many areas of arsenic pollution. The severity of adverse health effects is related to the chemical form of arsenic, and is also time- and dose-dependent [42,43]. Although the evidence of carcinogenicity of arsenic in humans seems strong, the mechanism by which it produces tumors in humans is not completely understood [44].

Mechanisms of Toxicity and Carcinogenicity

Analyzing the toxic effects of arsenic is complicated because the toxicity is highly influenced by its oxidation state and solubility, as well as many other intrinsic and extrinsic factors [45]. Several studies have indicated that the toxicity of arsenic depends on the exposure dose, frequency and duration, the biological species, age, and gender, as well as on individual susceptibilities, genetic and nutritional factors [46]. Most cases of human toxicity from arsenic have been associated with exposure to inorganic arsenic. Inorganic trivalent arsenite (As^{III}) is 2–10 times more toxic than pentavalent arsenate (As^{V}) [5]. By binding to thiol or sulfhydryl groups on proteins, As (III) can inactivate over 200 enzymes. This is the likely mechanism responsible for arsenic's widespread effects on different organ systems. As (V) can replace phosphate, which is involved in many biochemical pathways [5, 47].

One of the mechanisms by which arsenic exerts its toxic effect is through impairment of cellular respiration by the inhibition of various mitochondrial enzymes, and the uncoupling of oxidative phosphorylation. Most toxicity of arsenic results from its ability to interact with sulfhydryl groups of proteins and enzymes, and to substitute phosphorous in a variety of biochemical reactions [48]. Arsenic *in vitro* reacts with protein sulfhydryl groups to inactivate enzymes, such as dihydrolipoyl dehydrogenase and thiolase, thereby producing inhibited oxidation of pyruvate and betaoxidation of fatty acids [49]. The major metabolic pathway for inorganic arsenic in humans is methylation. Arsenic trioxide is methylated to two major metabolites via a non-enzymatic process to monomethylarsonic

acid (MMA), which is further methylated enzymatically to dimethyl arsenic acid (DMA) before excretion in the urine [40, 47]. It was previously thought that this methylation process is a pathway of arsenic detoxification, however, recent studies have pointed out that some methylated metabolites may be more toxic than arsenite if they contain trivalent forms of arsenic [41].

Tests for genotoxicity have indicated that arsenic compounds inhibit DNA repair, and induce chromosomal aberrations, sister-chromatid exchanges, and micronuclei formation in both human and rodent cells in culture [50–52] and in cells of exposed humans [53]. Reversion assays with *Salmonella typhimurium* fail to detect mutations that are induced by arsenic compounds. Although arsenic compounds are generally perceived as weak mutagens in bacterial and animal cells, they exhibit clastogenic properties in many cell types *in vivo* and *in vitro* [54]. In the absence of animal models, *in vitro* cell transformation studies become a useful means of obtaining information on the carcinogenic mechanisms of arsenic toxicity. Arsenic and arsenical compounds are cytotoxic and induce morphological transformations of Syrian hamster embryo (SHE) cells as well as mouse C3H10T1/2 cells and BALB/3T3 cells [55, 56].

Based on the comet assay, it has been reported that arsenic trioxide induces DNA damage in human lymphophytes [57] and also in mice leukocytes [58]. Arsenic compounds have also been shown to induce gene amplification, arrest cells in mitosis, inhibit DNA repair, and induce expression of the *c-fos* gene and the oxidative stress protein heme oxygenase in mammalian cells [58, 59]. They have been implicated as promoters and comutagens for a variety of toxic agents [60]. Recent studies in our laboratory have demonstrated that arsenic trioxide is cytotoxic and able to transcriptionally induce a significant number of stress genes and related proteins in human liver carcinoma cells [61].

Epidemiological investigations have indicated that long-term arsenic exposure results in promotion of carcinogenesis. Several hypotheses have been proposed to describe the mechanism of arsenic-induced carcinogenesis. Zhao et al. [62] reported that arsenic may act as a carcinogen by inducing DNA hypomethylation, which in turn facilitates aberrant gene expression. Additionally, it was found that arsenic is a potent stimulator of extracellular signal-regulated protein kinase Erk1 and AP-1 transactivational activity, and an efficient inducer of *c-fos* and *c-jun* gene expression [63]. Induction of *c-jun* and *c-fos* by arsenic is associated with activation of JNK [64]. However, the role of JNK activation by arsenite in cell transformation or tumor promotion is unclear.

In another study, Trouba et al. [65] concluded that long-term exposure to high levels of arsenic might make cells more susceptible to mitogenic stimulation and that alterations in mitogenic signaling proteins might contribute to the carcinogenic action of arsenic. Collectively, several recent studies have demonstrated that arsenic can interfere with cell signaling pathways (e.g., the p53 signaling pathway) that are frequently implicated in the promotion and progression of a variety of tumor types in experimental animal models, and of some human tumors [66, 68]. However, the specific alterations in signal transduction pathways or the actual targets that contribute to the development of arsenic-induced tumors in humans following chronic consumption of arsenic remains uncertain.

Recent clinical trials have found that arsenic trioxide has therapeutic value in the treatment of acute promyelocytic leukemia, and there is interest in exploring its effectiveness in the treatment of a variety of other cancers [69,70]. In acute promyelocytic leukemia, the specific molecular event critical to the formation of malignant cells is known. A study by Puccetti et al. [71] found that forced overexpression of BCR-ABL susceptibility in human lymphoblasts cells resulted in greatly enhanced sensitivity to arsenic-induced apoptosis. They also concluded that arsenic trioxide is a tumor specific agent capable of inducing apoptosis selectively in acute promyelocytic leukemia cells. Several recent studies have shown that arsenic can induce apoptosis through alterations in other cell signaling pathways [72,73]. In addition to acute peomyelocytic leukemia, arsenic is thought to have therapeutic potential for myeloma [74]. In summary, numerous cancer chemotherapy studies in cell cultures and in patients with acute promyelocytic leukemia demonstrate that arsenic trioxide administration can lead to cell-cycle arrest and apoptosis in malignant cells.

Previous studies have also examined p53 gene expression and mutation in tumors obtained from subjects with a history of arsenic ingestion. p53 participates in many cellular functions, cell-cycle control, DNA repair, differentiation, genomic plasticity and programmed cell death. Additional support for the hypothesis that arsenic can modulate gene expression has been provided by several different studies [75,76]. Collectively, these studies provide further evidence that various forms of arsenic can alter gene expression and that such changes could contribute substantially to the toxic and carcinogenic actions of arsenic treatment in human populations [77].

Several *in vitro* studies in our laboratory have demonstrated that arsenic modulates DNA synthesis, gene and protein expression, genotoxicity, mitosis and/or apoptotic mechanisms in various cell lines including keratinocytes, melanocytes, dendritic cells, dermal fibroblasts, microvascular endothelial cells, monocytes, and T-cells [78], colon cancer cells [79], lung cancer cells [80], human leukemia cells [81], Jurkat-T lymphocytes [82], and human liver carcinoma cells [83]. We have also shown that oxidative stress plays a key role in arsenic induced cytotoxicity, a process that is modulated by pro- and/or anti-oxidants such as ascorbic acid and n-acetyl cysteine [84–86]. We have further demonstrated that the toxicity of arsenic depends on its chemical form, the inorganic form being more toxic than the organic one [42].

Various hypotheses have been proposed to explain the carcinogenicity of inorganic arsenic. Nevertheless, the molecular mechanisms by which this arsenical induces cancer are still poorly understood. Results of previous studies have indicated that inorganic arsenic does not act through classic genotoxic and mutagenic mechanisms, but rather may be a tumor promoter that modifies signal transduction pathways involved in cell growth and proliferation [68]. Although much progress has been recently made in the area of arsenic's possible mode(s) of carcinogenic action, a scientific consensus has not yet reached. A recent review discusses nine different possible modes of action of arsenic carcinogenesis: induced chromosomal abnormalities, oxidative stress, altered DNA repair, altered DNA methylation patterns, altered growth factors, enhanced cell proliferation, promotion/progression, suppression of p53, and gene amplification [87]. Presently, three modes (chromosomal abnormality, oxidative stress, and altered growth factors) of arsenic carcinogenesis have shown a degree of positive evidence, both in experimental systems (animal and human cells) and in human tissues.

The remaining possible modes of carcinogenic action (progression of carcinogenesis, altered DNA repair, p53 suppression, altered DNA methylation patterns and gene amplification) do not have as much evidence, particularly from *in vivo* studies with laboratory animals, *in vitro* studies with cultured human cells, or human data from case or population studies. Thus, the mode-of-action studies suggest that arsenic might be acting as a cocarcinogen, a promoter, or a progressor of carcinogenesis.

Cadmium

Environmental Occurrence, Industrial Production and Use

Cadmium is a heavy metal of considerable environmental and occupational concern. It is widely distributed in the earth's crust at an average concentration of about 0.1 mg/kg. The highest level of cadmium compounds in the environment is accumulated in sedimentary rocks, and marine phosphates contain about 15 mg cadmium/kg [88].

Cadmium is frequently used in various industrial activities. The major industrial applications of cadmium include the production of alloys, pigments, and batteries [89]. Although the use of cadmium in batteries has shown considerable growth in recent years, its commercial use has declined in developed countries in response to environmental concerns. In the United States for example, the daily cadmium intake is about 0.4μg/kg/day, less than half of the U.S. EPA's oral reference dose [90]. This decline has been linked to the introduction of stringent effluent limits from plating works and, more recently, to the introduction of general restrictions on cadmium consumption in certain countries.

Potential for Human Exposure

The main routes of exposure to cadmium are via inhalation or cigarette smoke, and ingestion of food. Skin absorption is rare. Human exposure to cadmium is possible through a number of several sources including employment in primary metal industries, eating contaminated food, smoking cigarettes, and working in cadmium-contaminated work places, with smoking being a major contributor [91, 92]. Other sources of cadmium include emissions from industrial activities, including mining, smelting, and manufacturing of batteries, pigments, stabilizers, and alloys [93]. Cadmium is also present in trace amounts in certain foods such as leafy vegetables, potatoes, grains and seeds, liver and kidney, and crustaceans and mollusks [94]. In addition, foodstuffs that are rich in cadmium can greatly increase the cadmium concentration in human bodies. Examples are liver, mushrooms, shellfish, mussels, cocoa powder and dried seaweed. An important distribution route is the circulatory system whereas blood vessels are considered to be main stream organs of cadmium toxicity. Chronic inhalation exposure to cadmium particulates is generally associated with changes in pulmonary

function and chest radiographs that are consistent with emphysema [95]. Workplace exposure to airborne cadmium particulates has been associated with decreases in olfactory function [96]. Several epidemiologic studies have documented an association of chronic low-level cadmium exposure with decreases in bone mineral density and osteoporosis [97–99].

Exposure to cadmium is commonly determined by measuring cadmium levels in blood or urine. Blood cadmium reflects recent cadmium exposure (from smoking, for example). Cadmium in urine (usually adjusted for dilution by calculating the cadmium/creatinine ratio) indicates accumulation, or kidney burden of cadmium [100, 101]. It is estimated that about 2.3% of the U.S. population has elevated levels of urine cadmium (>2μg/g creatinine), a marker of chronic exposure and body burden [102]. Blood and urine cadmium levels are typically higher in cigarette smokers, intermediate in former smokers and lower in nonsmokers [102, 103]. Because of continuing use of cadmium in industrial applications, the environmental contamination and human exposure to cadmium have dramatically increased during the past century [104].

Molecular Mechanisms of Toxicity and Carcinogenicity

Cadmium is a severe pulmonary and gastrointestinal irritant, which can be fatal if inhaled or ingested. After acute ingestion, symptoms such as abdominal pain, burning sensation, nausea, vomiting, salivation, muscle cramps, vertigo, shock, loss of consciousness and convulsions usually appear within 15 to 30 min [105]. Acute cadmium ingestion can also cause gastrointestinal tract erosion, pulmonary, hepatic or renal injury and coma, depending on the route of poisoning [105, 106]. Chronic exposure to cadmium has a depressive effect on levels of norepinephrine, serotonin, and acetylcholine [107]. Rodent studies have shown that chronic inhalation of cadmium causes pulmonary adenocarcinomas [108, 109]. It can also cause prostatic proliferative lesions including adenocarcinomas, after systemic or direct exposure [110].

Although the mechanisms of cadmium toxicity are poorly understood, it has been speculated that cadmium causes damage to cells primarily through the generation of ROS [111], which causes single-strand DNA damage and disrupts the synthesis of nucleic acids and proteins [112]. Studies using two-dimensional gel electrophoresis have shown that several stress response systems are expressed in response to cadmium exposure, including those for heat shock, oxidative stress, stringent response, cold shock, and SOS [113– 115]. *In vitro* studies indicate that cadmium induces cytotoxic effects at the concentrations 0.1 to 10 mM and free radical-dependent DNA damage [116, 117]. *In vivo* studies have shown that cadmium modulates male reproduction in mice model at a concentration of 1 mg/kg body weight [118]. However, cadmium is a weak mutagen when compared with other carcinogenic metals [119]. Previous reports have indicated that cadmium affects signal transduction pathways; inducing inositol polyphosphate formation, increasing cytosolic free calcium levels in various cell types [120], and blocking calcium channels [121, 122]. At lower concentrations (1–100 μM), cadmium binds to proteins, decreases DNA repair [123], activates protein degradation, up-regulates cytokines and proto-oncogenes such as c-*fos*, c-*jun*, and c-*myc* [124], and induces expression of several genes including metallothioneins [125], heme oxygenases, glutathione transferases, heat-shock proteins, acute-phase reactants, and DNA polymerase β [126].

Cadmium compounds are classified as human carcinogens by several regulatory agencies. The International Agency for Research on Cancer [91] and the U.S. National Toxicology Program have concluded that there is adequate evidence that cadmium is a human carcinogen. This designation as a human carcinogen is based primarily on repeated findings of an association between occupational cadmium exposure and lung cancer, as well as on very strong rodent data showing the pulmonary system as a target site [91]. Thus, the lung is the most definitively established site of human carcinogenesis from cadmium exposure. Other target tissues of cadmium carcinogenesis in animals include injection sites, adrenals, testes, and the hemopoietic system [91, 108, 109]. In some studies, occupational or environmental cadmium exposure has also been associated with development of cancers of the prostate, kidney, liver, hematopoietic system and stomach [108, 109]. Carcinogenic metals including arsenic, cadmium, chromium, and nickel have all been associated with DNA damage through base pair mutation, deletion, or oxygen radical attack on DNA [126]. Animal studies have demonstrated reproductive and teratogenic effects. Small epidemiologic studies have noted an inverse relationship between cadmium in cord blood, maternal blood or maternal urine and birth weight and length at birth [127, 128].

Chromium

Environmental Occurrence, Industrial Production and Use

Chromium (Cr) is a naturally occurring element present in the earth's crust, with oxidation states (or valence states) ranging from chromium (II) to chromium (VI) [129]. Chromium compounds are stable in the trivalent [Cr(III)] form and occur in nature in this state in ores, such as ferrochromite. The hexavalent [Cr(VI)] form is the second-most stable state [28]. Elemental chromium [Cr(0)] does not occur naturally. Chromium enters into various environmental matrices (air, water, and soil) from a wide variety of natural and anthropogenic sources with the largest release coming from industrial establishments. Industries with the largest contribution to chromium release include metal processing, tannery facilities, chromate production, stainless steel welding, and ferrochrome and chrome pigment production. The increase in the environmental concentrations of chromium has been linked to air and wastewater release of chromium, mainly from metallurgical, refractory, and chemical industries. Chromium released into the environment from anthropogenic activity occurs mainly in the hexavalent form [Cr(VI)] [130]. Hexavalent chromium [Cr(VI)] is a toxic industrial pollutant that is classified as human carcinogen by several regulatory and non-regulatory agencies [130–132]. The health hazard associated with exposure to chromium depends on its oxidation state, ranging from the low toxicity of the metal form to the high toxicity of the hexavalent form. All Cr(VI)-containing compounds were once thought to be man-made, with only Cr(III) naturally ubiquitous in air, water, soil and biological materials. Recently, however, naturally occurring Cr(VI) has been found in ground and surface waters at values exceeding the World Health Organization limit for drinking water of 50 μg of Cr(VI) per liter [133]. Chromium is widely used in numerous industrial processes and as a result, is a contaminant of many environmental systems [134]. Commercially chromium compounds are used in industrial welding, chrome plating, dyes and pigments, leather tanning and wood preservation. Chromium is also used as anticorrosive in cooking systems and boilers [135, 136].

Potential for Human Exposure

It is estimated that more than 300,000 workers are exposed annually to chromium and chromium-containing compounds in the workplace. In humans and animals, [Cr(III)] is an essential nutrient that plays a role in glucose, fat and protein metabolism by potentiating the action of insulin [5]. However, occupational exposure has been a major concern because of the high risk of Cr-induced diseases in industrial workers occupationally exposed to Cr(VI) [137]. Also, the general human population and some wildlife may also be at risk. It is estimated that 33 tons of total Cr are released annually into the environment [130]. The U.S. Occupational Safety and Health Administration (OSHA) recently set a "safe" level of 5μg/m^3, for an 8-hr time-weighted average, even though this revised level may still pose a carcinogenic risk [138]. For the general human population, atmospheric levels range from 1 to 100 ng/cm^3 [139], but can exceed this range in areas that are close to Cr manufacturing.

Non-occupational exposure occurs via ingestion of chromium containing food and water whereas occupational exposure occurs via inhalation [140]. Chromium concentrations range between 1 and 3000 mg/kg in soil, 5 to 800 μg/L in sea water, and 26 μg/L to 5.2 mg/L in rivers and lakes [129]. Chromium content in foods varies greatly and depends on the processing and preparation. In general, most fresh foods typically contain chromium levels ranging from <10 to 1,300 μg/kg. Present day workers in chromium-related industries can be exposed to chromium concentrations two orders of magnitude higher than the general population [141]. Even though the principal route of human exposure to chromium is through inhalation, and the lung is the primary target organ, significant human exposure to chromium has also been reported to take place through the skin [142, 143]. For example, the widespread incidence of dermatitis noticed among construction workers is attributed to their exposure to chromium present in cement [143]. Occupational and environmental exposure to Cr(VI)-containing compounds is known to cause multiorgan toxicity such as renal damage, allergy and asthma, and cancer of the respiratory tract in humans [5, 144].

Breathing high levels of chromium (VI) can cause irritation to the lining of the nose, and nose ulcers. The main health problems seen in animals following ingestion of chromium (VI) compounds are irritation and ulcers in the stomach and small intestine, anemia, sperm damage and male reproductive system damage. Chromium (III) compounds are much less toxic and do not appear to cause these problems. Some individuals are extremely sensitive to chromium(VI) or chromium(III), allergic reactions consisting of severe redness and swelling of the skin have been noted. An increase in stomach tumors was observed in humans and animals exposed to chromium(VI) in drinking water. Accidental or intentional ingestion of extremely high doses of chromium (VI) compounds by humans has resulted in severe respiratory, cardiovascular, gastrointestinal, hematological, hepatic, renal, and neurological effects as part of the sequelae leading to death or in patients who survived because of medical treatment [141]. Although the evidence of carcinogenicity of chromium in humans and terrestrial mammals seems strong, the mechanism by which it causes cancer is not completely understood [145].

Mechanisms of Toxicity and Carcinogenicity

Major factors governing the toxicity of chromium compounds are oxidation state and solubility. Cr(VI) compounds, which are powerful oxidizing agents and thus tend to be irritating and corrosive, appear to be much more toxic systemically than Cr(III) compounds, given similar amount and solubility [146, 147]. Although the mechanisms of biological interaction are uncertain, the variation in toxicity may be related to the ease with which Cr(VI) can pass through cell membranes and its subsequent intracellular reduction to reactive intermediates. Since Cr(III) is poorly absorbed by any route, the toxicity of chromium is mainly attributable to the Cr(VI) form. It can be absorbed by the lung and gastrointestinal tract, and even to a certain extent by intact skin. The reduction of Cr(VI) is considered as being a detoxification process when it occurs at a distance from the target site for toxic or genotoxic effect while reduction of Cr(VI) may serve to activate chromium toxicity if it takes place in or near the cell nucleus of target organs [148]. If Cr(VI) is reduced to Cr(III) extracellularly, this form of the metal is not readily transported into cells and so toxicity is not observed. The balance that exists between extracellular Cr(VI) and intracellular Cr(III) is what ultimately dictates the amount and rate at which Cr(VI) can enter cells and impart its toxic effects [134].

Cr(VI) enters many types of cells and under physiological conditions can be reduced by hydrogen peroxide (H_2O_2), glutathione (GSH) reductase, ascorbic acid, and GSH to produce reactive intermediates, including Cr(V), Cr(IV), thiylradicals, hydroxyl radicals, and ultimately, Cr(III). Any of these species could attack DNA, proteins, and membrane lipids, thereby disrupting cellular integrity and functions [149, 150].

Studies with animal models have also reported many harmful effects of Cr (VI) on mammals. Subcutaneous administration of Cr (VI) to rats caused severe progressive proteinuria, urea nitrogen and creatinine, as well as elevation in serum alanine aminotransferase activity and hepatic lipid peroxide formation [151]. Similar studies reported by Gumbleton and Nicholls [152] found that Cr (VI) induced renal damage in rats when administered by single sub-cutaneous injections. Bagchi et al. demonstrated that rats received Cr (VI) orally in water induced hepatic mitochondrial and microsomal lipid peroxidation, as well as enhanced excretion of urinary lipid metabolites including malondialdehyde [153, 154].

Adverse health effects induced by Cr (VI) have also been reported in humans. Epidemiological investigations have reported respiratory cancers in workers occupationally exposed to Cr (VI)-containing compounds [142, 148]. DNA strand breaks in peripheral lymphocytes and lipid peroxidation products in urine observed in chromium-exposed workers also support the evidence of Cr (VI)-induced toxicity to humans [155, 156]. Oxidative damage is considered to be the underlying cause of these genotoxic effects including chromosomal abnormalities [157, 158], and DNA strand breaks [159]. Nevertheless, recent studies indicate a biological relevance of non-oxidative mechanisms in Cr(VI) carcinogenesis [160].

Carcinogenicity appears to be associated with the inhalation of the less soluble/insoluble Cr(VI) compounds. The toxicology of Cr(VI) does not reside with the elemental form. It varies greatly among a wide variety of very different Cr(VI) compounds [161]. Epidemiological evidence strongly points to Cr(VI) as the agent in carcinogenesis. Solubility and other characteristics of chromium, such as size, crystal modification, surface charge, and the ability to be phagocytized might be important in determining cancer risk [135].

Studies in our laboratory have indicated that chromium (VI) is cytotoxic and able to induce DNA damaging effects such as chromosomal abnormalities [162], DNA strand breaks, DNA fragmentation and oxidative stress in Sprague-Dawley rats and human liver carcinoma cells [27, 28]. Recently, our laboratory has also demonstrated that chromium (VI) induces biochemical, genotoxic and histopathologic effects in liver and kidney of goldfish, *carassius auratus* [163].

Various hypotheses have been proposed to explain the carcinogenicity of chromium and its salts, however some inherent difficulties exist when discussing metal carcinogenesis. A metal cannot be classified as carcinogenic per se since its different compounds may have different potencies. Because of the multiple chemical exposure in industrial establishments, it is difficult from an epidemiological standpoint to relate the carcinogenic effect to a single compound. Thus, the carcinogenic risk must often be related to a process or to a group of metal compounds rather than to a single substance. Differences in carcinogenic potential are related not only to different chemical forms of the same metal but also to the particle size of the inhaled aerosol and to physical characteristics of the particle such as surface charge and crystal modification [164].

Lead

Environmental Occurrence, Industrial Production and Use

Lead is a naturally occurring bluish-gray metal present in small amounts in the earth's crust. Although lead occurs naturally in the environment, anthropogenic activities such as fossil fuels burning, mining, and manufacturing contribute to the release of high concentrations. Lead has many different industrial, agricultural and domestic applications. It is currently used in the production of lead-acid batteries, ammunitions, metal products (solder and pipes), and devices to shield X-rays. An estimated 1.52 million metric tons of lead were used for various industrial applications in the United Stated in 2004. Of that amount, lead-acid batteries production accounted for 83 percent, and the remaining usage covered a range of products such as ammunitions (3.5 percent), oxides for paint, glass, pigments and chemicals (2.6 percent), and sheet lead (1.7 percent) [165, 166].

In recent years, the industrial use of lead has been significantly reduced from paints and ceramic products, caulking, and pipe solder [167]. Despite this progress, it has been reported that among 16.4 million United States homes with more than one child younger than 6 years per household, 25% of homes still had significant amounts of lead-contaminated deteriorated paint, dust, or adjacent bare soil [168]. Lead in dust and soil often re-contaminates cleaned houses [169] and contributes to elevating blood lead concentrations in children who play on bare, contaminated soil [170]. Today, the largest source of lead poisoning in children comes from dust and chips from deteriorating lead paint on interior surfaces [171]. Children who live in homes with deteriorating lead paint can achieve blood lead concentrations of 20μg/dL or greater [172].

Potential for Human Exposure

Exposure to lead occurs mainly via inhalation of lead-contaminated dust particles or aerosols, and ingestion of lead-contaminated food, water, and paints [173, 174]. Adults absorb 35 to 50% of lead through drinking water and the absorption rate for children may be greater than 50%. Lead absorption is influenced by factors such as age and physiological status. In the human body, the greatest percentage of lead is taken into the kidney, followed by the liver and the other soft tissues such as heart and brain, however, the lead in the skeleton represents the major body fraction [175]. The nervous system is the most vulnerable target of lead poisoning. Headache, poor attention spam, irritability, loss of memory and dullness are the early symptoms of the effects of lead exposure on the central nervous system [170, 173].

Since the late 1970's, lead exposure has decreased significantly as a result of multiple efforts including the elimination of lead in gasoline, and the reduction of lead levels in residential paints, food and drink cans, and plumbing systems [173, 174]. Several federal programs implemented by state and local health governments have not only focused on banning lead in gasoline, paint and soldered cans, but have also supported screening programs for lead poisoning in children and lead abatement in housing [167]. Despite the progress in these programs, human exposure to lead remains a serious health problem [176, 177]. Lead is the most systemic toxicant that affects several organs in the body including the kidneys, liver, central nervous system, hematopoetic system, endocrine system, and reproductive system [173].

Lead exposure usually results from lead in deteriorating household paints, lead in the work place, lead in crystals and ceramic containers that leaches into water and food, lead use in hobbies, and lead use in some traditional medicines and cosmetics [167, 174]. Several studies conducted by the National Health and Nutrition Examination surveys (NHANES) have measured blood lead levels in the U.S. populations and have assessed the magnitude of lead exposure by age, gender, race, income and degree of urbanization [176]. Although the results of these surveys have demonstrated a general decline in blood lead levels since the 1970s, they have also shown that large populations of children continue to have elevated blood lead levels (> 10μg/dL). Hence, lead poisoning remains one of the most common pediatric health problems in the United States today [167, 173, 174, 176–179]. Exposure to lead is of special

concern among women particularly during pregnancy. Lead absorbed by the pregnant mother is readily transferred to the developing fetus [180]. Human evidence corroborates animal findings [181], linking prenatal exposure to lead with reduced birth weight and preterm delivery [182], and with neuro-developmental abnormalities in offspring [183].

Molecular Mechanisms of Toxicity and Carcinogenicity

There are many published studies that have documented the adverse effects of lead in children and the adult population. In children, these studies have shown an association between blood level poisoning and diminished intelligence, lower intelligence quotient-IQ, delayed or impaired neurobehavioral development, decreased hearing acuity, speech and language handicaps, growth retardation, poor attention span, and anti social and diligent behaviors [178, 179, 184, 185]. In the adult population, reproductive effects, such as decreased sperm count in men and spontaneous abortions in women have been associated with high lead exposure [186, 187]. Acute exposure to lead induces brain damage, kidney damage, and gastrointestinal diseases, while chronic exposure may cause adverse effects on the blood, central nervous system, blood pressure, kidneys, and vitamin D metabolism [173, 174, 178, 179, 184–187].

One of the major mechanisms by which lead exerts its toxic effect is through biochemical processes that include lead's ability to inhibit or mimic the actions of calcium and to interact with proteins [173]. Within the skeleton, lead is incorporated into the mineral in place of calcium. Lead binds to biological molecules and thereby interfering with their function by a number of mechanisms. Lead binds to sulfhydryl and amide groups of enzymes, altering their configuration and diminishing their activities. Lead may also compete with essential metallic cations for binding sites, inhibiting enzyme activity, or altering the transport of essential cations such as calcium [188]. Many investigators have demonstrated that lead intoxication induces a cellular damage mediated by the formation of reactive oxygen species (ROS) [189]. In addition, Jiun and Hseien [190] demonstrated that the levels of malondialdehyde (MDA) in blood strongly correlate with lead concentration in the blood of exposed workers. Other studies showed that the activities of antioxidant enzymes, including superoxide dismutase (SOD), and glutathione peroxidase in erythrocytes of workers exposed to lead are remarkably higher than that in non-exposed workers [191]. A series of recent studies in our laboratory demonstrated that lead-induced toxicity and apoptosis in human cancer cells involved several cellular and molecular processes including induction of cell death and oxidative stress [29, 192], transcriptional activation of stress genes [30], DNA damage [29], externalization of phosphatidylserine and activation of caspase-3 [193].

A large body of research has indicated that lead acts by interfering with calcium-dependent processes related to neuronal signaling and intracellular signal transduction. Lead perturbs intracellular calcium cycling, altering releasability of organelle stores, such as endoplasmic reticulum and mitochondria [194, 195]. In some cases lead inhibits calcium-dependent events, including calcium-dependent release of several neurotransmitters and receptor-coupled ionophores in glutamatergic neurons [196]. In other cases lead appears to augment calcium-dependent events, such as protein kinase C and calmodulin [194, 197].

Experimental studies have indicated that lead is potentially carcinogenic, inducing renal tumors in rats and mice [198, 199], and is therefore considered by the IARC as a probable human carcinogen [200]. Lead exposure is also known to induce gene mutations and sister chromatid exchanges [201, 202], morphological transformations in cultured rodent cells [203], and to enhance anchorage independence in diploid human fibroblasts [204]. *In vitro* and *in vivo* studies indicated that lead compounds cause genetic damage through various indirect mechanisms that include inhibition of DNA synthesis and repair, oxidative damage, and interaction with DNA-binding proteins and tumor suppressor proteins. Studies by Roy and his group showed that lead acetate induced mutagenicity at a toxic dose at the *E. coli gpt* locus transfected to V79 cells [205]. They also reported that toxic doses of lead acetate and lead nitrate induced DNA breaks at the *E. coli gpt* locus transfected to V79 cells [205]. Another study by Wise and his collaborators found no evidence for direct genotoxic or DNA-damaging effects of lead except for lead chromate. They pointed out that the genotoxicity may be due to hexavalent chromate rather than lead [206].

Mercury

Environmental Occurrence, Industrial Production and Use

Mercury is a heavy metal belonging to the transition element series of the periodic table. It is unique in that it exists or is found in nature in three forms (elemental, inorganic, and organic), with each having its own profile of toxicity [207]. At room temperature elemental mercury exists as a liquid which has a high vapor pressure and is released into the environment as mercury vapor. Mercury also exists as a cation with oxidation states of +1 (mercurous) or +2 (mercuric) [208]. Methylmercury is the most frequently encountered compound of the organic form found in the environment, and is formed as a result of the methylation of inorganic (mercuric) forms of mercury by microorganisms found in soil and water [209].

Mercury is a widespread environmental toxicant and pollutant which induces severe alterations in the body tissues and causes a wide range of adverse health effects [210]. Both humans and animals are exposed to various chemical forms of mercury in the environment. These include elemental mercury vapor (Hg^0), inorganic mercurous (Hg^{+1}), mercuric (Hg^{+2}), and the organic mercury compounds [211]. Because mercury is ubiquitous in the environment, humans, plants and animals are all unable to avoid exposure to some form of mercury [212].

Mercury is utilized in the electrical industry (switches, thermostats, batteries), dentistry (dental amalgams), and numerous industrial processes including the production of caustic soda, in nuclear reactors, as antifungal agents for wood processing, as a solvent for reactive and precious metal, and as a preservative of pharmaceutical products [213]. The industrial demand for mercury peaked in 1964 and began to sharply decline between 1980 and 1994 as a result of federal bans on mercury additives in paints, pesticides, and the reduction of its use in batteries [214].

Potential for Human Exposure

Humans are exposed to all forms of mercury through accidents, environmental pollution, food contamination, dental care, preventive medical practices, industrial and agricultural operations, and occupational operations [215]. The major sources of chronic, low level mercury exposure are dental amalgams and fish consumption. Mercury enters water as a natural process of off-gassing from the earth's crust and also through industrial pollution [216]. Algae and bacteria methylate the mercury entering the waterways. Methyl mercury then makes its way through the food chain into fish, shellfish, and eventually into humans [217].

The two most highly absorbed species are elemental mercury (Hg^0) and methyl mercury (MeHg). Dental amalgams contain over 50% elemental mercury [218]. The elemental vapor is highly lipophilic and is effectively absorbed through the lungs and tissues lining the mouth. After Hg^0 enters the blood, it rapidly passes through cell membranes, which include both the blood-brain barrier and the placental barrier [219]. Once it gains entry into the cell, Hg^0 is oxidized and becomes highly reactive Hg^{2+}. Methyl mercury derived from eating fish is readily absorbed in the gastrointestinal tract and because of its lipid solubility, can easily cross both the placental and blood-brain barriers. Once mercury is absorbed it has a very low excretion rate. A major proportion of what is absorbed accumulates in the kidneys, neurological tissue and the liver. All forms of mercury are toxic and their effects include gastrointestinal toxicity, neurotoxicity, and nephrotoxicity [213].

Molecular Mechanisms of Mercury Toxicity and Carcingenicity

The molecular mechanisms of toxicity of mercury are based on its chemical activity and biological features which suggest that oxidative stress is involved in its toxicity [220]. Through oxidative stress mercury has shown mechanisms of sulfhydryl reactivity. Once in the cell both Hg^{2+} and MeHg form covalent bonds with cysteine residues of proteins and deplete cellular antioxidants. Antioxidant enzymes serve as a line of cellular defense against mercury compounds [221]. The interaction of mercury compounds suggests the production of oxidative damage through the accumulation of reactive oxygen species (ROS) which would normally be eliminated by cellular antioxidants.

In eukaryotic organisms the primary site for the production of reactive oxygen species (ROS) occurs in the mitochondria through normal metabolism [222]. Inorganic mercury has been reported to increase the production of these ROS by causing defects in oxidative phosphorylation and electron transport at the ubiquinone-cytochrome b5 step [223]. Through the acceleration of the rate of electron transfer in the electron transport chain in the mitochondria, mercury induces the premature shedding of electrons to molecular oxygen which causes an increase in the generation of reactive oxygen species [224].

Oxidative stress appears to also have an effect on calcium homeostasis. The role of calcium in the activation of proteases, endonucleases and phospholipases is well established. The activation of phospholipase A_2 has been shown to result in an increase in reactive oxygen species through the increase generation of arachidonic acid. Arachidonic acid has also been shown to be an important target of reactive oxygen species [225]. Both organic and inorganic mercury have been shown to alter calcium homeostasis but through different mechanisms. Organic mercury compounds (MeHg) are believed to increase intracellular calcium by accelerating the influx of calcium from the extracellular medium and mobilizing intracellular stores, while inorganic mercury (Hg^{2+}) compounds increase intracellular calcium stores only through the influx of calcium from the extracellular medium [226]. Mercury compounds have also been shown to induce increased levels of MDA in both the livers, kidneys, lungs and testes of rats treated with $HgCl_2$ [227]. This increase in concentration was shown to correlate with the severity of hepatotoxicity and nephrotoxicity [228]. $HgCl_2$-induced lipid peroxidation was shown to be significantly reduced by antioxidant pretreatment with selenium. Selenium has been shown to achieve this protective effect through direct binding to mercury or serving as a cofactor for glutathione peroxidase and facilitating its ability to scavenge ROS [229]. Vitamin E has also been reported to protect against $HgCl_2$-induced lipid peroxidation in the liver [230].

Metal-induced carcinogenicity has been a research subject of great public health interest. Generally, carcinogenesis is considered to have three stages including initiation, promotion, and progression and metastasis. Although mutations of DNA, which can activate oncogenesis or inhibit tumor suppression, were traditionally thought to be crucial factors for the initiation of carcinogenesis, recent studies have demonstrated that other molecular events such as transcription activation, signal transduction, oncogene amplification, and recombination, also constitute significant contributing factors [231, 232]. Studies have shown that mercury and other toxic metals effect cellular organelles and adversely affect their biologic functions [231, 233]. Accumulating evidence also suggests that ROS play a major role in the mediation of metal-induced cellular responses and carcinogenesis [234–236].

The connection between mercury exposure and carcinogenesis is very controversial. While some studies have confirmed its genotoxic potential, others have not shown an association between mercury exposure and genotoxic damage [237]. In studies implicating mercury as a genotoxic agent, oxidative stress has been described has the molecular mechanism of toxicity. Hence, mercury has been shown to induce the formation of ROS known to cause DNA damage in cells, a process which can lead to the initiation of carcinogenic processes [238, 239]. The direct action of these free radicals on nucleic acids may generate genetic mutations. Although mercury-containing compounds are not mutagenic in bacterial assays, inorganic mercury has been shown to induce mutational events in eukaryotic cell lines with doses as low as 0.5 μM [240]. These free radicals may also induce conformational changes in proteins that are responsible for DNA repair, mitotic spindle, and chromosomal segregation [241]. To combat these effects, cells have antioxidant mechanisms that work to correct and avoid the formation of ROS (free radicals) in excess. These antioxidant mechanisms involve low molecular weight compounds such as vitamins C and E, melatonin, glutathione, superoxide dismutase, catalase, glutathione peroxidase and glutathione reductase that protect the cells by chelating mercury and reducing its oxidative stress potential [242].

Glutathione levels in human populations exposed to methylmercury intoxication by eating contaminated fish have been shown to be higher than normal [243]. These studies were also able to confirm a direct and positive correlation between mercury and glutathione levels in blood. They also confirmed an increased mitotic index and polyploidal aberrations associated with mercury exposure [243]. Epidemiological studies have demonstrated that enzymatic activity was altered in populations exposed to mercury; producing genotoxic alterations, and suggesting that both chronic and relatively low level mercury exposures may inhibit enzyme activity and induce oxidative stress in the cells [244]. There is no doubt that the connection between mercury exposure and carcinogenesis is very controversial. However, *in-vitro* studies suggest that the susceptibility to DNA damage exists as a result of cellular exposure to mercury. These studies also indicate that mercury-induced toxicity and carcinogenicity may be cell-, organ- and/or species- specific.

Prospects

A comprehensive analysis of published data indicates that heavy metals such as arsenic cadmium, chromium, lead, and mercury, occur naturally. However, anthropogenic activities contribute significantly to environmental contamination. These metals are systemic toxicants known to induce adverse health effects in humans, including cardiovascular diseases, developmental abnormalities, neurologic and neurobehavioral disorders, diabetes, hearing loss, hematologic and immunologic disorders, and various types of cancer. The main pathways of exposure include ingestion, inhalation, and dermal contact. The severity of adverse health effects is related to the type of heavy metal and its chemical form, and is also time- and dose-dependent. Among many other factors, speciation plays a key role in metal toxicokinetics and toxicodynamics, and is highly influenced by factors such as valence state, particle size, solubility, biotransformation, and chemical form. Several studies have shown that toxic metals exposure causes long term health problems in human populations. Although the acute and chronic effects are known for some metals, little is known about the health impact of mixtures of toxic elements. Recent reports have pointed out that these toxic elements may interfere metabolically with nutritionally essential metals such as iron, calcium, copper, and zinc [245, 246]. However, the literature is scarce regarding the combined toxicity of heavy metals. Simultaneous exposure to multiple heavy metals may produce a toxic effect that is either additive, antagonistic or synergistic.

A recent review of a number of individual studies that addressed metals interactions reported that co-exposure to metal/metalloid mixtures of arsenic, lead and cadmium produced more severe effects at both relatively high dose and low dose levels in a biomarker-specific manner [247]. These effects were found to be mediated by dose, duration of exposure and genetic factors. Also, human co-exposure to cadmium and inorganic arsenic resulted in a more pronounced renal damage than exposure to each of the elements alone [248]. In many areas of metal pollution, chronic low dose exposure to multiple elements is a major public health concern. Elucidating the mechanistic basis of heavy metal interactions is essential for health risk assessment and management of chemical mixtures. Hence, research is needed to further elucidate the molecular mechanisms and public health impact associated with human exposure to mixtures of toxic metals.

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PARTNER

PHASE I ENVIRONMENTAL SITE ASSESSMENT REPORT

Fox Shores Apartments

400 Fox Shores Drive
Kaukauna, Wisconsin 54130

Regulatory Date: June 12, 2018
Assessment Date: June 14, 2018
Report Date: July 6, 2018
Partner Project No. 18-215232.1

Prepared for

BERKADIA COMMERCIAL MORTGAGE LLC
St. Louis, Missouri 63105



Engineers who understand your business

PARTNER

July 6, 2018

Mr. Darak LaCroix
Berkadia Commercial Mortgage LLC
101 South Hanley Road, Suite 550
St. Louis, Missouri 63105

Subject: Phase I Environmental Site Assessment
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project No. 18-215232.1

Dear Mr. LaCroix:

Partner Engineering and Science, Inc. (Partner) is pleased to provide the results of the *Phase I Environmental Site Assessment* (Phase I ESA) report of the abovementioned address (the "subject property"). This assessment was performed in conformance with the scope and limitations as detailed in the ASTM Standard Practice E1527-13 Standard Practice for Environmental Site Assessments.

This assessment included a site reconnaissance on June 14, 2018 as well as research and interviews with representatives of the public, property ownership, site manager, and regulatory agencies. The regulatory assessment activities were initiated on June 12, 2018. An assessment was made, conclusions stated, and recommendations outlined.

We appreciate the opportunity to provide environmental services to Berkadia Commercial Mortgage LLC. If you have any questions concerning this report, or if we can assist you in other matter, please contact me at (214) 234-9561.

Sincerely,

DRAFT

Scott Chiu
National Client Manager

PARTNER

July 6, 2018

Mr. Darak LaCroix
Berkadia Commercial Mortgage LLC
101 South Hanley Road, Suite 550
St. Louis, Missouri 63105

Subject: Phase I Environmental Site Assessment
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project No. 18-215232.1

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Sincerely,

Scott Chiu
National Client Manager

EXECUTIVE SUMMARY

Partner Engineering and Science, Inc. (Partner) has performed a Phase I Environmental Site Assessment (ESA) in accordance with the scope of work and limitations of ASTM Standard Practice E1527-13, the Environmental Protection Agency Standards and Practices for All Appropriate Inquiries (AAI) (40 CFR Part 312) for the property located at 400 Fox Shores Drive in the City of Kaukauna, Outagamie County, Wisconsin (the "subject property"). The Phase I Environmental Site Assessment is designed to provide Berkadia Commercial Mortgage LLC with an assessment concerning environmental conditions (limited to those issues identified in the report) as they exist at the subject property.

Property Description

The subject property is located to the north and west of Fox Shores Drive within a mixed commercial and residential area of Kaukauna, Wisconsin. Please refer to the table below for further description of the subject property:

Subject Property Data	
Address(es):	400 Fox Shores Drive, Kaukauna, Wisconsin
Property Use:	Multi-Family
Land Acreage (Ac):	2.185 Ac
Number of Buildings:	6
Number of Floors:	2 (no basement)
Auxiliary Buildings	400 Fox Shores Garage Bays 1-6 (1,300 SF); 400 Fox Shores Garage Bays 7-12 and maintenance (1,600 SF); 410 Fox Shore Garage Bays 1-6 (1,300 SF); 410 Fox Shore Garage Bays 7-12 (1,300 SF); 400 and 410 Bicentennial Court Garage Bays 1-7 (1,500 SF); 380 and 390 Bicentennial Court Garage Bays 1-7 (1,500 SF)
Gross Building Area (SF):	67,060 SF
Date of Construction:	1983 (Bicentennial Court buildings); 1992 (Fox Shores buildings)
Assessor's Parcel Number (APN):	323-0408-00; 323-0408-01; 323-0408-02
Type of Construction:	Wood-Framed
Number of Units:	56
Current Tenants:	Fox Shores Apartments
Site Assessment Performed By:	John Hetner of Partner
Site Assessment Conducted On:	June 14, 2018
HUD Program:	MAP 223f*

HUD Part 50 Form, Partner Worksheets and supporting documentation are included under a separate cover and provided concurrent with the Phase I ESA outlined herein.

The subject property is currently occupied by the Fox Shores Apartments for residential use. Onsite operations consist of general residential operations and maintenance activities. In addition to the current structures, the subject property is also improved with paved-parking areas and limited landscaping.

According to available historical sources, the subject property was formerly developed as early as circa 1890. Development activities, as depicted on Sanborn fire insurance maps, indicate the subject property

and vicinity were developed as part of the Chicago and Northwest Rail Road Shops. Numerous structures were developed on the subject property between approximately 1890 until at least 1971 per historical aerial imagery. Aerial imagery depicts the site as undeveloped in 1982. Tax assessor documents indicate development of the subject property began in 1983 with the development of the existing multi-family residential structures along Bicentennial Court. A second phase of residential structures were developed in 1992 along Fox Shores Drive.

Sanborn fire insurance maps provide the best indication of historical tenancy during the period of time the subject property was occupied by a railroad service yard. The 1925 Sanborn map depicts a carpentry shop, machine shop, repair shop, engine room, coal room, blacksmith shop, supply warehouses, tin shop, and pipe shed. It is assumed that these occupants and structures existed at the subject property throughout the period (*c. 1890-1971*) the subject property was developed for railroad services. From 1983 to present, the subject property has been occupied by residential tenants.

The immediately surrounding properties consist of the Fox River to the north; an operations facility occupied by the City of Kaukauna Street and Park Department used to store vehicles and equipment to the south across Bicentennial Court; a fitness center to the east across Fox Shores Drive; and an apartment complex to the west.

According to a 2006 Phase II Subsurface Investigation conducted at the south adjacent property and correspondence with the Wisconsin Department of Natural Resources, the depth and direction of groundwater in the vicinity of the subject property is inferred to be approximately 5-feet below ground surface (bgs) and flow toward the southeast.

Findings – ASTM Items

Report Section	ASTM Items	No Further Action	De Minimis	BER* / Environmental Issue	REC	CREC	HREC
3.0	Historical Background				**X**		
4.0	Federal, State, Local, Tribal Database Listings, Vapor Intrusion				**X**		
5.0	User Provided information	**X**					
6.0	Onsite Reconnaissance	**X**					
6.1	General Site Characteristics	**X**					
6.2	Potential Environmental Hazards	**X**					
6.2.10	Non-ASTM	**X**					
6.3	Adjacent Properties				**X**		

**BER - Business Environmental Risk*

A *recognized environmental condition (REC)* refers to the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: due to release to the environment; under conditions indicative of a release to the environment; or under conditions that pose a material threat of a future release to the environment.

- The west adjacent property, identified as the USACE – Parcel J (Kaukauna Power Canal) is an open Environmental Repair Program (ERP) case on the online Wisconsin Bureau for Redevelopment and Remediation Tracking (WI BRRTS) database. The site's address is identified as the "end of 420 Bicentennial Court". The responsible party for this site is listed at the United States Army Corps of Engineers (USACE). According to Wisconsin Department of Natural Resources (WI DNR) records, the constituent of concern for this site is identified as lead and impacts are known to be present in the soil media. The case was opened and responsible party notified on March 1, 2003. To date, no remedial activities have occurred. Per correspondence with the WI DNR case manager assigned to site, the USACE has not made efforts to pursue remediation of the site. Parcel J, as depicted on a sampling map obtained from the WI DNR, encompasses the shoreline of the Fox River beginning to the west of the subject property and extends eastward toward the subject property, ultimately concluding at the northeast corner of the subject property. In total, this site represents the north and northwest adjacent property. Soil sampling results from 2004 and 2005 subsurface investigation indicate elevated levels of lead immediately north and northwest of the subject property boundary along the Fox River shoreline.

  Limited information is available for the USACE – Parcel J site given the USACE's denial of responsibility for the contamination to date. Correspondence with WI DNR also indicated the site's priority level with the WI DNR does not qualify it for State funded remediation. As of the August 9, 2016 semi-annual status report, no action has been taken at the site. The WI DNR will continue to issue semi-annual status updates per WI DNR policy, however, at this time, no action is anticipated.

  Based on the known soil contamination abutting the northern and northwestern boundary of the subject property, this site represents a *recognized environmental condition (REC)* at the subject property.

A *controlled recognized environmental condition (CREC)* refers to a REC resulting from a past release of hazardous substances or petroleum products that has been addressed to the satisfaction of the applicable regulatory authority, with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls. The following was identified during the course of this assessment:

- The property, identified as Ghost Town Fitness Center at 180 Fox Shores Drive, is located adjacent to the east of the subject property. This site is registered as an WI ERP site which originates from its listing on the WI DNR Environmental Cleanup and Brownfields Redevelopment (BRRTS) database. According to the EDR regulatory database and WI DNR files, groundwater contamination was identified at this property. Substances identified exceeding regulatory

reporting thresholds are listed as arsenic and selenium. The substances were identified through subsurface testing that occurred in 2006. An excerpt of the discussion from the limited subsurface investigation is provided below:

- *The NR 140 Permissible Allowable Limit (PAL) for arsenic is 1 microgram (µ) per liter. Arsenic was detected at a concentration of 7.8 micrograms per liter (µg/L) in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 3.0 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for selenium is 10 µg/L. Selenium was detected at a concentration of 32 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 14.7 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. Lead was detected at a concentration of 5.8 µg/L during the July 26, 2006 push-probe assessment but was not detected in the groundwater sample collected from the monitoring well on September 12, 2006.*

Findings of the limited subsurface investigation were submitted to the WI DNR, along with the required documentation to obtain a closure letter from the State. Upon review of the limited subsurface investigation, the WI DNR granted closure to the site pursuant to an exemption to a PAL for a substance of public health concern (*Wisconsin Administrative Code s. NR 140.28(2)(b)*) given the following criteria were met at the site:

1. The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically feasible and economically feasible;
2. Compliance with the PAL is either not technically or economically feasible;
3. The enforcement standard for the substance will not be attained or exceeded at the point of standards application; and
4. Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

Per a WI DNR *No Further Action Letter*, dated October 9, 2006, this case was granted closure with no further investigation, remediation or other action required at this site. The WI DNR granted closure to the site as the constituent levels of arsenic and selenium at the site were remediated to WI DNR standards in accordance with *Wisconsin Administrative Code s. NR 726.05*.

Based on the case closure and direction of groundwater flow identified through subsurface investigation, this site represents a *controlled recognized environmental condition (CREC)*.

- The property, identified as the Kaukauna Waste Oil Collection Site at 201 West 2nd Street, 222 3rd Street, and 3rd Street 200 Block, and is located adjacent to the south of the subject property beyond Bicentennial Court. This site reported a release of petroleum based fuels *circa 1993*, which reportedly impacted soil and groundwater. The release occurred as a result of leaking UST and was reported to the WI DNR on December 28, 1993. The responsible party for the release,

contamination and remediation is identified as the City of Kaukauna – Public Works Department. Remedial efforts at the subject property include soil excavation and the removal of two, 10,000-gallon USTs and one, 550-gallon waste oil UST. Regulatory documents obtained from the WI DNR indicate soil excavations around tank pits at ranging between 4′ and 13′ below ground surface. Groundwater gradient maps indicate groundwater flow to the east-southeast, away from the subject property.

As a result of the known contamination, soil and groundwater deed restrictions were placed on the property as indicated on the *Deed Restriction* recording document dated May 20, 2003. The Deed Restriction document states that natural attenuation has been approved by the WI DNR to remediate groundwater contamination exceeding *ch. NR 140 of the Wisconsin Administrative Code* for groundwater standards within the boundary of the deed-restricted property. Given the implementation of the Deed Restriction, further groundwater and soil remediation activities are considered unnecessary.

The responsible party submitted all required documentation pursuant to receiving a Final Case Closure letter from the WI DNR. As stated by the WI DNR, the responsible party complied with the conditions for closure, including submittal of the Deed Restriction, and as such, the WI DNR concluded, "Based on the correspondence and data provided, it appears that your case meets the screening criteria of s. *NR 746.07*, and the requirements of *ch. NR 726* of the Wisconsin Administrative Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time."

Based on the case closure and the groundwater Deed Restriction, this site represents a *controlled recognized environmental condition (CREC)*

A *historical recognized environmental condition (HREC)* refers to a past release of any hazardous substances or petroleum products that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authority or meeting unrestricted use criteria established by a regulatory authority, without subjecting the property to any required controls. The following was identified during the course of this assessment:

- Partner did not identify historical recognized environmental conditions during the course of this assessment.

An *environmental issue* (also referred to as *Business Environmental Risk*) refers to environmental concerns identified by Partner, which do not qualify as RECs; however, warrant further discussion. The following was identified during the course of this assessment:

- Partner did not identify environmental issues during the course of this assessment.

Conclusions, Opinions and Recommendations

Partner has performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Standard Practice E1527-13 of 400 Fox Shores Drive in the City of Kaukauna,

Outagamie County, Wisconsin (the "subject property"). Any exceptions to or deletions from this practice are described in Section 1.5 of this report.

This assessment has revealed evidence of recognized environmental conditions and/or environmental issues in connection with the subject property. Based on the conclusions of this assessment, Partner recommends the following:

- Given the known contamination of the surrounding properties as described in Section 4.2.2, a limited subsurface investigation should be conducted in order to evaluate the presence or absence of soil and/or groundwater contamination due at the subject property to the historical use of the subject property. Compliance with HUD MAP Guidelines, specifically Section 9.3, *Contamination Analysis,* will be addressed during and upon completion of the limited subsurface investigation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope of Work 2
1.3 Limitations 2
1.4 User Reliance 3
1.5 Limiting Conditions 3
2.0 SITE DESCRIPTION 5
2.1 Site Location and Legal Description 5
2.2 Current Property Use 5
2.3 Description of Subject Property Structures and Improvements 5
2.4 Current Use of Adjoining Properties 6
2.5 Physical Setting Sources 6
2.5.1 Topography 6
2.5.2 Geology & Hydrology 7
2.5.3 Surface Water Drainage 7
2.5.4 Soils 8
2.5.5 Flood Zone Information 8
3.0 HISTORICAL INFORMATION 9
3.1 Aerial Photograph Review 9
3.2 Sanborn Fire Insurance Maps 11
3.3 City Directories 12
3.4 Historical Topographic Maps 13
4.0 REGULATORY RECORDS REVIEW 15
4.1 Regulatory Agencies 15
4.1.1 State Department 15
4.1.2 Health Department 15
4.1.3 Fire Department 15
4.1.4 Building Department 16
4.1.5 Planning Department 16
4.1.6 Assessor's Office 16
4.1.7 Super Priority Lien Statutes 17
4.2 Regulatory Database Summary 17
4.2.1 Subject Property Listings 18
4.2.2 Adjacent Property Listings 18
4.2.3 Sites of Concern Listings 20
4.2.4 Orphan Listings 20
4.2.5 Vapor Intrusion 21
5.0 USER PROVIDED INFORMATION AND INTERVIEWS 22
5.1 Interviews 23
5.1.1 Interview with Owner 23
5.1.2 Interview with Report User 23
5.1.3 Interview with Key Site Manager 23
5.1.4 Interviews with Past Owners, Operators and Occupants 23
5.1.5 Interview with Others 23
5.2 User Provided Information 23

5.2.1 Title Records, Environmental Liens, and AULs 23
5.2.2 Specialized Knowledge 24
5.2.3 Actual Knowledge of the User 24
5.2.4 Valuation Reduction for Environmental Issues 24
5.2.5 Commonly Known or Reasonably Ascertainable Information 24
5.2.6 Previous Reports and Other Provided Documentation 24
6.0 SITE RECONNAISSANCE 25
6.1 General Site Characteristics 26
6.1.1 Solid Waste Disposal 26
6.1.2 Source of Heating and Cooling 26
6.1.3 Wells and Cisterns 26
6.1.4 Surface Water Drainage 27
6.1.5 Sewage Discharge and Disposal 27
6.1.6 Wastewater 27
6.1.7 Lead in Drinking Water 27
6.1.8 Additional Site Observations 28
6.2 Potential Environmental Hazards 28
6.2.1 Hazardous Materials and Petroleum Products Used or Stored at the Site 28
6.2.2 Aboveground & Underground Hazardous Substance or Petroleum Product Storage Tanks (ASTs/USTs) 28
6.2.3 Evidence of Releases 28
6.2.4 Polychlorinated Biphenyls (PCBs) 28
6.2.5 Strong, Pungent or Noxious Odors 29
6.2.6 Pools of Liquid 29
6.2.7 Drains, Sumps and Clarifiers 29
6.2.8 Stressed Vegetation 29
6.2.9 Additional Potential Environmental Hazards 30
6.3 Adjacent Property Reconnaissance 30
7.0 HUD HEROS / COMPLIANCE ITEMS 31
8.0 FINDINGS AND CONCLUSIONS 32
9.0 SIGNATURES OF ENVIRONMENTAL PROFESSIONALS 36
10.0 REFERENCES 37

Figures

Figure 1 Site Location Map
Figure 2 Site Plan
Figure 3 Topographic Map

Appendices

Appendix A Site Photographs
Appendix B Historical Documentation
- B1 Aerial Photographs
- B2 Fire Insurance Maps (No Coverage)
- B3 City Directories
- B4 Historical Topographic Maps
- B5 Client-Provided Documentation
- B6 Supporting Documentation (tax assessor, zoning, etc)

Appendix C Interviews/FOIAs
Appendix D Qualifications

1.0 INTRODUCTION

Partner Engineering and Science, Inc. (Partner) has performed a Phase I Environmental Site Assessment (ESA) in conformance with the scope and limitations of ASTM Standard Practice E1527-13 and the Environmental Protection Agency Standards and Practices for All Appropriate Inquiries (AAI) (40 CFR Part 312) for the property located at 400 Fox Shores Drive in the City of Kaukauna, Outagamie County, Wisconsin (the "subject property"). Any exceptions to, or deletions from, this scope of work are described in the report.

1.1 Purpose

The purpose of this ESA is to identify existing or potential Recognized Environmental Conditions (as defined by ASTM Standard E-1527-13) affecting the subject property that: 1) constitute or result in a material violation or a potential material violation of any applicable environmental law; 2) impose any material constraints on the operation of the subject property or require a material change in the use thereof; 3) require clean-up, remedial action or other response with respect to Hazardous Substances or Petroleum Products on or affecting the subject property under any applicable environmental law; 4) may affect the value of the subject property; and 5) may require specific actions to be performed with regard to such conditions and circumstances. In addition, a purpose of the Phase I ESA is to document compliance with 24 CFR 50.3(i), which states HUD's policy that all properties proposed for use in HUD programs be free of hazardous materials, contamination, toxic chemicals and gases, and radioactive substances, where a hazard could affect the health and safety of occupants or conflict with the intended utilization of the property. The *HUD Part 50 Form*, *HUD Partner Worksheets* and supporting documentation are included under a separate cover and provided concurrent with the Phase I ESA outlined herein.

The information contained in the ESA Report will be used by Client to: 1) evaluate its legal and financial liabilities for transactions related to foreclosure, purchase, sale, loan origination, loan workout or seller financing; 2) evaluate the subject property's overall development potential, the associated market value and the impact of applicable laws that restrict financial and other types of assistance for the future development of the subject property; and/or 3) determine whether specific actions are required to be performed prior to the foreclosure, purchase, sale, loan origination, loan workout or seller financing of the subject property.

This ESA was performed to permit the User to satisfy one of the requirements to qualify for the innocent landowner, contiguous property owner, or bona fide prospective purchaser limitations on scope of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 U.S.C. §9601) liability (hereinafter, the "landowner liability protections," or "LLPs"). ASTM Standards E-1527-13 and E-1527-13 constitutes "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" as defined at 42 U.S.C. §9601(35)(B).

In addition, a purpose of the Phase I ESA is to document compliance with 24 Code of Federal Regulations (CFR) 50.3(i)(1). An additional purpose is to determine the presence or absence of hazardous materials, contamination, toxic chemicals and gases, and radioactive substances, where a hazard could affect the health and safety of occupants or conflict with the intended utilization of the property.

1.2 Scope of Work

The scope of work for this ESA is in accordance with the requirements of ASTM Standard Practice E1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process; the Environmental Protection Agency Standards and Practices for All Appropriate Inquiries (AAI) (40 CFR Part 312). This assessment included: 1) a property and adjacent site reconnaissance; 2) interviews with key personnel; 3) a review of historical sources; 4) a review of regulatory agency records; 5) a review of a regulatory database report provided by a third-party vendor and 6) Client provided documents, if available.

1.3 Limitations

Partner warrants the findings and conclusions contained herein were accomplished in accordance with the methodologies set forth in the Scope of Work. These methodologies are described as representing good commercial and customary practice for conducting an ESA of a property for the purpose of identifying recognized environmental conditions. There is a possibility that even with the proper application of these methodologies there may exist on the subject property conditions that could not be identified within the scope of the assessment or which were not reasonably identifiable from the available information. Partner believes the information obtained from the record review and the interviews concerning the subject property is reliable. However, Partner cannot and does not warrant or guarantee the information provided by these other sources is accurate or complete. The conclusions and findings set forth in this report are strictly limited in time and scope to the date of the evaluations. The conclusions presented in the report are based solely on the services described therein, and not on scientific tasks or procedures beyond the scope of agreed-upon services or the time and budgeting restraints imposed by the Client. No other warranties are implied or expressed.

Some of the information provided in this report is based upon personal interviews, and research of available documents, records, and maps held by the appropriate government and private agencies. This report is subject to the limitations of historical documentation, availability, and accuracy of pertinent records, and the personal recollections of those persons contacted.

This practice does not address requirements of any state or local laws or of any federal laws other than the All Appropriate Inquiry provisions of the LLPs. Further, this report does not intend to address all of the safety concerns, if any, associated with the subject property.

Environmental concerns, which are beyond the scope of a Phase I ESA as defined by ASTM include the following: ACMs, LBP, radon, and lead in drinking water. These issues may affect environmental risk at the subject property and may warrant discussion and/or assessment; however, are considered non-scope issues.

These non-ASTM scope issues are discussed in the *HUD Part 50 Form*, *HUD Partner Worksheets* and supporting documentation, which are provided under a separate cover concurrent with this Phase I ESA.

1.4 User Reliance

Berkadia Commercial Mortgage LLC, as well as the U.S. Department of Housing and Urban Development, their employees, agents, successors, and assigns may rely upon this report in evaluating a request for an extension of credit (the "Mortgage Loan") to be secured by the subject property. This information also may be used by any actual or prospective purchaser, transferee, assignee, or servicer of the Mortgage Loan, any actual or prospective investor (including agent or advisor) in any securities evidencing a beneficial interest in or backed by the Mortgage Loan, any rating agency actually or prospectively rating any such securities, any indenture trustee, and any institutional provider(s) from time to time of any liquidity facility or credit support for such financing, provided that any such reliance by any of the foregoing is subject to the terms and conditions in place between Partner and its Client, which terms and conditions include (by way of illustration and not by way of limitation) a standard of care, a limitation of liability plus distribution and reliance restrictions and which terms and conditions, along with these limitations and reliance provisions shall be disclosed by Client to any and all of the foregoing who receive Partner's report. In addition, the Client and all of the foregoing realize and acknowledge hereby that providing Partner's report to any of the foregoing by the Client may create an actual or potential conflict of interest for Partner, and, as an essential pre-condition to such disclosure and receipt of this, or any Partner report, both the Client and all of the foregoing who may be in receipt of any Partner report agree to also waive any conflict of interest as to Partner or its employees, officers, directors or shareholders in connection with receipt of the Partner report by any of the foregoing. Reliance by any of the foregoing subject to the said terms and conditions and waiver of conflict of interest shall in no event increase Partner's total maximum aggregate liability regardless of the number of claims or claimants. In addition, this report, or a reference to this report, may be included or quoted in any offering circular, private placement memorandum, registration statement, or prospectus, and Partner agrees to cooperate in answering questions by any of the above parties in connection with a securitization or transaction involving the Mortgage Loan and/or such securities, provided that any such inclusion expressly sets out these terms and conditions, use limitations and reliance restrictions and waiver of conflict of interest provisions.

This report has been completed under specific **Terms and Conditions** relating to scope, relying parties, limitations of liability, indemnification, dispute resolution, and other factors relevant to any reliance on this report. Any parties relying on this report do so having accepted the Terms and Conditions for which this report was completed. A copy of Partner's standard **Terms and Conditions** can be found at http://www.partneresi.com/terms-and-conditions.php.

1.5 Limiting Conditions

The findings and conclusions contain all of the limitations inherent in these methodologies that are referred to in ASTM E-1527-13.

Specific limitations and exceptions to this ESA are more specifically set forth below:

- Partner was not able to document the historical use of the subject property prior to 1890. The general vicinity of the subject property is depicted as developed, however, site specific information is not shown on the map. Other sources of historical information, such as aerial imagery, topographic maps, and city directories do not provide coverage for the subject property prior to 1938. This data failure is not considered critical and does not change the conclusions of this report.

- Partner was unable to determine the property use at 5-year intervals, which constitutes a data gap. Except for property tax files and recorded land title records, which were not considered to be sufficiently useful, Partner reviewed all standard historical sources and conducted appropriate interviews.

- Partner submitted Freedom of Information Act (FOIA) requests to the Kaukauna City Clerk (City Health Department, Building Department, Fire Department) for information pertaining to hazardous substances, underground storage tanks, releases, inspection records, etc. for the subject property. As of this writing, the City Clerk has not responded to Partner's request. Based on information obtained from other historical sources, this limitation is not expected to alter the overall findings of this assessment. If issues of an environmental concern are identified upon review of these documents, Partner will issue an addendum to this report.

- Partner inspected approximately 25% of all interior units and all common areas. Based on the size and nature of use of the uninspected units, this limited method of inspection is not expected to alter the overall findings of this assessment.

The Client has requested the report despite the above-listed limitations.

2.0 SITE DESCRIPTION

2.1 Site Location and Legal Description

The subject property is located to the north and west of Fox Shores Drive within a mixed commercial and residential area of Kaukauna, Wisconsin. According to the Outagamie County Assessor, the subject property is comprised of three unique parcels. Abbreviated legal descriptions for the three parcels are described as follows:

- *CSM 307 Lot 2 (PLATTED OUT OF PRT LOT 1 CSM 59) .83AC M/L #1256329*
- *COM SE COR LT 1 CSM 155 N10D E43.02FT TO POB N10D E203.23FT S79D E104.54FT S54D E110FT S35D W225.23FT TO ST N 55D W76.22FT N57D W40.80FT TO POB ALSO DESC AS LOT 1 CSM VOL 2 PG 307 .83AC*
- *CSM 6200 LOT 1 (PLATTED OUT OF PRT GOV LOT 8 SEC21-21-8) 1.56AC M/L*

Ownership for the three parcels that comprise the subject property is listed as Fox Investments LLC.

Please refer to Figure 1: Site Location Map, Figure 2: Site Plan, Figure 3: Topographic Map, and Appendix A: Site Photographs for the location and site characteristics of the subject property.

2.2 Current Property Use

The subject property is currently occupied by the Fox Shores Apartments for multi-family use. Onsite operations consist of typical residential operations and maintenance activities.

The subject property is designated for residential development by the City of Kaukauna.

The subject property was not identified in the regulatory database report outlined herein.

2.3 Description of Subject Property Structures and Improvements

Subject Property Data	
Property Use:	Multi-Family
Land Acreage (Ac):	2.185 Ac
Number of Buildings:	Six (6)
Number of Floors:	Two (2) (no basement)
Gross Building Area (SF):	67,060 SF
Auxiliary Buildings:	400 Fox Shores Garage Bays 1-6 (1,300 SF); 400 Fox Shores Garage Bays 7-12 and maintenance (1,600 SF); 410 Fox Shore Garage Bays 1-6 (1,300 SF); 410 Fox Shore Garage Bays 7-12 (1,300 SF); 400 and 410 Bicentennial Court Garage Bays 1-7 (1,500 SF); 380 and 390 Bicentennial Court Garage Bays 1-7 (1,500 SF)
Date of Construction:	1983 (Bicentennial Court buildings); 1992 (Fox Shores buildings)
Type of Construction:	Wood-Framed

In addition to the current structures, the subject property is also improved with paved-parking surfaces and limited landscaping.

2.4 Current Use of Adjoining Properties

The subject property is located within a mixed commercial and residential area of Kaukauna, Wisconsin. During the vicinity reconnaissance, Partner observed the following land use on properties in the immediate vicinity of the subject property:

Immediately Surrounding Properties	
North:	Fox River
South:	Bicentennial Court beyond which is City of Kaukauna Street and Parks Department operations facility (206 West Third Street and 201 Reaume Avenue)
East:	Fox Shores Drive beyond which is Ghost Town Fitness Center (180 Fox Shores Drive)
West:	River Park Place Apartments (420 Bicentennial Court)

The adjacent property to the east was identified as a Wisconsin Emergency Repair Program (WI ERP) site in the regulatory database report and the adjacent property to the south was identified as an leaking underground storage tank (LUST) and activity and use limitation (AUL) site in the regulatory database. Additionally, while not described as a known address per current tax assessor records, the south adjacent property (listed in the EDR database under 201 West 2nd Street) is also identified as an aboveground storage tank (AST), Resource Conservation Recovery Act (RCRA) – Conditionally Exempt Small Quantity Generator (CESQG), State Hazardous Waste and Incident Management Sites (SHWIMS), SPILLS, Bureau of Remediation & Redevelopment Tracking System (BRRTS), FINDS, ECHO, and MANIFEST site.

The west adjacent site is identified on the Wisconsin Department of Natural Resources' (WI DNR) database of open cases. The lack of an associated listing on the EDR regulatory database may be attributed to the lack of physical address on the WI DNR's database. Per the WI DNR database, the west adjacent site is known as the USACE (United States Army Corps of Engineers)– Parcel J (Kaukauna Power Canal) and located at the end of 420 Bicentennial Court.

These sites, as further described in the regulatory database section of this report, represent a *Recognized Environmental Condition* at the subject property.

Please refer to Figure 2: Site Plan.

2.5 Physical Setting Sources

2.5.1 Topography

Topography Information	
Site Elevation:	657-feet above mean sea level (MSL)
Slope Characteristic:	Gently
Surface Runoff/Topographic Gradient:	Southeast
Information Source:	USGS *Kaukauna Wisconsin* Quadrangle 7.5-minute series topographic map

The subject property is depicted on the 2013 map as developed.

Please refer to Figure 3: Topographic Map.

2.5.2 Geology & Hydrology

Hydrology Information	
Formation:	The subject property is situated within the Eastern Ridges and Lowlands physiographic province of the State of Wisconsin
Description:	The topography of the eastern ridges and lowlands is controlled by cuestas. The westernmost ridge is the rather low, narrow cuesta formed by the resistant Lower Magnesian limestone. It is alluded to hereafter as the Magnesian cuesta. The eastern upland is the higher and broader cuesta of Niagara limestone. The intermediate Green Bay- Lake Winnebago- Rock River lowland lies upon the belt of Black River and Galena limestone, with the gentle back slope of the Magnesian cuesta for one wall and the steep escarpment of the Niagara cuesta for the other.
Closest Surface Water:	Fox River (north adjacent property)
Estimated Depth to First Occurrence of Groundwater:	5' bgs
Hydrogeologic Gradient:	Southeast
Information Source:	Wisconsin DNR (Subsurface investigation at south adjacent property)

** The groundwater flow direction and the depth to shallow, unconfined groundwater, if present, would likely vary depending upon seasonal variations in rainfall and other hydrogeological features. Without the benefit of onsite groundwater monitoring wells surveyed to a datum, groundwater depth and flow direction beneath the subject property cannot be directly ascertained.*

According to available information, a public water system operated by the Kaukauna Utilities Department (KUD) serves the subject property vicinity. According to a representative of the KUD, shallow groundwater directly beneath the subject property is not utilized for domestic purposes. The sources of public water for the City of Kaukauna is groundwater from five groundwater wells that are located through the city. The depths of the wells range from 500- to 850-feet below ground surface.

According to a Phase II Subsurface Investigation conducted at the south adjacent property and correspondence with the Wisconsin Department of Natural Resources, the depth and direction of groundwater in the vicinity of the subject property is inferred to be approximately 5-feet below ground surface (bgs) and flow toward the southeast.

2.5.3 Surface Water Drainage

Surface Water Drainage		
Item or Feature	**Observed**	**REC**
Stormwater	Yes	No
Stormwater Management Pond(s)	No	
Surface water bodies	No	
Other	No	

Storm water is removed from the subject property primarily by sheet flow action across the paved surfaces towards storm water drains located in the public right of way. The subject property is connected to a municipal owned and maintained sewer system.

No pits, ponds or lagoons were observed on the subject property.

2.5.4 Soils

Soil Characteristics	
Soil Type:	Udorthents
Description:	This unit consists of well drained to excessively drained soils along mainly the southern edge of Block Island adjacent to Block Island Sound in the Mohegan Bluff area. Wind, waves, and rain have eroded these soils and undercut areas on bluffs. Areas are long and narrow and mostly range from 10 to 200 acres.
Source Information:	USDA Natural Resources Conservation Service Web Soil Survey online database

No soil stability, erosion and drainage concerns were observed on the subject property during the site reconnaissance.

2.5.5 Flood Zone Information

Flood Zone/Descriptions	
Unshaded, Zone X	An area located outside of the 100-year and 500-year flood plains.
Source Information:	Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM), Community Panel Number 55087C0342D, dated July 22, 2010

Additional information and HUD requirements for HUD flood zone compliance are outlined within the *HUD Part 50 Form and Partner Flood Management Worksheet,* which are provided under a separate cover concurrent with this Phase I ESA.

3.0 HISTORICAL INFORMATION

Partner obtained historical use information about the subject property from a variety of sources, which are outlined within the *Reference Section* of this report. A chronological listing of the historical data found is summarized in the table below:

Historical Use Information		
Period/Date	**Source**	**Description/Use**
c. 1890-1971	Aerial Photographs, Interviews, Topographic Maps, Sanborn Maps, Regulatory Records	Industrial
1982	Aerial Photographs, Building Records, City Directories, Interviews, Previous Report, Sanborn Maps	Undeveloped
1983-Present	Aerial Photographs, Building Records, City Directories, Interviews, Onsite Observations	Multifamily Residential

According to available historical sources, the subject property was formerly developed as early as circa 1890. Development activities as depicted on Sanborn fire insurance maps indicate the subject property and vicinity were developed as part of the Chicago and Northwest Rail Road Shops. Numerous structures were developed on the subject property during between approximately 1890 until at least 1971 per historical aerial imagery. Aerial imagery depicts the site as undeveloped in 1982. Tax assessor documents indicate development of the subject property began in 1983 with the development of the existing multi-family residential structures along Bicentennial Court. A second phase of residential structures were developed in 1992 along Fox Shores Drive.;

Sanborn fire insurance maps provide the best indication of historical tenancy during the period of time the subject property was occupied by a railroad service yard. The 1925 Sanborn map depicts a carpentry shop, machine shop, repair shop, engine room, coal room, blacksmith shop, supply warehouses, tin shop, and pipe shed. It is assumed that these occupants and structures existed at the subject property throughout the period (*c. 1890-1971*) the subject property was developed for railroad services. From 1983 to present, the subject property has been occupied by residential tenants.

Potential environmental concerns were identified in association with the current or historic use of the subject property, as further discussed in Section 4.22.

3.1 Aerial Photograph Review

Partner obtained available aerial photographs of the subject property and surrounding area from Environmental Data Resources (EDR). The following observations were noted to be visible on the subject property and adjacent properties during the aerial photograph review:

Date: 1938	***Scale: 1"=500'***
Subject Property:	The subject property appears to be developed as part of a railroad service yard. Several buildings and smaller objects, which may be rail cars, are visible throughout the property.
North:	Fox River

South:	The south adjacent appears to be developed with industrial structures associated with the railroad service yard as well as residential structures
East:	The east adjacent appears to be developed with industrial structures that extend from the subject property and are part of the railroad service yard that encompasses the general vicinity of the subject property
West:	The west adjacent appears to be developed with extensions of the rail lines that originate from the east (subject property) and are associated with the railroad service yard that encompasses the general vicinity of the subject property

Date: 1952, 1957, 1964, 1971	***Scale: 1"=500'***
Subject Property:	No significant changes visible
North:	No significant changes visible
South:	No significant changes visible
East:	No significant changes visible
West:	No significant changes visible

Date: 1982	***Scale: 1"=500'***
Subject Property:	The structures appear to have been razed and the subject property appears vacant with the exception of the former foundations and drive lanes
North:	No significant changes visible
South:	Bicentennial Court appears to have been developed. Beyond Bicentennial Court appears to be a structure that resembles the existing City operations facility.
East:	The east adjacent appears to be vacant. Former structures appear to have been razed with the exception of foundations and drive lanes.
West:	The west adjacent appears to be developed with multi structures that resemble the existing apartment complex.

Date: 1986	***Scale: 1"=500'***
Subject Property:	The subject property appears to have been developed with four structures on the south side of the property that resemble the existing multi-family buildings.
North:	No significant changes visible
South:	No significant changes visible
East:	The east adjacent appears to have been developed with a single structure that resembles the existing commercial facility.
West:	No significant changes visible

Date: 1992	***Scale: 1"=500'***
Subject Property:	Additional structures appear to have been developed on the north side of the property that resemble the existing multi-family buildings.
North:	No significant changes visible
South:	No significant changes visible
East:	No significant changes visible
West:	No significant changes visible

Date: 2006, 2010, 2015	***Scale: 1"=500'***
Subject Property:	No significant changes visible
North:	No significant changes visible

South:	No significant changes visible
East:	No significant changes visible
West:	No significant changes visible

Copies of select aerial photographs are included in Appendix B of this report.

3.2 Sanborn Fire Insurance Maps

Partner reviewed the collection of Sanborn Fire insurance maps from Environmental Data Resources (EDR). The following observations were noted to be depicted on the subject property and adjacent properties during the fire insurance map review:

Date: 1890	
Subject Property:	The subject property is not depicted on the Sanborn map. However, based on the surrounding developments depicted, it can be inferred the subject property was developed as part of the railroad service yard that encompasses the general vicinity.
North:	Not depicted (Fox River)
South:	The south adjacent property is not depicted on the Sanborn map. However, based on what is provided on the map, it can be inferred that at least portions of the south adjacent property were occupied by railroad lines and a lumber yard.
East:	The east adjacent property is not entirely depicted on the Sanborn map. However, based on what is provided on the map, it can be inferred that the east adjacent property is occupied by railroad lines and railcar turn table
West:	The west adjacent property is not depicted on the Sanborn map.

Date: 1894, 1900	
Subject Property:	No significant changes depicted
North:	No significant changes depicted
South:	No significant changes depicted
East:	No significant changes depicted
West:	No significant changes depicted

Date: 1900	
Subject Property:	No significant changes depicted
North:	No significant changes depicted
South:	No significant changes depicted
East:	No significant changes depicted

Date: 1906	
Subject Property:	The subject property is depicted with multiple buildings associated with a railway service that occupies the general vicinity of the subject property. Specific notations on the Sanborn map include three warehouses and an office.
North:	Not depicted (Fox River)
South:	The south adjacent property is not depicted on the Sanborn map. However, based on what is provided on the map, it can be inferred that at least portions of the south adjacent property were occupied by railroad lines and a lumber yard.

East:	The east adjacent property is depicted as developed with a railway service that occupies the general vicinity. Specific depictions include a round house turn table (utilized for repositioning railcars for reverse transit), an oil housing structure, a machine shop, blacksmith shop, water tower and sand housing structure.
West:	The west adjacent property is not depicted on the Sanborn map. However, based on what is provided on the map, it can be inferred that at least portions of the west adjacent property were occupied by railroad lines

Date: 1913	
Subject Property:	The subject property is depicted with multiple buildings associated with a railway service that occupies the general vicinity of the subject property. Specific notations on the Sanborn map include a repair shop, carpentry shop, supply warehouses, pipe shed, machine shoe, blacksmith shop, and railroad lines.
North:	No significant changes depicted
South:	The south adjacent developments are now depicted as the Standard Oil Co. Several structures are depicted beyond multiple railroad lines.
East:	No significant changes depicted
West:	No significant changes depicted

Date: 1925, 1945, 1956	
Subject Property:	No significant changes depicted
North:	No significant changes depicted
South:	No significant changes depicted
East:	No significant changes depicted
West:	No significant changes depicted

Copies of reviewed Sanborn Maps are included in Appendix B of this report.

3.3 City Directories

Partner reviewed historical city directories obtained from Environmental Data Resources (EDR) for past names and businesses that were listed for the subject property and adjacent properties. The findings are presented in the following table:

City Directory Search for 400 Fox Shores Drive (Subject Property)	
Year(s)	**Occupant Listed**
1990	No Listing (400 Fox Shores Drive)
1992	Residential Listings (400 Fox Shores Drive)
1995	Residential Listings (400 Fox Shores Drive)
2000	Residential Listings (400 Fox Shores Drive)
2005	Residential Listings (400 Fox Shores Drive)
2010	Residential Listings (400 Fox Shores Drive)
2014	Residential Listings (400 Fox Shores Drive)

Based on the city directory review, no environmentally sensitive listings were identified for the subject property address. However, it should be noted that City Directory coverage was not identified prior to 1990; the subject property is known to have been developed dating back to circa 1890.

City Directory Search for Adjacent Properties	
Year(s)	**Occupant Listed**
1990	Physically Fit (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)
1992	Physically Fit (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)
1995	Jeffrey Eitting (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)
2000	Jeffrey Eitting (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)
2005	Ghost Town Fitness Center (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)
2010	Ghost Town Fitness Center (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)
2014	Ghost Town Fitness Center (180 Fox Shores Drive), Residential Listings (420 Bicentennial Court)

Based on the city directory review, no environmentally sensitive listings were identified for the adjacent property addresses. However, it should be noted that City Directory coverage was not identified prior to 1990; the adjacent properties area known to have been developed dating back to circa 1890.

Copies of reviewed city directories are included in Appendix B of this report.

3.4 Historical Topographic Maps

Partner reviewed historical topographic maps obtained from Environmental Data Resources (EDR). The following observations were noted to be depicted on the subject property and adjacent properties during the topographic map review:

Date: 1954/1955	
Subject Property:	Developed with multiple structures that resemble structures depicted in historical Sanborn maps
North:	Fox River
South:	Railroad lines beyond which is a developed area as indicated by red shading
East:	Developed with multiple structures that resemble structures depicted in historical Sanborn maps
West:	Railroad line

Date: 1974	
Subject Property:	No developments depicted
North:	No significant changes depicted
South:	Developed with rail lines and a single, rectangular structure
East:	No developments depicted
West:	No developments depicted

Date: 1984	
Subject Property:	No significant changes depicted

North:	No significant changes depicted
South:	No significant changes depicted
East:	No significant changes depicted
West:	Developed with two structures that resemble the current multi-family buildings

Date: 1995	
Subject Property:	Depicted as situated within a developed area as indicated by grey shading
North:	Depicted as situated within a developed area as indicated by grey shading
South:	Depicted as situated within a developed area as indicated by grey shading
East:	Depicted as situated within a developed area as indicated by grey shading
West:	Depicted as situated within a developed area as indicated by grey shading

Copies of reviewed topographic maps are included in Appendix B of this report.

4.0 REGULATORY RECORDS REVIEW

4.1 Regulatory Agencies

4.1.1 State Department

Regulatory Agency Data	
Name of Agency:	Wisconsin Department of Natural Resources (WI DNR)
Point of Contact:	Ms. Jennifer Borski (WI DNR Hydrogeologist - Remediation & Redevelopment Program / Environmental Management)
Agency Address:	625 East County Road Y, Suite 700, Oshkosh, Wisconsin 54901
Agency Phone Number:	(920) 424-7887
Date of Contact:	June 15 and 26, 2018
Method of Communication:	Online / Telephone / Email

Summary of Communication: No records regarding hazardous substance use, storage or releases, or the presence of USTs and AULs on the subject property were on file with the WI DNR. However, WI DNR records were obtained for the south, east and west adjacent properties. These files are further discussed in Section 4.2.

4.1.2 Health Department

Regulatory Agency Data	
Name of Agency:	Kaukauna City Clerk
Point of Contact:	Ms. Sally Kenney
Agency Address:	144 West Second Street, Kaukauna, Wisconsin 54130
Agency Phone Number:	(920) 766-6300
Date of Contact:	June 15, 2018
Method of Communication:	Email

Summary of Communication: As of the date of this report, Partner has not received a response from the Kaukauna City Clerk for inclusion in this report.

4.1.3 Fire Department

Regulatory Agency Data	
Name of Agency:	Kaukauna Fire Department (KFD) c/o Kaukauna City Clerk
Point of Contact:	Ms. Sally Kenney
Agency Address:	144 West Second Street, Kaukauna, Wisconsin 54130
Agency Phone Number:	(920) 766-6300
Date of Contact:	June 15, 2018

Method of Communication:	Email

Summary of Communication: As of the date of this report, Partner has not received a response from the Kaukauna City Clerk for inclusion in this report.

4.1.4 Building Department

Regulatory Agency Data	
Name of Agency:	Kaukauna Building Inspection Department (KBID)
Point of Contact:	Mr. Jon Oldenburg
Agency Address:	144 West Second Street, Kaukauna, Wisconsin 54130
Agency Phone Number:	(920) 766-6300
Date of Contact:	June 15, 2018
Method of Communication:	Email

Summary of Communication: As of the date of this report, Partner has not received a response from the KBID for inclusion in this report.

4.1.5 Planning Department

Regulatory Agency Data	
Name of Agency:	Kaukauna Planning Department (KPD)
Point of Contact:	Mr. Jason Holmes
Agency Address:	144 West Second Street, Kaukauna, Wisconsin 54130
Agency Phone Number:	(920) 766-6300
Date of Contact:	June 15, 2018
Method of Communication:	Email

As of the date of this report, Partner has not received a response from the KPD for inclusion in this report. Per the City of Kaukauna's zoning map, the subject property is zoned *CCD: Commercial Core District*. A description of this zoning ordinance is provided within the appendices of this report.

4.1.6 Assessor's Office

Regulatory Agency Data	
Name of Agency:	Outagamie County Assessor (OCA)
Agency Address:	320 South Walnut Street, Appleton, Wisconsin 54911
Agency Phone Number:	(920) 832-5665
Date of Contact:	June 15, 2018
Method of Communication:	Online

Summary of Communication: According to records reviewed, the subject property is identified by Assessor Parcel Numbers (APNs) 323040802, 323040801, and 323040800 and is currently owned by Fox Investments LLC.

4.1.7 Super Priority Lien Statutes

According to the Environmental Lien and AUL State Statutes via the internet, **http://environmental.netronline.com/lienStatutes.aspx**, the State of Wisconsin does currently maintain an environmental super lien law.

4.2 Regulatory Database Summary

Information from standard federal, state, county, and city environmental record sources was provided by Environmental Data Resources, Inc. (EDR), dated June 12, 2018. Data from governmental agency lists are updated and integrated into one database, which is updated as these data are released. The information contained in this report was compiled from publicly available sources and the locations of the subject property are plotted utilizing a geographic information system, which geocodes the subject property addresses. The accuracy of the geocoded locations is approximately +/-300 feet.

Radius Report Data

Database	Search Radius (mile)	Site	Adjacent Properties	Sites of Concern
Federal NPL or Delisted NPL Site	1.00	N	N	N
Federal CERCLIS Site	0.50	N	N	N
Federal CERCLIS-NFRAP Site	0.50	N	N	N
Federal RCRA CORRACTS Facility	1.00	N	N	N
Federal RCRA TSDF Facility	0.50	N	N	N
Federal RCRA Generators Site (LQG, SQG, CESQG)	0.25	N	N	N
Federal IC/EC Registries	0.50	N	N	N
Federal ERNS Site	Subject Property	N	NA	NA
State/Tribal Equivalent NPL	1.00	N	N	N
State/Tribal Equivalent CERCLIS	1.00	N	N	N
State/Tribal Landfill/Solid Waste Disposal Site	0.50	N	N	N
State/Tribal Leaking Storage Tank Site	0.50	N	**Y**	N
State/Tribal Registered Storage Tank Sites (UST/AST)	0.25	N	**Y**	N
State/Tribal Voluntary Cleanup Sites (VCP)	0.50	N	N	N
State/Tribal Spills	0.50	N	**Y**	N
Federal Brownfield Sites	0.50	N	N	N
State Brownfield Sites	0.50	N	**Y**	N
EDR MGP	Varies	N	N	N
EDR US Hist Auto Station	Varies	N	N	N
EDR US Hist Cleaners	Varies	N	N	N
Other	Varies	N	N	N

4.2.1 Subject Property Listings

The subject property is not identified in the regulatory database report.

4.2.2 Adjacent Property Listings

The adjacent property to the east was identified as a WI ERP site in the regulatory database report as discussed below:

- The property, identified as Ghost Town Fitness Center at 180 Fox Shores Drive, is located adjacent to the east of the subject property. This site is registered as an WI ERP site which originates from its listing on the WI DNR Environmental Cleanup and Brownfields Redevelopment (BRRTS) database. According to the EDR regulatory database and WI DNR files, groundwater contamination was identified at this property. Substances identified exceeding regulatory reporting thresholds are listed as arsenic and selenium. The substances were identified through subsurface testing that occurred in 2006. An excerpt of the discussion from the limited subsurface investigation is provided below:
    - *The NR 140 PAL for arsenic is 1 microgram (µ) per liter. Arsenic was detected at a concentration of 7.8 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 3.0 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for selenium is 10 µg/L. Selenium was detected at a concentration of 32 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 14.7 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. Lead was detected at a concentration of 5.8 µg/L during the July 26, 2006 push-probe assessment but was not detected in the groundwater sample collected from the monitoring well on September 12, 2006.*

  Findings of the limited subsurface investigation were submitted to the WI DNR, along with the required documentation to obtain a closure letter from the State. Upon review of the limited subsurface investigation, the WI DNR granted closure to the site pursuant to an exemption to a PAL for a substance of public health concern (*Wisconsin Administrative Code s. NR 140.28(2)(b)*) given the following criteria were met at the site:

  1. The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically feasible and economically feasible;
  2. Compliance with the PAL is either not technically or economically feasible;
  3. The enforcement standard for the substance will not be attained or exceeded at the point of standards application; and
  4. Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

Per a WI DNR *No Further Action Letter*, dated October 9, 2006, this case was granted closure with no further investigation, remediation or other action required at this site. The WI DNR granted closure to the site as the constituent levels of arsenic and selenium at the site were remediated to WI DNR standards in accordance with *Wisconsin Administrative Code s. NR 726.05*.

Based on the case closure and direction of groundwater flow identified through subsurface investigation, this site represents a *controlled recognized environmental condition (CREC)*.

The adjacent property to the south beyond Bicentennial Court was identified as an LUST, AST, RRCA-CESQG, SHWIMS, SPILLS, BRRTS, FINDS, ECHO, MANIFEST and AUL site in the regulatory database as discussed below:

- The property, identified as the Kaukauna Waste Oil Collection Site at 201 West 2nd Street, 222 3rd Street, and 3rd Street 200 Block, and is located adjacent to the south of the subject property beyond Bicentennial Court. This site reported a release of petroleum based fuels *circa 1993*, which reportedly impacted soil and groundwater. The release occurred as a result of leaking UST and was reported to the WI DNR on December 28, 1993. The responsible party for the release, contamination and remediation is identified as the City of Kaukauna – Public Works Department. Remedial efforts at the subject property include soil excavation and the removal of two, 10,000-gallon USTs and one, 550-gallon waste oil UST. Regulatory documents obtained from the WI DNR indicate soil excavations around tank pits at ranging between 4' and 13' below ground surface. Groundwater gradient maps indicate groundwater flow to the east-southeast, away from the subject property.

  As a result of the known contamination, soil and groundwater deed restrictions were placed on the property as indicated on the *Deed Restriction* recording document dated May 20, 2003. The Deed Restriction document states that natural attenuation has been approved by the WI DNR to remediate groundwater contamination exceeding *ch. NR 140 of the Wisconsin Administrative Code* for groundwater standards within the boundary of the deed-restricted property. Given the implementation of the Deed Restriction, further groundwater and soil remediation activities are considered unnecessary.

  The responsible party submitted all required documentation pursuant to receiving a Final Case Closure letter from the WI DNR. As stated by the WI DNR, the responsible party complied with the conditions for closure, including submittal of the Deed Restriction, and as such, the WI DNR concluded, "Based on the correspondence and data provided, it appears that your case meets the screening criteria of s. *NR 746.07*, and the requirements of *ch. NR 726* of the Wisconsin Administrative Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time."

  Based on the case closure and the groundwater Deed Restriction, this site represents a *controlled recognized environmental condition (CREC)*.

Additionally, while not listed in the EDR Regulatory Database, the west adjacent site, identified as the United States Army Corps of Engineers (USACE) – Parcel J (Kaukauna Power Canal) in the WI DNR BRRTS database is an open case as described below:

- The west adjacent property, identified as the USACE – Parcel J (Kaukauna Power Canal) is an open Environmental Repair Program (ERP) case on the online Wisconsin Bureau for Redevelopment and Remediation Tracking (WI BRRTS) database. The site's address is identified as the "end of 420 Bicentennial Court". The responsible party for this site is listed at the United States Army Corps of Engineers (USACE). According to Wisconsin Department of Natural Resources (WI DNR) records, the constituent of concern for this site is identified as lead and impacts are known to be present in the soil media. The case was opened and responsible party notified on March 1, 2003. To date, no remedial activities have occurred. Per correspondence with the WI DNR case manager assigned to site, the USACE has not made efforts to pursue remediation of the site. Parcel J, as depicted on a sampling map obtained from the WI DNR, encompasses the shoreline of the Fox River beginning to the west of the subject property and extends eastward toward the subject property, ultimately concluding at the northeast corner of the subject property. In total, this site represents the north and northwest adjacent property. Soil sampling results from 2004 and 2005 subsurface investigation indicate elevated levels of lead immediately north and northwest of the subject property boundary along the Fox River shoreline.

  Limited information is available for the USACE – Parcel J site given the USACE's denial of responsibility for the contamination to date. Correspondence with WI DNR also indicated the site's priority level with the WI DNR does not qualify it for State funded remediation. As of the August 9, 2016 semi-annual status report, no action has been taken at the site. The WI DNR will continue to issue semi-annual status updates per WI DNR policy, however, at this time, no action is anticipated.

  Based on the known soil contamination abutting the northern and northwestern boundary of the subject property, this site represents a *recognized environmental condition (REC)* at the subject property.

Given the known contamination of the surrounding properties described above, Partner recommends a limited subsurface investigation should be conducted in order to evaluate the presence or absence of soil and/or groundwater contamination due at the subject property to the historical use of the subject property. Compliance with HUD MAP Guidelines, specifically Section 9.3, Contamination Analysis, will be addressed during and upon completion of the limited subsurface investigation.

4.2.3 Sites of Concern Listings

No other sites of concern are identified in the regulatory database report.

4.2.4 Orphan Listings

The property to the south is identified as the Kaukauna Waste Oil Collection Site at 3rd Street 200 Block in the regulatory database report, as previously discussed in Section 4.2.2.

4.2.5 Vapor Intrusion

Partner has performed a Vapor Intrusion Assessment (Tier 1 Screen) in accordance with the scope of work and limitations of ASTM Standard Practice E 2600-10 for the subject property. The purpose of this Vapor Intrusion Assessment (Tier 1 Screen) was to identify existing or potential Vapor Intrusion Conditions (*pVIC*) (as defined by ASTM Standard E 2600-10) affecting the subject property. The initial Tier 1 Vapor Encroachment Screen (VES) has been completed in accordance with the above stated requirements. The data and research completed as part of this Phase I ESA Report was also utilized in the review of the potential for a Vapor Encroachment Condition (VEC) and included the following sources:

- USGS Topographic Map
- Historical Aerial Photographs
- EDR Regulatory Database
- Subject property and Vicinity Photographs
- Interviews

Vapor intrusion additional criteria

Question	Response	Comments
1. Is the property known to have current or past contamination?	No	None reported
2. Is contamination of the property suspected?	**Yes**	See Section 4.2.2
3. Is an adjacent property known to have current or past contamination which may have impacted the subject property?	**Yes**	See Section 4.2.2
4. Is a nearby property known to have current or past contamination which may have impacted the subject property?	**Yes**	See Section 4.2.2
5. Is regional groundwater contamination known to exist beneath the property?	No	None reported
6. Are you aware of other conditions which may result in vapor intrusion at the property?	No	None reported

A Vapor Encroachment worksheet and Vapor Encroachment Screen (VES) was completed by Partner and provided by EDR. The VES was performed using Tier 1 non-invasive screening pursuant to ASTM E 2600-10 "Standard Guide for Vapor Encroachment Screening on Property Involved in Real Estate Transactions, Section 8". Based on the findings of the Tier I screen and VES, vapor intrusion cannot be ruled out. As such, additional assessment is recommended.

A copy of the EDR regulatory database report and completed VES are included with the HUD Partner Worksheets, which are provided under a separate cover concurrent with this Phase I ESA.

5.0 USER PROVIDED INFORMATION AND INTERVIEWS

In order to qualify for one of the *Landowner Liability Protections (LLPs)* offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2001 (the *Brownfields Amendments*), the *User* must provide the following information (if available) to the *environmental professional*. Failure to provide this information could result in a determination that *all appropriate inquiry* is not complete. The user is asked to provide information or knowledge of the following:

- Environmental cleanup liens that are filed or recorded against the site.
- Activity and land use limitations that are in place on the site or that have been filed or recorded in a registry.
- Specialized knowledge or experience of the person seeking to qualify for the LLPs.
- Relationship of the purchase price to the fair market value of the *property* if it were not contaminated.
- Commonly known or *reasonably ascertainable* information about the *property*.
- The degree of obviousness of the presence or likely presence of contamination at the *property*, and the ability to detect the contamination by appropriate investigation.
- The reason for preparation of this Phase I ESA.

Fulfillment of these user responsibilities is key to qualification for the identified defenses to CERCLA liability. Partner requested our Client to provide information to satisfy User Responsibilities as identified in Section 6 of the ASTM guidance.

Pursuant to ASTM E 1527-13, Partner requested the following site information from Berkadia Commercial Mortgage LLC (User of this report). Copies of pertinent documents are included in Appendix B of this report.

User Responsibilities				
Item	**Provided By User**	**Not Provided By User**	**Discussed Below**	**Does Not Apply**
Environmental Pre-Survey Questionnaire	**X**		**X**	
Title Records, Environmental Liens, and AULs	**X**		**X**	
Specialized Knowledge	**X**		**X**	
Actual Knowledge	**X**		**X**	
Valuation Reduction for Environmental Issues	**X**		**X**	
Identification of Key Site Manager	**Section 5.1.3**			
Reason for Performing Phase I ESA	**Section 1.1**			
Prior Environmental Reports	**Section 5.2.6**		**X**	
Other				**X**

5.1 Interviews

5.1.1 Interview with Owner

According to Mr. Thomas Vandeyacht, representative of the subject property owner, the subject property was developed in 1983 and 1991 for residential use. Prior to that, the subject property was occupied by a railway service yard. Mr. Vandeyacht further stated there are no USTs, ASTs, clarifiers, oil/water separators, groundwater monitoring wells, or hazardous substance use/storage/generation on the subject property to the best of his knowledge.

5.1.2 Interview with Report User

Please refer to Section 5.2 below for information requested from the Report User. The information requested was not received prior to the issuance of this report. Because the Report User (Client) is a lender, it is understood the Report User would not have knowledge of the property that would significantly impact our ability to satisfy the objectives of this assessment. The lack of this information is not considered to represent a significant data gap.

5.1.3 Interview with Key Site Manager

Mr. Vandeyacht, key site manager, indicated that he information pertaining to pending, threatened, or past litigation relevant to hazardous substances or petroleum products in, on, or from the subject property; pending, threatened, or past administrative proceedings relevant to hazardous substances or petroleum products in, on, or from the subject property; or notices from a governmental entity regarding possible violation of environmental laws or possible liability relating to hazardous substances or petroleum products.

Mr. Vandeyacht completed the environmental site questionnaires provided by Partner for the subject property. According to Mr. Vandeyacht and as noted in the completed questionnaires, no proposed and/or existing stationary tank(s) containing explosive or fire-prone materials of 100-gallons or larger are located and/or planned for the subject property. Furthermore, no environmental concerns/issues were noted in the completed questionnaires. Mr. Vandeyacht did note the presence of one irrigation well at the subject property. A copy of the completed questionnaires is included within the appendices.

5.1.4 Interviews with Past Owners, Operators and Occupants

Interviews with past owners, operators and occupants were not conducted since information regarding the potential for contamination at the subject property was obtained from other sources.

5.1.5 Interview with Others

As the subject property is not an abandoned property as defined in ASTM 1527-13, interview with others were not performed.

5.2 User Provided Information

5.2.1 Title Records, Environmental Liens, and AULs

Partner was not provided with title records or environmental lien and AUL information for review as part of this assessment.

5.2.2 Specialized Knowledge

No specialized knowledge of environmental conditions associated with the subject property was provided by the User at the time of the assessment.

5.2.3 Actual Knowledge of the User

No actual knowledge of environmental lien or AULs encumbering the subject property or in connection with the subject property was provided by the User at the time of the assessment.

5.2.4 Valuation Reduction for Environmental Issues

No knowledge of valuation reductions associated with the subject property was provided by the User at the time of the assessment.

5.2.5 Commonly Known or Reasonably Ascertainable Information

The User did not provide information that is commonly known or *reasonably ascertainable* within the local community about the subject property at the time of the assessment.

5.2.6 Previous Reports and Other Provided Documentation

The following information was provided to Partner for review during the course of this assessment:

Phase I Environmental Site Assessment, Global Realty Services Group (January 26, 2010)

Global Realty Services Group (GRS) prepared this report on behalf of Alliant Capital LLC. The assessment was performed in accordance with ASTM Standard E1527-05. The assessment consisted of a site reconnaissance, interviews with knowledgeable personnel, review of historical information, and a review of federal, state and local regulatory databases. Pertinent information contained in this report is summarized below:

- At the time of the 2010 assessment, the subject property was occupied by the current Fox Shores Apartments
- According to the GRS report, the subject property formerly occupied by a railyard and railroad roundhouse
- No current or former ASTs or USTs were identified on the subject property.

GRS identified the east adjacent property (Ghost Town Fitness Center) as an HREC. No RECs and recommended no further investigation.

Copies of pertinent pages reviewed are included in Appendix B of this report.

6.0 SITE RECONNAISSANCE

The weather at the time of the site visit was sunny and clear. Refer to Section 1.5 for limitations encountered during the field reconnaissance and Sections 2.1 and 2.2 for subject property operations. The table below provides the site assessment details:

Site Assessment Data	
Site Assessment Performed By:	John Hetner
Site Assessment Conducted On:	June 14, 2018

The table below provides the subject property personnel interviewed during the field reconnaissance:

Site Visit Personnel for 400 Fox Shores Drive (Subject Property)			
Name	**Title/Role**	**Contact Number**	**Site Walk* Yes/No**
Mr. Thomas Vandeyacht	Key Site Manager	(903) 213-7145	Yes

* Accompanied Partner during the field reconnaissance activities and provided information pertaining to the current operations and maintenance of the subject property

The subject property is currently occupied by the Fox Shores Apartments for residential use. Onsite operations consist of typical residential operations and maintenance activities.

No environmental concerns were identified attributed to the current use of the subject property.

Partner observed all common areas, down units, vacant units and 25% of the occupied, residential units listed below:

DWELLING UNITS OBSERVED		
Bldg./Unit Number	**Type**	**Comments/Issue**
400 Fox Shores – 1	2 Bedroom/2 Bath	Good condition with no issues observed.
400 Fox Shores – 12	2 Bedroom/2 Bath	Good condition with no issues observed.
400 Fox Shores – 10	2 Bedroom/2 Bath	Good condition with no issues observed.
410 Fox Shores – 9	2 Bedroom/2 Bath	Good condition with no issues observed.
410 Fox Shores – 8	2 Bedroom/2 Bath	Good condition with no issues observed.
410 Fox Shores - 7	2 Bedroom/2 Bath	Good condition with no issues observed.
410 Bicentennial Court – 3	2 Bedroom/1 Bath	Good condition with no issues observed.
410 Bicentennial Court – 6	2 Bedroom/1 Bath	Good condition with no issues observed.
400 Bicentennial Court – 3	2 Bedroom/1 Bath	Good condition with no issues observed.
400 Bicentennial Court – 7	2 Bedroom/1 Bath	Good condition with no issues observed.
390 Bicentennial Court – 4	2 Bedroom/1 Bath	Good condition with no issues observed.
390 Bicentennial Court – 8	2 Bedroom/1 Bath	Good condition with no issues observed.
380 Bicentennial Court – 1	2 Bedroom/1 Bath	Good condition with no issues observed.
380 Bicentennial Court – 7	2 Bedroom/1 Bath	Good condition with no issues observed.

6.1 General Site Characteristics

6.1.1 Solid Waste Disposal

Solid Waste Disposal		
Item or Feature	**Observed**	**REC**
Trash, debris, and/or other waste materials	Yes	No
Dumping or disposal areas	No	
Construction/demolition debris and/or dumped fill dirt	No	
Landfilling activities	No	
Other	No	

Solid waste generated at the subject property is disposed of in commercial dumpsters located on the subject property. An independent solid waste disposal contractor removes solid waste from the subject property. According to property personnel, only household trash is collected in the on-site solid waste dumpsters. No evidence of illegal dumping of solid waste was observed during the Partner site reconnaissance.

6.1.2 Source of Heating and Cooling

Confirm the sources for heating and cooling with the site contact and/or owner as early as possible PRIOR TO the site visit and again DURING the site inspection. Certain regions of the country require fuel oil for heating, which can be stored in an AST or UST. If current tank is AST, be sure to investigate and rule out potential for former UST.

Source of Heating and Cooling			
Item or Feature	**Service Provider**	**Observed**	**REC**
Heating and/or cooling systems	Kaukauna Power and Light	Yes	No
Other (Hot Water)	Kaukauna Power and Light	Yes	No

Heating and cooling of the dwelling units is provided by electric baseboard heating strips. Cooling is provided by through-wall air conditioning units. Hot water is provided by central natural gas boiler units/individual natural gas/electric hot water heaters. The subject property contains individual 40-gallon electric powered water heaters located in utility closets in each dwelling unit.

6.1.3 Wells and Cisterns

Wells and Cisterns		
Item or Feature	**Observed**	**REC**
Potable wells	No	
Monitoring wells	No	
Irrigation wells	No	
Other	No	

No aboveground evidence of wells or cisterns was observed during the site reconnaissance.

6.1.4 Surface Water Drainage

Surface Water Drainage		
Item or Feature	**Observed**	**REC**
Stormwater	Yes	No
Surface water bodies	No	
Wetlands	No	
Other	No	

Storm water is removed from the subject property primarily by sheet flow action across the paved surfaces towards storm water drains located in the public right of way. The subject property is connected to a municipal owned and maintained sewer system.

6.1.5 Sewage Discharge and Disposal

Sewage Discharge and Disposal		
Item or Feature	**Observed**	**REC**
Septic system and/or leachfield	No	
Cesspools	No	
Wastewater treatment system	No	
Exterior pipe discharges and/or other effluent discharges	No	
Other	Yes	No

Sanitary discharges on the subject property are directed into the municipal sanitary sewer system. The City of Kaukauna services the subject property vicinity. No wastewater treatment facilities or septic systems are observed or reported on the subject property.

6.1.6 Wastewater

Wastewater		
Item or Feature	**Observed**	**REC**
Wastewater treatment systems and/or water treatment systems	No	
Oil/water separators	No	
Other	No	

Domestic wastewater generated at the subject property is disposed by means of the sanitary sewer system. No industrial process is currently performed at the subject property.

6.1.7 Lead in Drinking Water

According to available information, a public water system operated by the Kaukauna Utilities Department (KUD) serves the subject property vicinity. According to a representative of the KUD, shallow groundwater beneath the subject property is not utilized for domestic purposes. The sources of public water for the City of Kaukauna is groundwater from five groundwater wells that are located through the city. The depths of the wells range from 500- to 850-feet below ground surface. According to the City of Kaukauna and the 2017 Annual Water Quality Report, water supplied to the subject property is in compliance with all State and Federal regulations pertaining to drinking water standards, including lead and copper. Water sampling was not conducted to verify water quality.

6.1.8 Additional Site Observations

No additional general site characteristics were observed.

6.2 Potential Environmental Hazards

6.2.1 Hazardous Materials and Petroleum Products Used or Stored at the Site

Hazardous Substances and/or Petroleum Products Noted Onsite		
Item or Feature	**Observed**	**REC**
Drums, Barrels, and/or Containers >5 gallons	No	
Parts Washer	No	
MSDS	No	
Other	No	

No hazardous substances or petroleum products were observed on the subject property during the site reconnaissance.

6.2.2 Aboveground & Underground Hazardous Substance or Petroleum Product Storage Tanks (ASTs/USTs)

AST and UST Hazardous Substance or Petroleum Product Storage Tanks		
Item or Feature	**Observed**	**REC**
ASTs	No	
USTs	No	
Other	No	

No evidence of current or former ASTs or USTs was observed during the site reconnaissance.

6.2.3 Evidence of Releases

Evidence of Releases		
Item or Feature	**Observed**	**REC**
Stained Soil	No	
Stained Pavement or Similar Surface	No	
Surface Water Discoloration, Odor, Sheen, and/or Free Floating Product	No	
Other	No	

No spills, stains or other indications that a surficial release has occurred at the subject property were observed.

6.2.4 Polychlorinated Biphenyls (PCBs)

PCBs		
Item or Feature	**Observed**	**REC**
Pole or Pad-Mounted Transformers and/or Capacitors	No	
Hydraulic Lifts	No	
Elevators	No	

PCBs		
Item or Feature	**Observed**	**REC**
Compactors/Balers	No	
Other	No	

No potential PCB-containing equipment (transformers (labeled as non-PCB containing), oil-filled switches, hoists, lifts, dock levelers, hydraulic elevators, etc) was observed on the subject property during Partner's reconnaissance.

6.2.5 Strong, Pungent or Noxious Odors

Strong, Pungent, or Noxious Odors		
Item or Feature	**Observed**	**REC**
Odors	No	
Other	No	

No strong, pungent or noxious odors were evident during the site reconnaissance.

6.2.6 Pools of Liquid

Pools of Liquid		
Item or Feature	**Observed**	**REC**
Pools of Liquids	No	
Other	No	

No pools of liquid were observed on the subject property during the site reconnaissance.

6.2.7 Drains, Sumps and Clarifiers

Drains, Sumps, and Clarifiers		
Item or Feature	**Observed**	**REC**
Interior Floor Drains	No	
Sumps, Cisterns, Catch Basins, and/or Dry Wells	No	
Grease Traps	No	
Oil/Water Separator	No	
Other	No	

No drains, sumps, or clarifiers, other than those associated with storm water removal, were observed on the subject property during the site reconnaissance.

6.2.8 Stressed Vegetation

Stressed Vegetation		
Item or Feature	**Observed**	**REC**
Stressed Vegetation	No	
Other	No	

No stressed vegetation was observed on the subject property.

6.2.9 Additional Potential Environmental Hazards

Additional Potential Environmental Hazards		
Item or Feature	**Observed**	**REC**
Dry Cleaning	No	
Photo Processing	No	
Laboratory Hoods and/or Incinerators	No	
Radiological Hazards (does not include radon)	No	
Other	No	

No additional environmental hazards, including landfill activities or radiological hazards, were observed.

6.2.10 Mold (Non-ASTM Item)

Molds are microscopic organisms found virtually everywhere, indoors and outdoors. Mold will grow and multiply under the right conditions, needing only sufficient moisture (e.g.in the form of very high humidity, condensation, or water from a leaking pipe, etc.) and organic material (e.g., ceiling tile, drywall, paper, or natural fiber carpet padding).

Partner observed accessible, interior areas for the subject property buildings for significant evidence of mold growth with the exceptions detailed in Section 1.5 of this report; however, this ESA should not be used as a mold survey or inspection. Additionally, this limited assessment was not designed to assess all areas of potential mold growth that may be affected by mold growth on the subject property. Rather, it is intended to give the client an indication as to whether or not conspicuous (based on observed areas) mold growth is present at the subject property. This evaluation did not include a review of pipe chases, mechanical systems, or areas behind enclosed walls and ceilings.

No obvious indications of water damage or mold growth were observed during Partner's visual assessment.

6.3 Adjacent Property Reconnaissance

The adjacent property reconnaissance consisted of observing the adjacent properties from the subject property premises. No items of environmental concern were identified on the adjacent properties during the site inspection, including hazardous materials, petroleum products, ASTs, USTs, evidence of releases, PCBs, strong or noxious odors, pools of liquids, sumps or clarifiers, pits or lagoons, stressed vegetation, or other potential environmental hazards.

7.0 HUD HEROS / COMPLIANCE ITEMS

HUD has established the HUD Environmental Review Online System (HEROS) – Form HUD 4128 to document the environmental review process, "Environmental Assessment and Compliance Finding for Related Laws", with NEPA and other environmental Federal laws, authorities, Executive Orders, and HUD standards, outlined within the Multifamily Accelerated Processing (MAP) Guide dated January 29, 2016 (Effective Date May 28, 2016).

This section is outlined within the *HUD Part 50 – Environmental Assessment Form* and *HUD Partner Worksheets* along with supporting documentation. This worksheet information noted below is provided under a separate cover that is included concurrent with this Phase I ESA.

- Air Quality
- Airport Hazards
- Coastal Barrier/Management Zone
- Endangered or Threatened Species or Habitats
- Environmental Assessment Factors and Analysis
- Environmental Justice
- Environmental Review Housing Requirements (Lead-Based Paint, Radon, Asbestos, Additional Nuisances and Hazards)
- Environmental Review Project Information
- Farmland Protection
- Flood Insurance
- Flood Management
- Hazardous Industrial Operations
- Noise Compliance
- Sole Source Aquifer
- State Historic Preservation Office (SHPO)
- Toxic Chemical and Radioactive Materials, Including VES
- Wetland
- Wild and Scenic Rivers

8.0 FINDINGS AND CONCLUSIONS

Findings – ASTM Items

A *recognized environmental condition (REC)* refers to the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: due to release to the environment; under conditions indicative of a release to the environment; or under conditions that pose a material threat of a future release to the environment.

- The west adjacent property, identified as the USACE – Parcel J (Kaukauna Power Canal) is an open Environmental Repair Program (ERP) case on the online Wisconsin Bureau for Redevelopment and Remediation Tracking (WI BRRTS) database. The site's address is identified as the "end of 420 Bicentennial Court". The responsible party for this site is listed at the United States Army Corps of Engineers (USACE). According to Wisconsin Department of Natural Resources (WI DNR) records, the constituent of concern for this site is identified as lead and impacts are known to be present in the soil media. The case was opened and responsible party notified on March 1, 2003. To date, no remedial activities have occurred. Per correspondence with the WI DNR case manager assigned to site, the USACE has not made efforts to pursue remediation of the site. Parcel J, as depicted on a sampling map obtained from the WI DNR, encompasses the shoreline of the Fox River beginning to the west of the subject property and extends eastward toward the subject property, ultimately concluding at the northeast corner of the subject property. In total, this site represents the north and northwest adjacent property. Soil sampling results from 2004 and 2005 subsurface investigation indicate elevated levels of lead immediately north and northwest of the subject property boundary along the Fox River shoreline.

  Limited information is available for the USACE – Parcel J site given the USACE's denial of responsibility for the contamination to date. Correspondence with WI DNR also indicated the site's priority level with the WI DNR does not qualify it for State funded remediation. As of the August 9, 2016 semi-annual status report, no action has been taken at the site. The WI DNR will continue to issue semi-annual status updates per WI DNR policy, however, at this time, no action is anticipated.

  Based on the known soil contamination abutting the northern and northwestern boundary of the subject property, this site represents a *recognized environmental condition (REC)* at the subject property.

A *controlled recognized environmental condition (CREC)* refers to a REC resulting from a past release of hazardous substances or petroleum products that has been addressed to the satisfaction of the applicable regulatory authority, with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls. The following was identified during the course of this assessment:

- The property, identified as Ghost Town Fitness Center at 180 Fox Shores Drive, is located adjacent to the east of the subject property. This site is registered as an WI ERP site which originates from its listing on the WI DNR Environmental Cleanup and Brownfields Redevelopment (BRRTS)

database. According to the EDR regulatory database and WI DNR files, groundwater contamination was identified at this property. Substances identified exceeding regulatory reporting thresholds are listed as arsenic and selenium. The substances were identified through subsurface testing that occurred in 2006. An excerpt of the discussion from the limited subsurface investigation is provided below:

- *The NR 140 Permissible Allowable Limit (PAL) for arsenic is 1 microgram (µ) per liter. Arsenic was detected at a concentration of 7.8 micrograms per liter (µg/L) in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 3.0 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for selenium is 10 µg/L. Selenium was detected at a concentration of 32 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 14.7 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. Lead was detected at a concentration of 5.8 µg/L during the July 26, 2006 push-probe assessment but was not detected in the groundwater sample collected from the monitoring well on September 12, 2006.*

Findings of the limited subsurface investigation were submitted to the WI DNR, along with the required documentation to obtain a closure letter from the State. Upon review of the limited subsurface investigation, the WI DNR granted closure to the site pursuant to an exemption to a PAL for a substance of public health concern (*Wisconsin Administrative Code s. NR 140.28(2)(b)*) given the following criteria were met at the site:

5. The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically feasible and economically feasible;
6. Compliance with the PAL is either not technically or economically feasible;
7. The enforcement standard for the substance will not be attained or exceeded at the point of standards application; and
8. Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

Per a WI DNR *No Further Action Letter*, dated October 9, 2006, this case was granted closure with no further investigation, remediation or other action required at this site. The WI DNR granted closure to the site as the constituent levels of arsenic and selenium at the site were remediated to WI DNR standards in accordance with *Wisconsin Administrative Code s. NR 726.05*.

Based on the case closure and direction of groundwater flow identified through subsurface investigation, this site represents a *controlled recognized environmental condition (CREC)*.

- The property, identified as the Kaukauna Waste Oil Collection Site at 201 West 2nd Street, 222 3rd Street, and 3rd Street 200 Block, and is located adjacent to the south of the subject property beyond Bicentennial Court. This site reported a release of petroleum based fuels *circa 1993*,

which reportedly impacted soil and groundwater. The release occurred as a result of leaking UST and was reported to the WI DNR on December 28, 1993. The responsible party for the release, contamination and remediation is identified as the City of Kaukauna – Public Works Department. Remedial efforts at the subject property include soil excavation and the removal of two, 10,000-gallon USTs and one, 550-gallon waste oil UST. Regulatory documents obtained from the WI DNR indicate soil excavations around tank pits at ranging between 4' and 13' below ground surface. Groundwater gradient maps indicate groundwater flow to the east-southeast, away from the subject property.

As a result of the known contamination, soil and groundwater deed restrictions were placed on the property as indicated on the *Deed Restriction* recording document dated May 20, 2003. The Deed Restriction document states that natural attenuation has been approved by the WI DNR to remediate groundwater contamination exceeding *ch. NR 140 of the Wisconsin Administrative Code* for groundwater standards within the boundary of the deed-restricted property. Given the implementation of the Deed Restriction, further groundwater and soil remediation activities are considered unnecessary.

The responsible party submitted all required documentation pursuant to receiving a Final Case Closure letter from the WI DNR. As stated by the WI DNR, the responsible party complied with the conditions for closure, including submittal of the Deed Restriction, and as such, the WI DNR concluded, "Based on the correspondence and data provided, it appears that your case meets the screening criteria of s. *NR 746.07*, and the requirements of *ch. NR 726* of the Wisconsin Administrative Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time."

Based on the case closure and the groundwater Deed Restriction, this site represents a *controlled recognized environmental condition (CREC)*

A *historical recognized environmental condition (HREC)* refers to a past release of any hazardous substances or petroleum products that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authority or meeting unrestricted use criteria established by a regulatory authority, without subjecting the property to any required controls. The following was identified during the course of this assessment:

- Partner did not identify historical recognized environmental conditions during the course of this assessment.

An *environmental issue* (also referred to as *Business Environmental Risk*) refers to environmental concerns identified by Partner, which do not qualify as RECs; however, warrant further discussion. The following was identified during the course of this assessment:

- Partner did not identify environmental issues during the course of this assessment.

Conclusions, Opinions and Recommendations

Partner has performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Standard Practice E1527-13 of 400 Fox Shores Drive in the City of Kaukauna, Outagamie County, Wisconsin (the "subject property"). Any exceptions to or deletions from this practice are described in Section 1.5 of this report.

This assessment has revealed evidence of recognized environmental conditions and/or environmental issues in connection with the subject property. Based on the conclusions of this assessment, Partner recommends the following:

- Given the known contamination of the surrounding properties as described in Section 4.2.2, a limited subsurface investigation should be conducted in order to evaluate the presence or absence of soil and/or groundwater contamination due at the subject property to the historical use of the subject property. Compliance with HUD MAP Guidelines, specifically Section 9.3, *Contamination Analysis,* will be addressed during and upon completion of the limited subsurface investigation.

9.0 SIGNATURES OF ENVIRONMENTAL PROFESSIONALS

Partner has performed a Phase I Environmental Site Assessment of the property located at 400 Fox Shores Drive in the City of Kaukauna, Outagamie County, Wisconsin in conformance with the scope and limitations of the protocol and the limitations stated earlier in this report. Exceptions to or deletions from this protocol are discussed earlier in this report.

By signing below, Partner declares that, to the best of our professional knowledge and belief, the undersigned meet the definition of an *Environmental Professional* as defined in §312.10 of 40 CFR 312 and have the specific qualifications based on education, training, and experience to assess a *property* of the nature, history, and setting of the subject *property*. Partner has developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in 40 CFR Part 312.

I understand that my Environmental Site Assessment (ESA) will be used by Berkadia Commercial Mortgage LLC to document to the U.S. Department of Housing and Urban Development that the MAP Lender's application for FHA multifamily mortgage insurance was prepared and reviewed in accordance with HUD requirements. I certify that my review was in accordance with the HUD requirements applicable on the date of my review and that I have no financial interest or family relationship with the officers, directors, stockholders, members or partners of the lender or affiliated entities, Borrower or affiliated entities, the general contractor, any subcontractors, the buyer or seller of the proposed property or engage in any business that might present a conflict of interest.

I hereby certify under penalty of perjury that all of the information I have provided on this form and in any accompanying documentation is true and accurate. I acknowledge that if I knowingly have made any false, fictitious, or fraudulent statement, representation, or certification on this form or on any accompanying documents, I may be subject to criminal, civil, and/or administrative sanctions, including fines, penalties, and/or imprisonment under applicable federal law, including but not limited to 12 U.S.C. § 1833a; 18 U.S.C. §§1001, 1006, 1010, 1012, and 1014; 12 U.S.C. §1708 and 1735f-14; and 31 U.S.C. §§3729 and 3802.

Prepared By:	Prepared By:	Reviewed By:
John Hetner	Scott Chiu	Angelique Crews
Environmental Scientist	Environmental Professional	Senior Author

10.0 REFERENCES

Reference Documents

American Society for Testing and Materials, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, ASTM Designation: E1527-13.

Environmental Data Resources (EDR), Radius Report, July 2018

Environmental Data Resources (EDR), Vapor Encroachment worksheet and Vapor Encroachment Screen (VES) Report, July 2018

Federal Emergency Management Agency, Federal Insurance Administration, National Flood Insurance Program, Flood Insurance Map, accessed via internet, July 2018

United States Geological Survey, Soil Survey, accessed via the Internet, July 2018

United States Geological Survey Topographic Map, 7.5 minute series, accessed via internet, July 2018

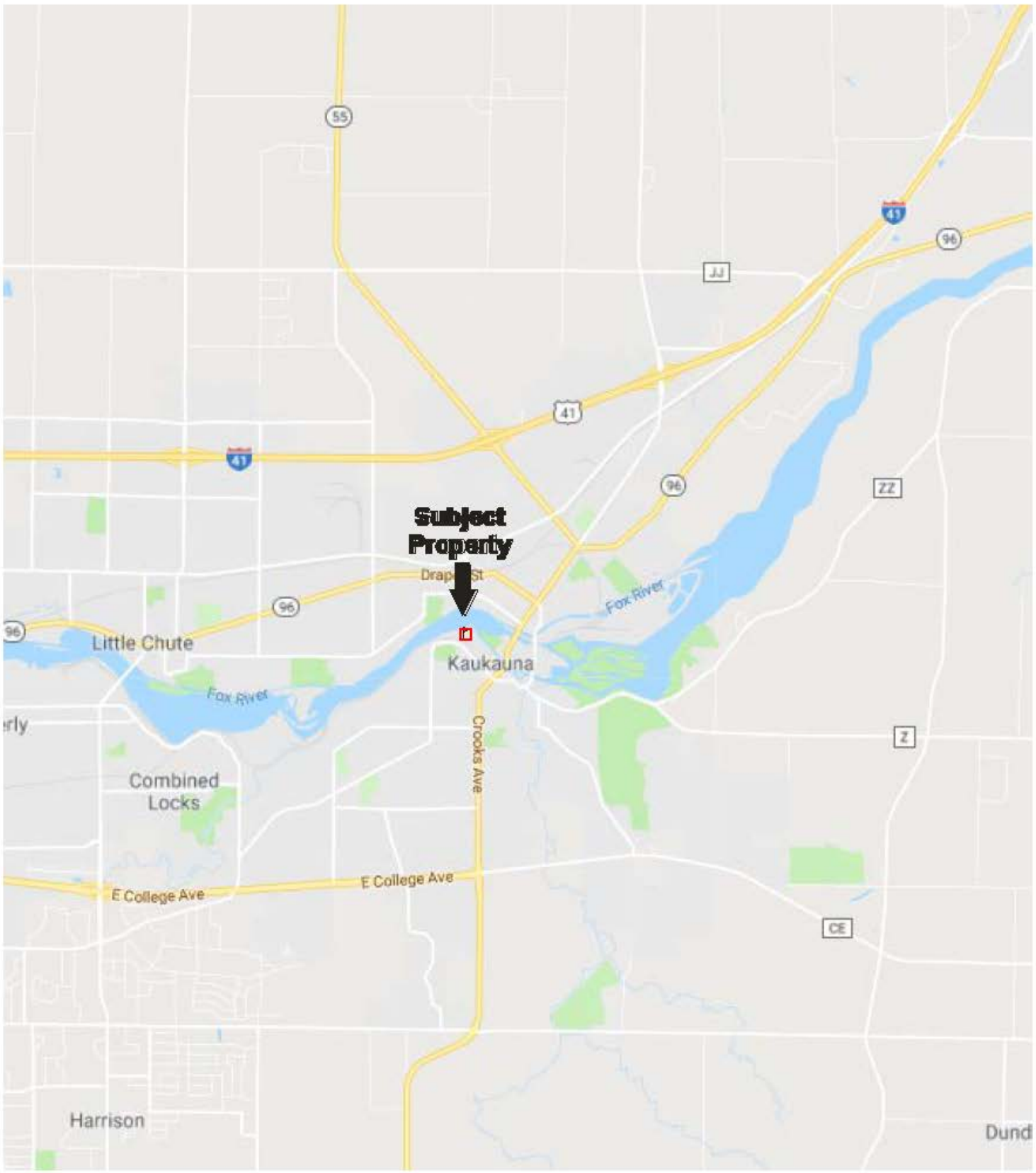
FIGURES

Site Location Map

Site Plan

Topographic Map

PARTNER



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Drawing Not To Scale

KEY:
Subject Property

FIGURE 1: SITE LOCATION MAP
Project No. 18-215232.1

PARTNER



FIGURE 2: SITE PLAN
Project No. 18-215232.1

PARTNER



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USGS 7.5 Minute *Wrightstown/Kaukauna, WI* Quadrangle
Created: 2013

KEY:
Subject Property

FIGURE 3: TOPOGRAPHIC MAP
Project No. 18-215232.1

PARTNER

APPENDIX A: SITE PHOTOGRAPHS

PARTNER



1. Property identification signage



2. Front elevation of a Fox Shores apartment building



3. Rear (riverside) elevation of a Fox Shores apartment building



4. Exterior of a Bicentennial Court apartment building



5. Rear exterior elevation of a Bicentennial Court apartment building with view of patios and balconies



6. Bicentennial Court garage



7. Fox Shore garages



8. Maintenance shop n a Fox Shore garage bay





9. Maintenance shop



11. Garage bay

10. Maintenance shop paint storage area



12. Trash dumpster enclosure



13. Landscaping along the Fox River



14. Dwelling unit electric baseboard heating



15. Dwelling unit through-wall AC unit



16. Dwelling unit electric water heater

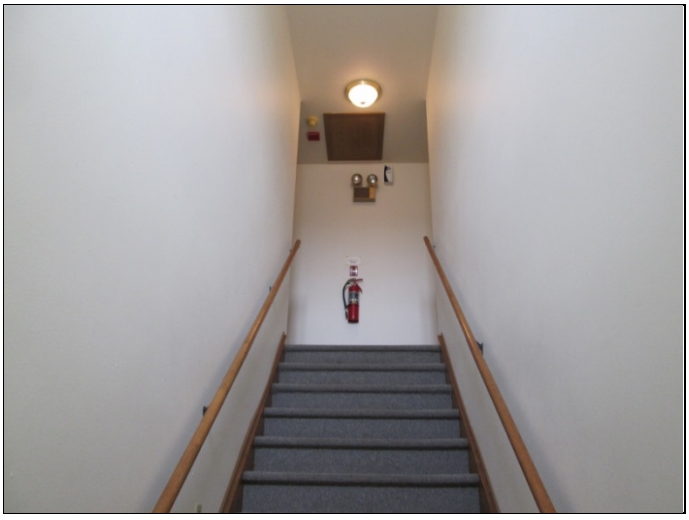


17. Dwelling unit electric baseboard heating



18. Pad-mounted electrical transformers





19. Water softener

20. Fox Shore building interior common 2nd floor access stair



21. Fox Shore dwelling unit kitchen



22. Fox Shore 2nd floor dwelling unit bathroom



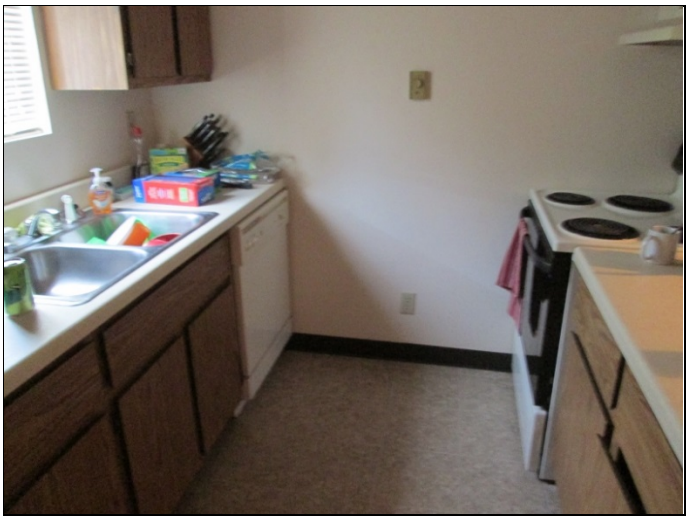
23. Fox Shore dwelling unit living / dining room



24. Fox Shore dwelling unit bedroom



25. Bicentennial Court dwelling unit access breezeway



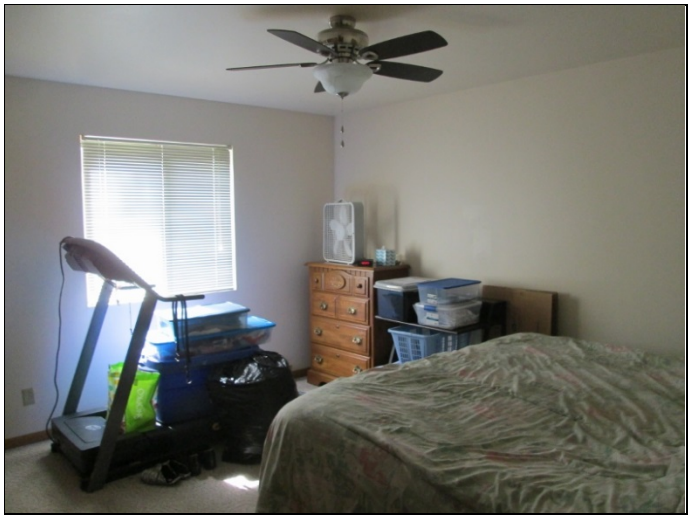
26. Bicentennial Court dwelling unit kitchen



27. Bicentennial Court dwelling unit bathroom



28. Bicentennial Court dwelling unit living room





29. Bicentennial Court dwelling unit bedroom

30. Building attic



31. North adjoining property – Fox River



32. Northeast adjoining property – Water Power Canal



33. East adjoining property – Parking lot (under same owner but is not included in asset)



34. East adjoining property – Fox Shores Drive followed by Ghost Town Fitness (180 Fox Shores Drive)



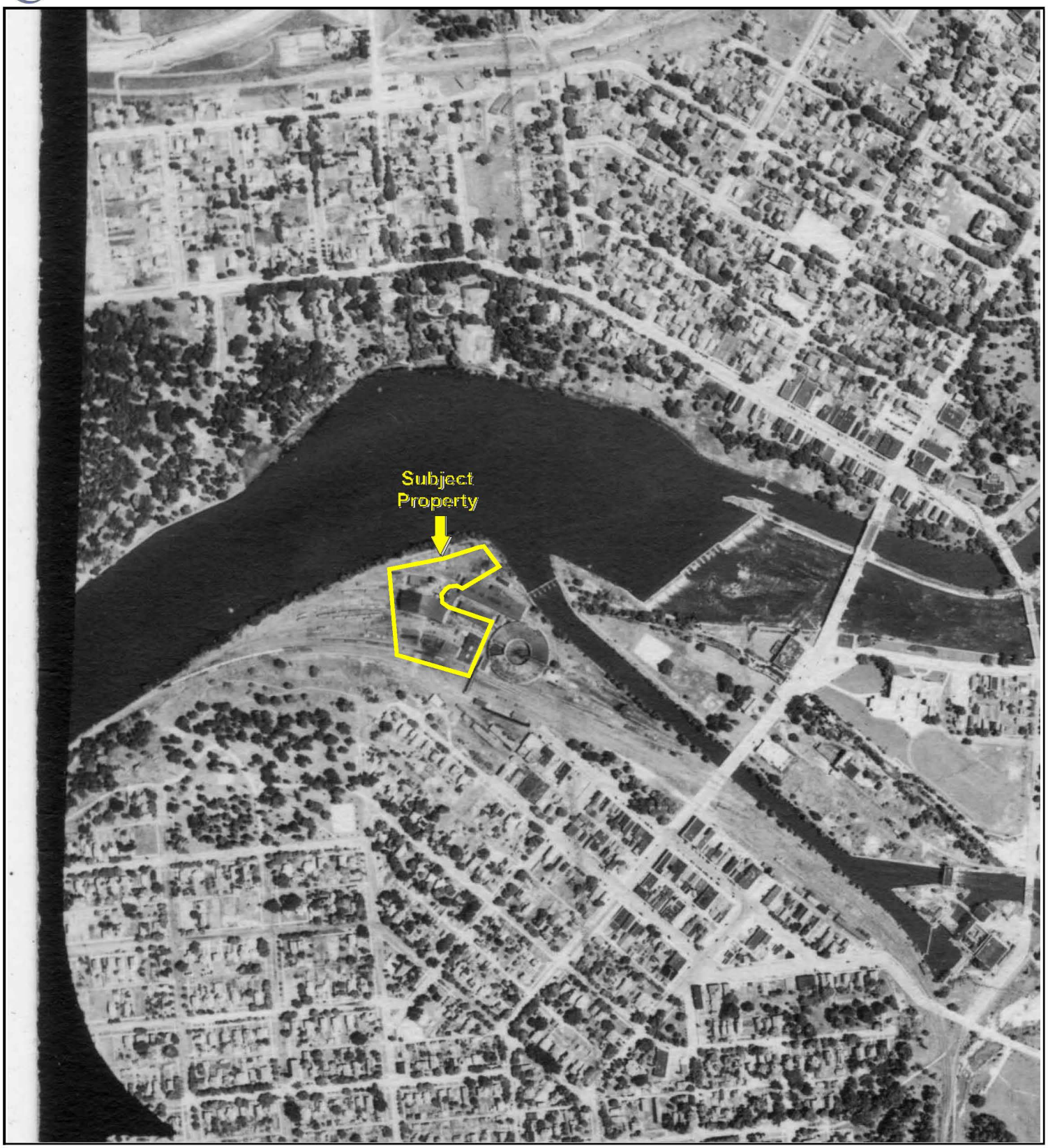
35. South adjoining property – Bicentennial Court followed by the City of Kaukana Street Department maintenance yard (222 W 3rd St)



36. West adjoining property – River Park Place apartment complex (420 Bicentennial Court)

APPENDIX B: HISTORICAL DOCUMENTATION

PARTNER



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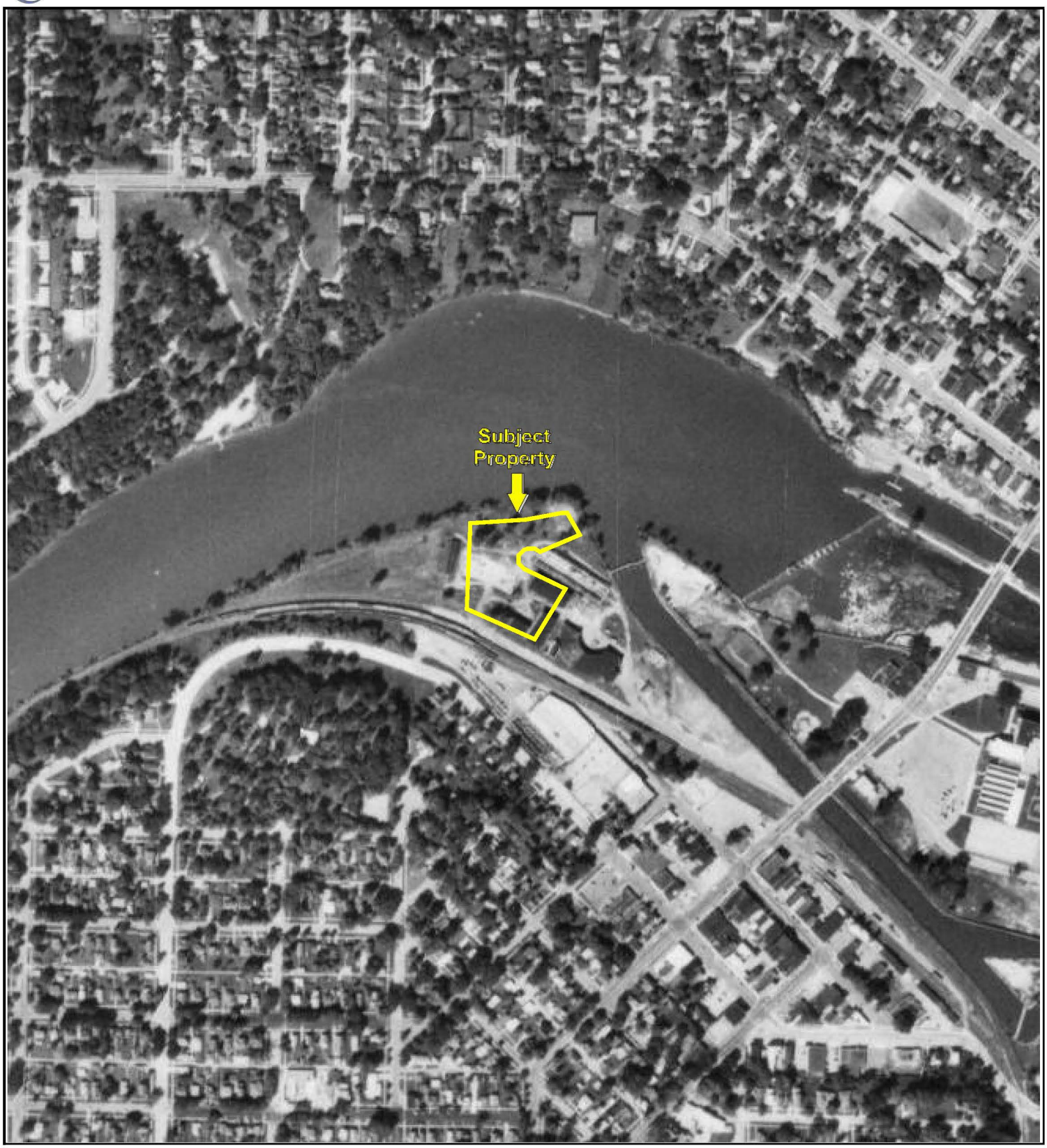

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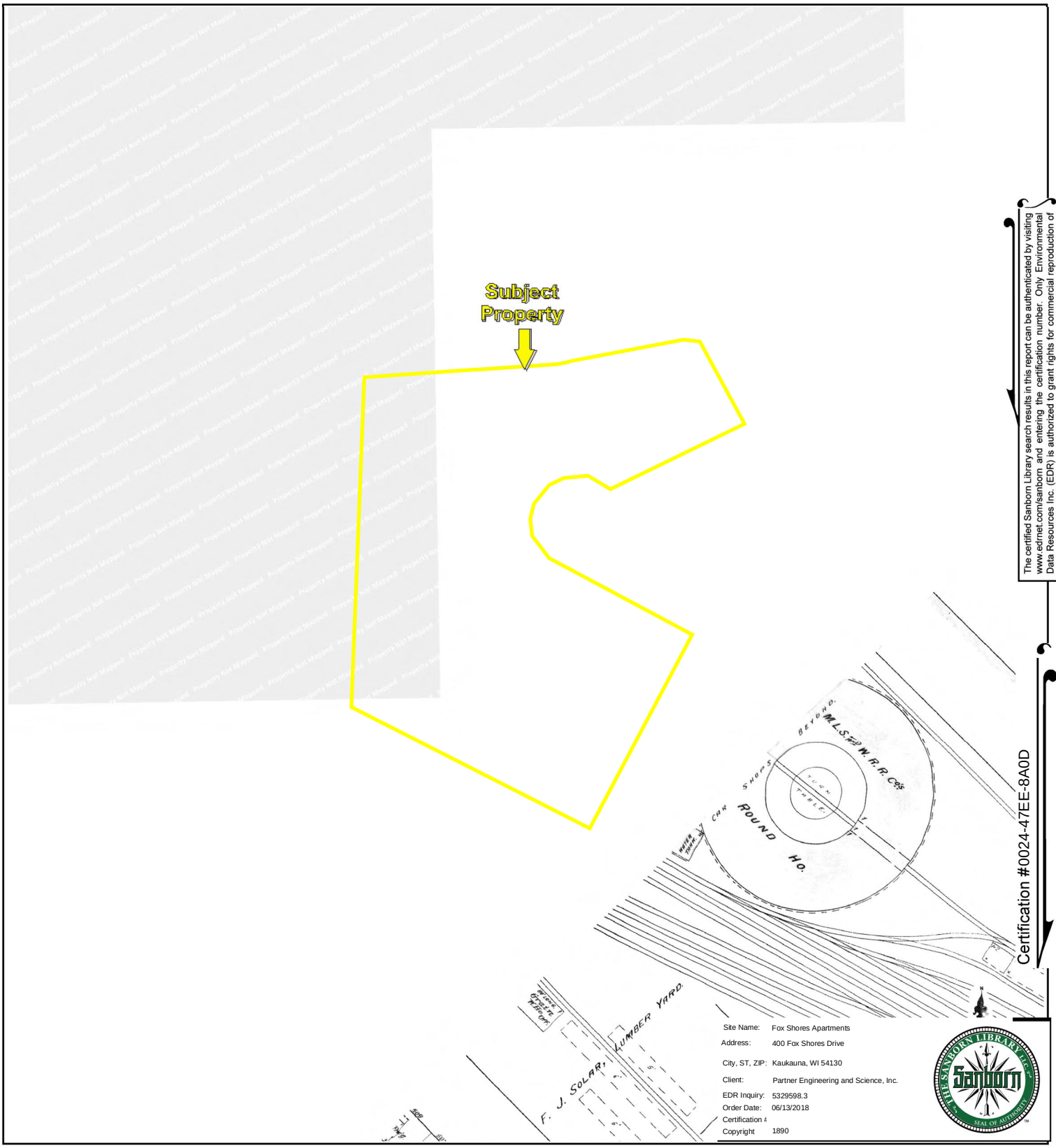

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Volume 1, Sheet 2

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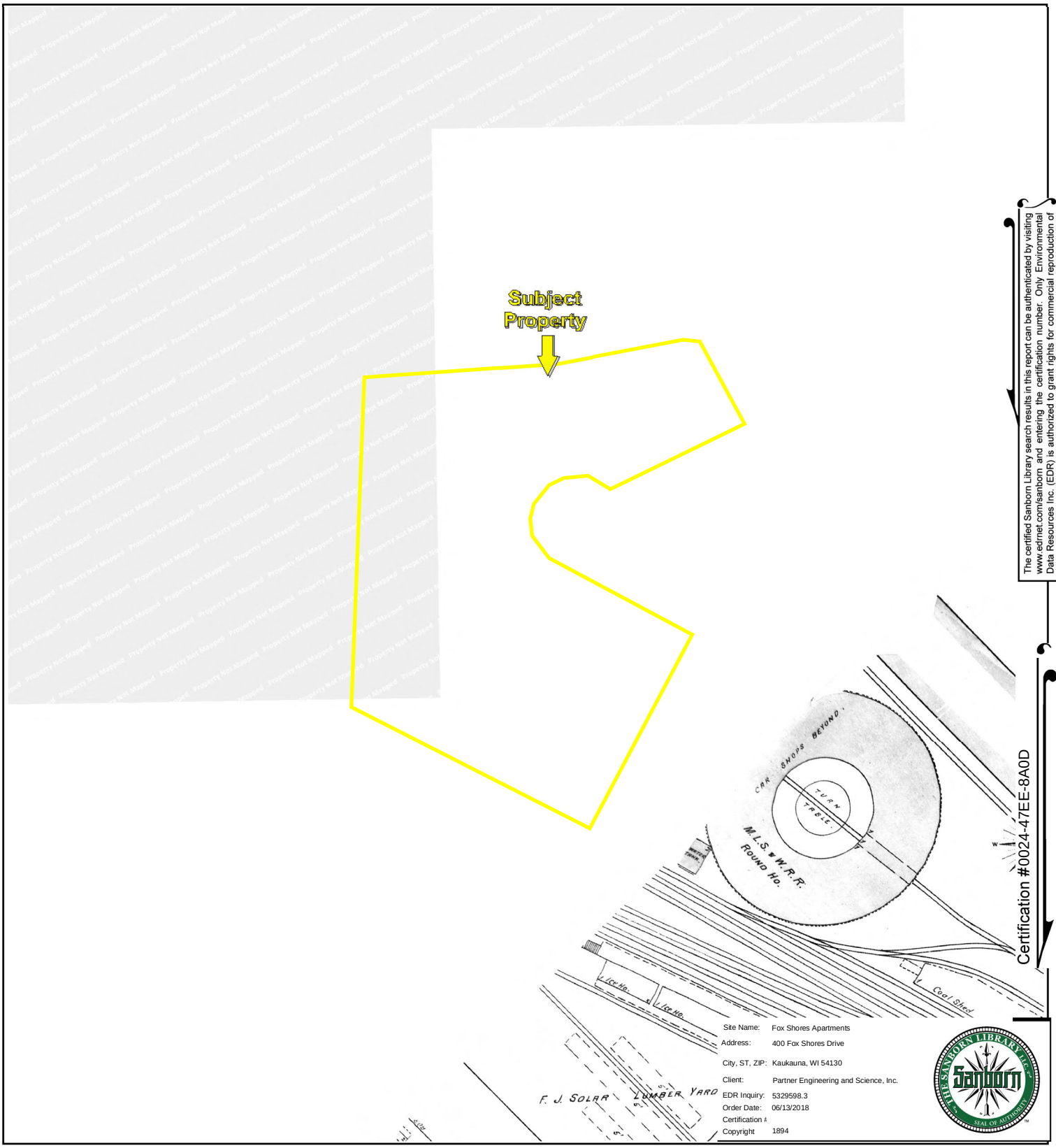

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Volume 1, Sheet 7

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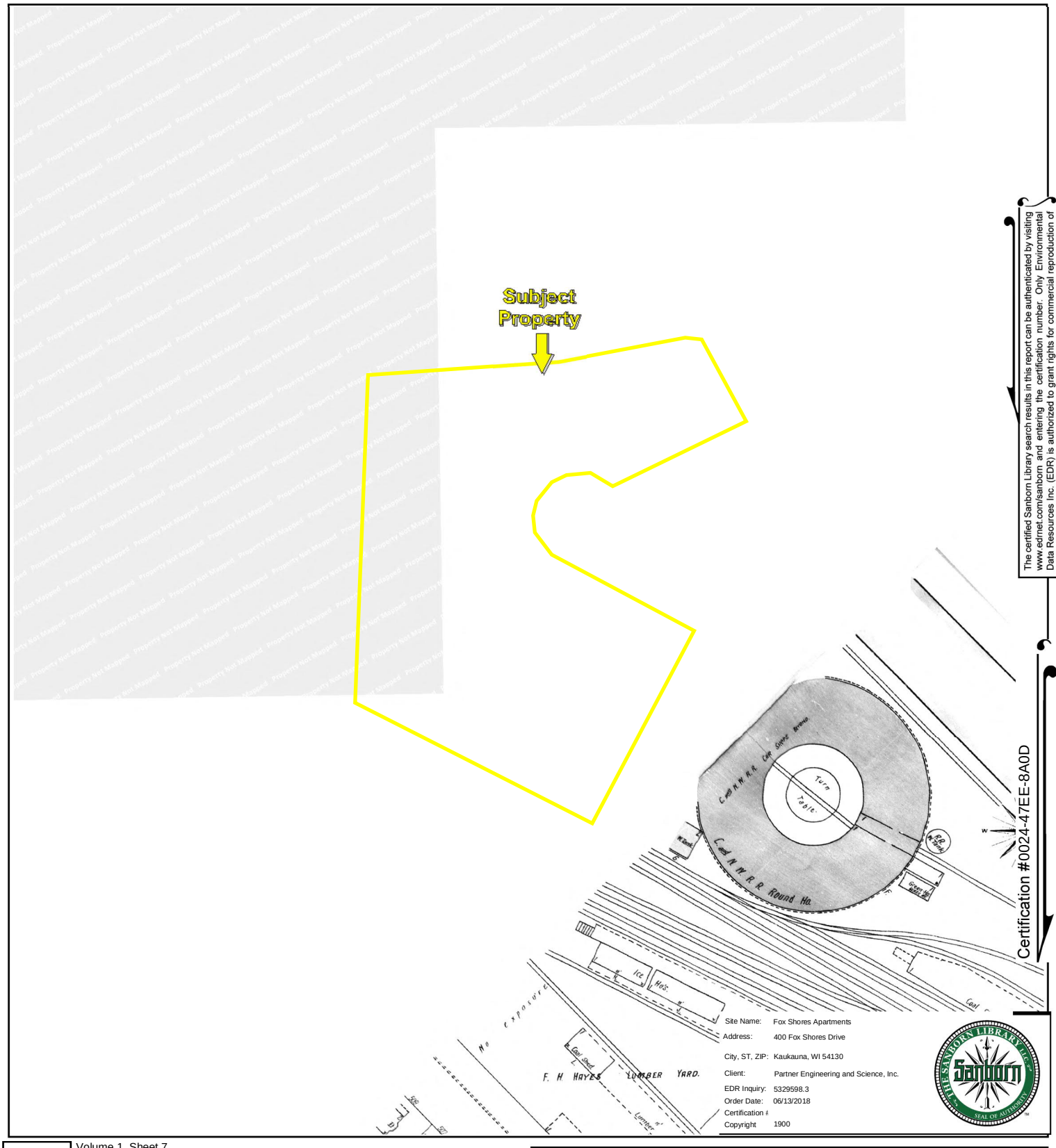

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Volume 1, Sheet 7

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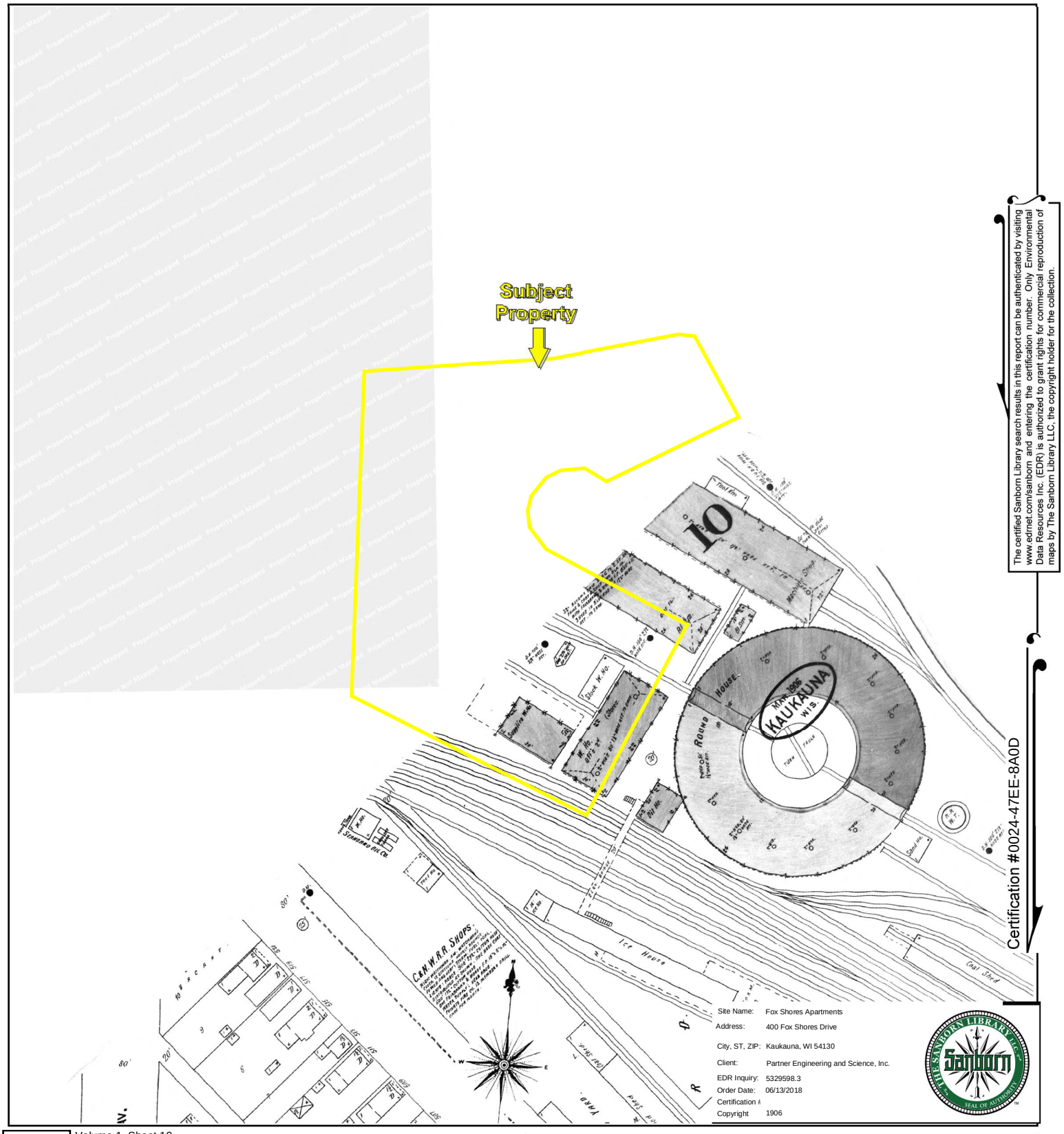

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Volume 1, Sheet 10

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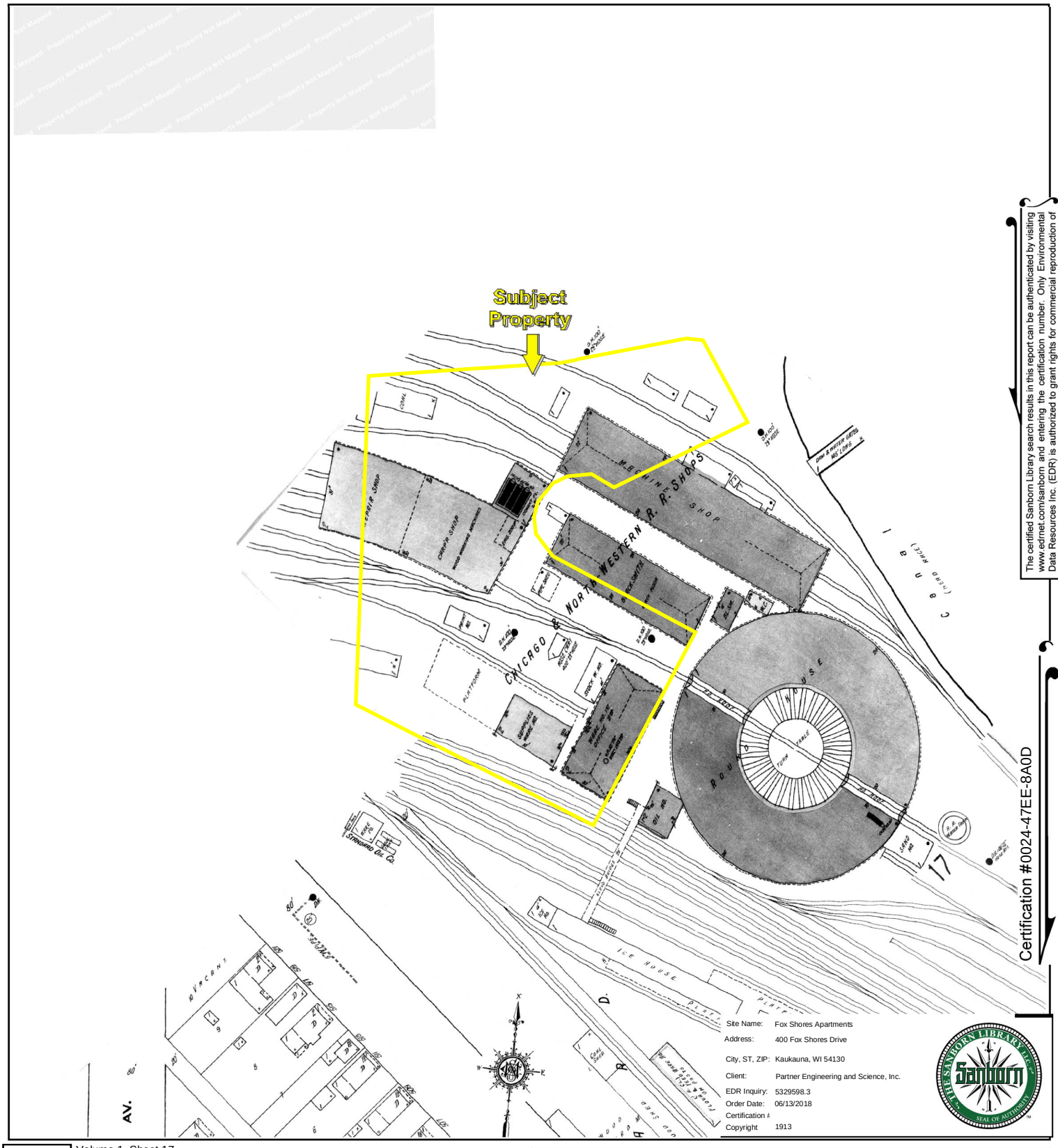

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Volume 1, Sheet 17
Volume 1, Sheet 10

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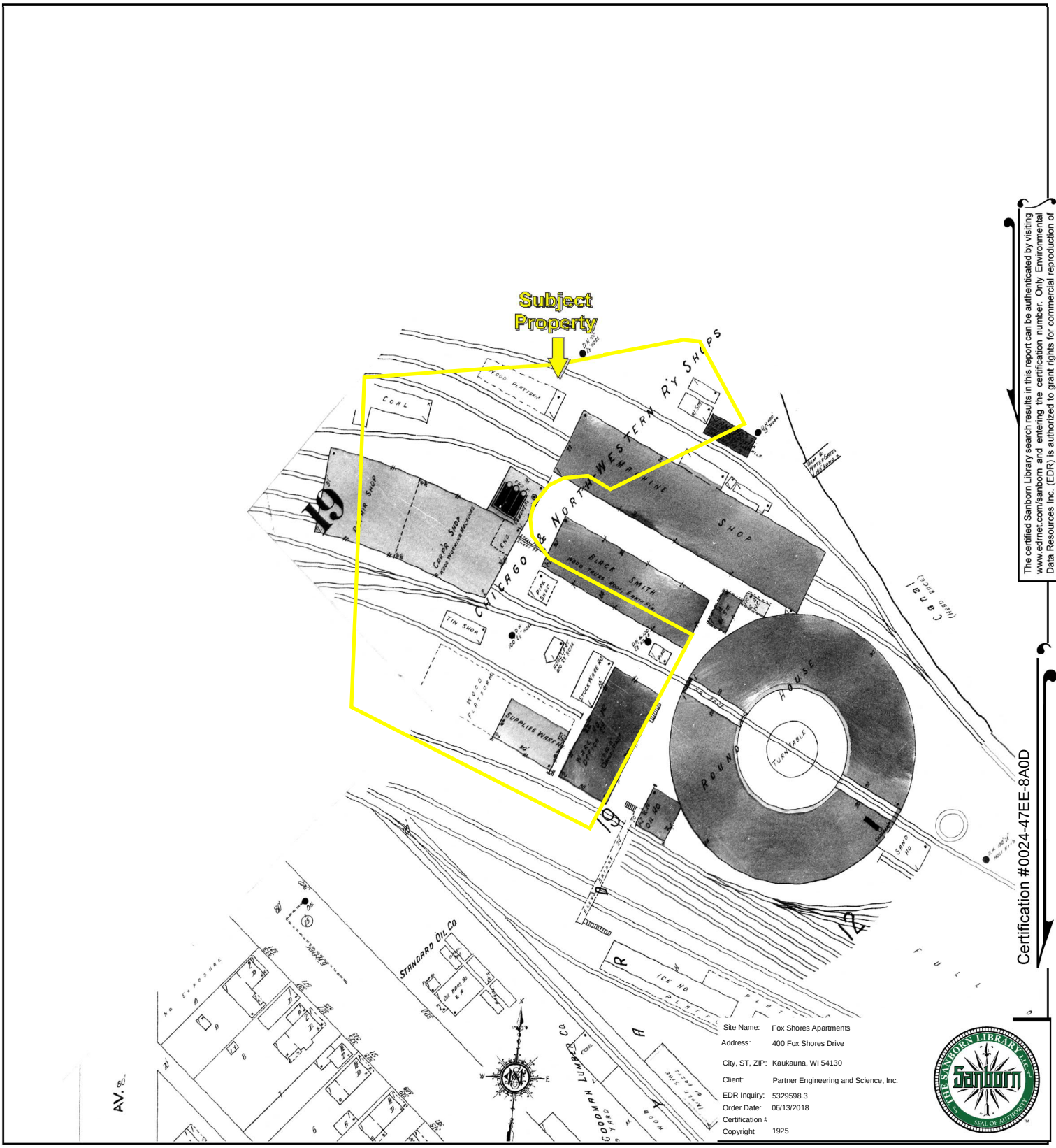
Key: Subject Property



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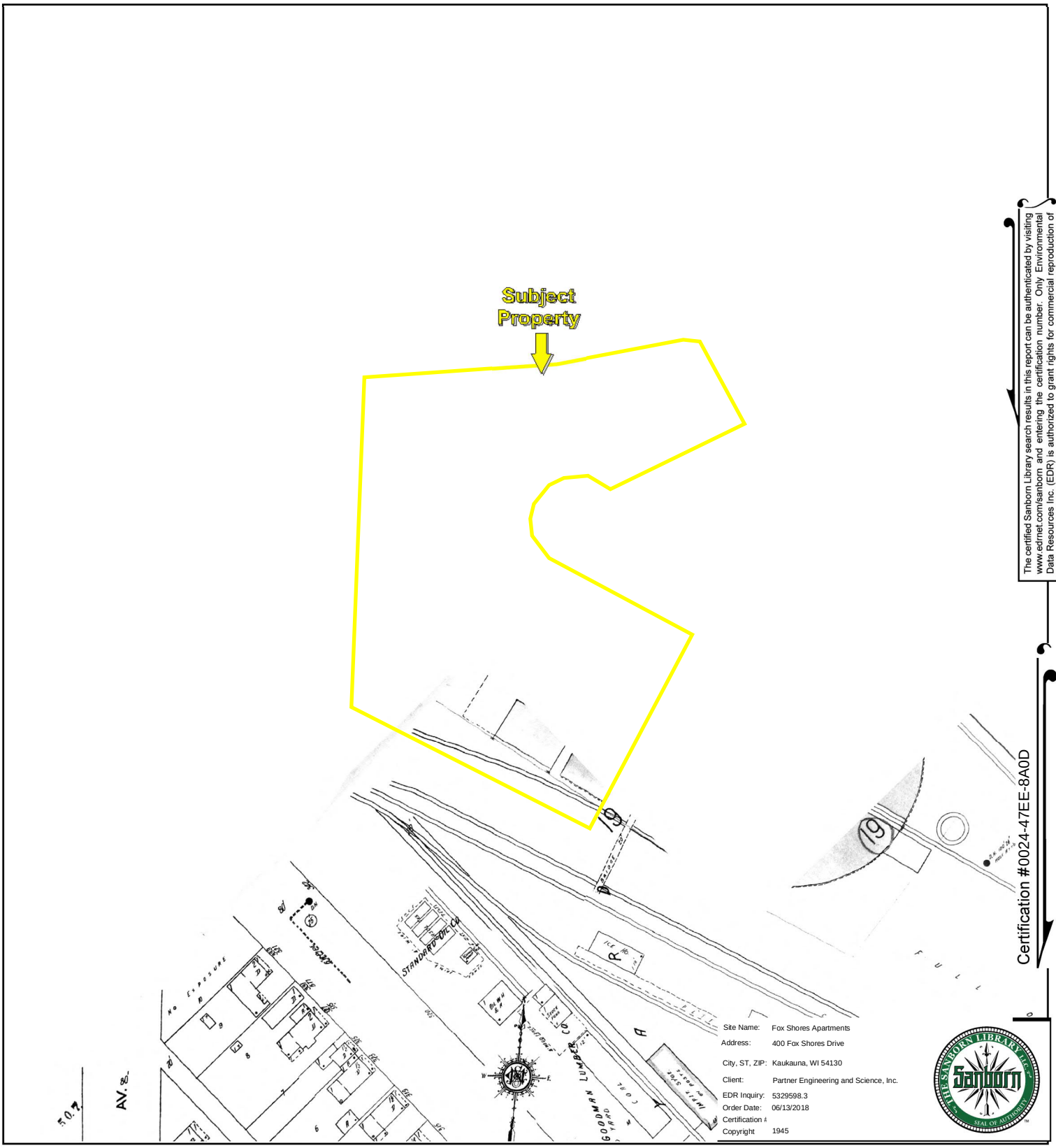
Volume 1, Sheet 19
Volume 1, Sheet 12

0 Feet 150 300 600

Key: Subject Property



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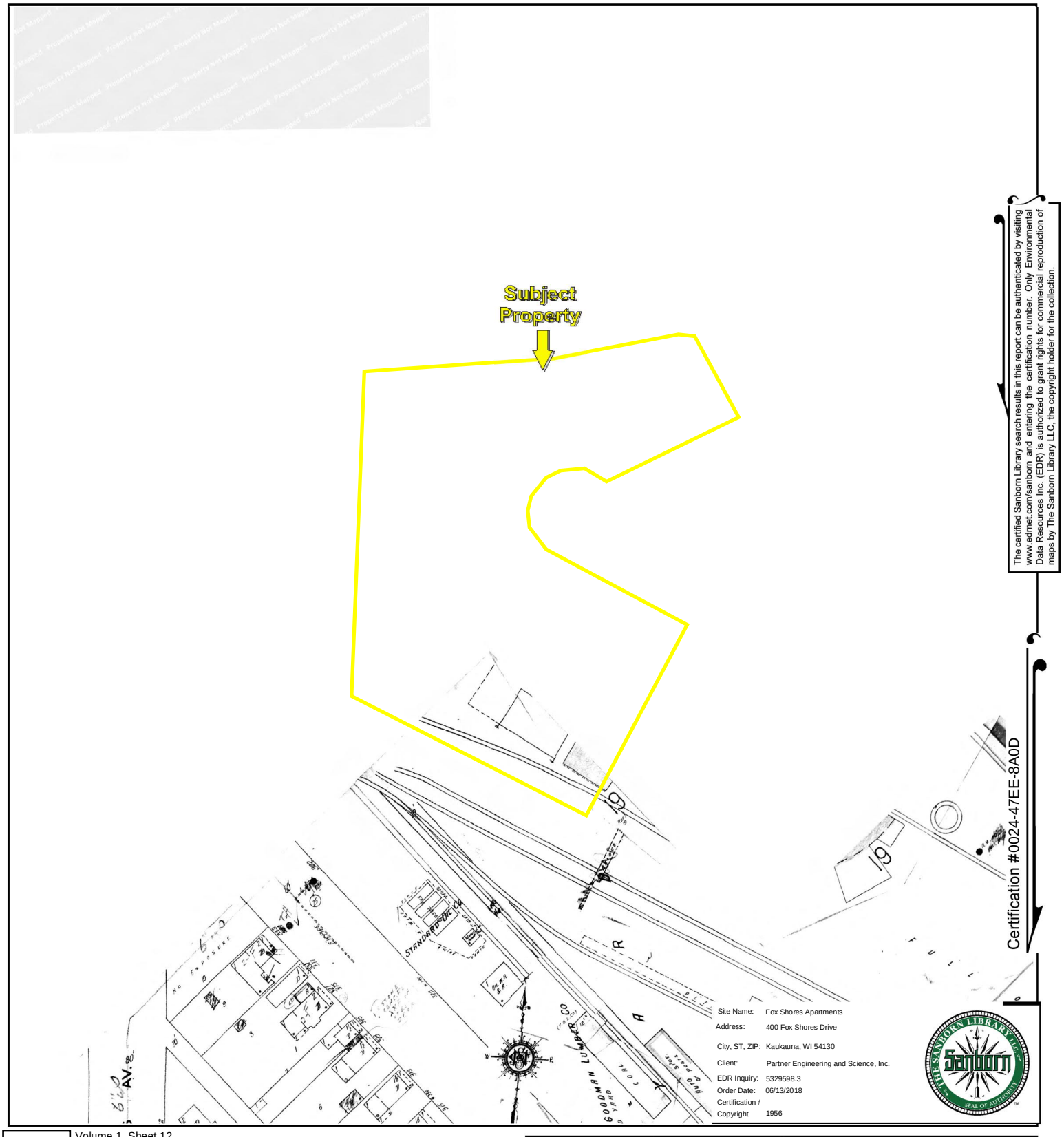
Volume 1, Sheet 12

0 Feet 150 300 600

Key: Subject Property



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Volume 1, Sheet 12

0 Feet 150 300 600

Key: Subject Property

Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, WI 54130

Inquiry Number: 5329598.5
June 14, 2018

The EDR-City Directory Image Report

Environmental Data Resources Inc

6 Armstrong Road
Shelton, CT 06484
800.352.0050
www.edrnet.com

TABLE OF CONTENTS

SECTION

Executive Summary

Findings

City Directory Images

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

DESCRIPTION

Environmental Data Resources, Inc.'s (EDR) City Directory Report is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's City Directory Report includes a search of available city directory data at 5 year intervals.

RECORD SOURCES

EDR's Digital Archive combines historical directory listings from sources such as Cole Information and Dun & Bradstreet. These standard sources of property information complement and enhance each other to provide a more comprehensive report.

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RESEARCH SUMMARY

The following research sources were consulted in the preparation of this report. A check mark indicates where information was identified in the source and provided in this report.

Year	Target Street	Cross Street	Source
2014	☑	☑	EDR Digital Archive
2010	☑	☑	EDR Digital Archive
2005	☑	☑	EDR Digital Archive
2000	☑	☑	EDR Digital Archive
1995	☑	☑	EDR Digital Archive
1992	☑	☑	EDR Digital Archive
1990	☑	☑	Johnson's City Directory

FINDINGS

TARGET PROPERTY STREET

400 Fox Shores Drive
Kaukauna, WI 54130

Year	*CD Image*	*Source*

FOX SHORES DR

2014	pg A4	EDR Digital Archive
2010	pg A8	EDR Digital Archive
2005	pg A12	EDR Digital Archive
2000	pg A16	EDR Digital Archive
1995	pg A21	EDR Digital Archive
1992	pg A25	EDR Digital Archive
1990	pg A27	Johnson's City Directory

FINDINGS

CROSS STREETS

Year	*CD Image*	*Source*

BICENTENNIAL CT

2014	pg. A2	EDR Digital Archive
2010	pg. A5	EDR Digital Archive
2005	pg. A9	EDR Digital Archive
2000	pg. A13	EDR Digital Archive
1995	pg. A17	EDR Digital Archive
1992	pg. A22	EDR Digital Archive
1990	pg. A26	Johnson's City Directory

City Directory Images

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2014

300	ARNOLD, LUCY S
	ARNOLDUSSEN, PATRICIA M
	ASHLEY, MELISSA S
	BARTSCH, TRACY L
	BASSETT, MARLENE R
	BERG, SHIRLEY A
	BOGENSCHUTZ, ALICE H
	BRICCO, PATRICIA J
	CHADWICK, GARY V
	CHADWICK, VIRGINIA K
	COLLINS, RORY
	DEBRUIN, LOIS G
	DEKLEYN, MARY J
	EITING, MARY K
	GIRTS, KIM R
	GRIESE, LINDA J
	HEINRITZ, MARYLYNN L
	JANEIRO, MARYANN
	KINDLE, ANGELA
	LEGAULT, SHIRLEY M
	MALLIETT, MARIE C
	MAYNARD, WANDA D
	MOLITOR, BEVERLY A
	PINGEL, GAYLE
	RADERMACHER, KATHY A
	RICKMEYER, GARY E
	ROUND HOUSE MANOR INC
	SCOTT, JOHN P
	STARNOLD, LUCY K
	TARKET, GERALDINE
	VANDENHEUVEL, JANE M
	VANDENQYNGAAED, JUNE V
	VETTER, SHIRLEY H
	WALTER, CATHY
	WUELLNER, GAIL A
380	BEVER, CRAIG
	FREES, PAMELA A
	HUEBNER, LYNN A
	HUSS, KEVIN L
	HUSS, TRAVIS
	JOHNSON, TONYA J
	TRAHAN, LYNN
390	VERKUILEN, ED
	WHITE, KENNETH J
400	BOUCHE, MICHELLE
	JOHNSON, NANCY M
	LOR, KOUA
	MCGINNIS, PHYLLIS A
	SATTERWAITE, MELISSA
	VANDERWIELEN, NICHOLE

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2014 (Cont'd)

410	DUFRANE, SARA
	MARSICEK, THOMAS A
	MAURITZ, JENNIFER
	NAGAN, MICHELLE D
	SEIBEL, HOLLIE S
	SIENKO, JOSEPH
420	BURHOP, NICOLE
	CHITTENDEN, LLORIEN A
	DEUSTER, KYLE
	GITZ, JOHN S
	JURKSAITIS, JEROME N
	KURTZ, KAREN M
	LAUKO, JOSEPH S
	LEITZKE, COREY
	REISSMANN, KELLI C
	SCHREIBER, KATHLEEN A
	SUPRISE, ASHTEN
440	ABHOLD, RENEE N
	ARNOLDUSSEN, RICHARD N
	DUPRAS, ROB
	EISENSCHINK, DENISE F
	GRIMH, MICHELLE M
	GRISSMAN, MARY J
	HANSON, PETER J
	HERRICK, ASHLEY
	JAEGER, JENNY
	KACZMAREK, LEAH
	KREUZIGER, KENNETH J
	LAMBERT, EILEEN J
	LAUX, STEPHEN J
	OLKOWSKI, LARRY L
	PALMER, PETER R
	SIEBERS, KATHY
500	BORCHARDT, ALAN
	JANSEN, THOMAS C
	JEZESKI, JAMES M
	KUENZL, ANTHONY J
	MEIVES, MARIA A
	SCHIEDERMAYER, LEO M
	SCHUMANN, ROBERT J
	VANGOMPLE, MELISSA
	ZOLD, CATHERINE A
520	CALMES, JOHN H
	KLEIN, CYNTHIA A

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

FOX SHORES DR 2014

180	GHOST TOWN FITNESS CENTER
400	BATHKE, BECKY
	BERKERS, COREY A
	COMERFORD, ROBERT J
	CWIAK, ALOYSIUS J
	KIERSTEN, JAMES P
	PUFALL, TAD A
	ROSIN, TREVOR
	VANDEYACHT, THOMAS
410	BAER, AGNES A
	FELDKAMP, DOLORES A
	FREIER, LAUREN C
	HACKBARTH, KYLE R
	HEISE, SPENCER
	HESS, JULIE A
	LUTHER, NANCY J
	MITCHELL, RANDY E
	RIHN, SARAH
	SCHOMMER, CAROL S

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2010

300	ARNOLDUSSEN, PATRICIA M
	BARTSCH, TRACY L
	BASSETT, MARLENE R
	BODDE, FRIDA M
	BOGENSCHUTZ, ALICE H
	BRICCO, PATRICIA J
	BRUSS, ALICE J
	CARBINE, PATRICIA L
	CHADWICK, VIRGINIA K
	COLLINS, MARGARET A
	CORK, LUELLA M
	DEKLEYN, MARY J
	EITING, MARGARET A
	ERICKSON, MAE
	FREITAG, K
	FRIEBEL, JEROME J
	GALKOWSKI, FLORENCE B
	GRIESE, LINDA J
	HEINRITZ, M L
	JANEIRO, MARYANN
	JENSEN, MARY L
	KINDLE, LELAH G
	LEEDS, LEON
	LEGAULT, SHIRLEY M
	MCGRATH, HILDA H
	MEIDAM, LEORA E
	MILLER, MARION K
	MOLITOR, BEVERLY
	MURRAY, MICHAEL
	OBERMEYER, ELIZABETH C
	ROLLO, MARGUERITE
	ROUND HOUSE MANOR INC
	SCHROEDER, BEVERLY F
	STUCKART, JAMES F
	WALKER, PEARL M
	WIER, RUTH A
	WUELLNER, GAIL A
	YANG, TRUE
	ZWICK, ROBERT G
380	BEAHM, LORENE K
	BREHMER, AMANDA M
	HOLSCHBACH, TONYA J
	HUSS, LINDA J
	SCHMIDT, KAREN
	STOVER, STEPHANIE
	WILLIAMS, KATHY
390	CUMMINGS, NATHAN
	MCGOWAN, HEATHER
	MICKE, HAROLD J
	WEST, BRYAN A

BICENTENNIAL CT 2010 (Cont'd)

390	WHITE, KENNETH J
	WILLIAMS, DEVAUGHN
400	LANKEY, MARC W
	MCGINNIS, PHYLLIS A
	MUTER, DANE B
	SCHILCHER, STEVE
	VANASTEN, CRAIG M
410	ANDERSON, JUDITH L
	KOBS, LISA J
	MARSICEK, THOMAS A
	REETZ, SARA A
	SABALLY, JD
	SAUER, ASHLEY
	STOVER, MARY J
420	ELLIOTT, CHARLES F
	FORSTER, SARAH J
	JANSEN, AMANDA
	KRUAS, BRENDAN
	KURTZ, KAREN M
	LEVISTON, MICHAEL
	LEY, DAN J
	LOEWENHAGEN CHRISTOPHER
	REISSMANN, DONALD E
	ZIBER PETER
440	CASELTON, PAMELA M
	COERPER, MATTHEW
	COERPER, SUSAN K
	DAMRAU, KEVIN J
	GAMMONS, LEAH
	GEIGER, LEANN N
	GRISSMAN, MARY J
	HANSON, PETER J
	KENNETH J KREUZIGER
	KREUZIGER, KENNETH
	LAUX, STEPHEN J
	LEIGHTLEY CHADWICK
	LEIGHTLEY, CHARLES H
	MAAS, MICHAEL
	OLKOWSKI, LARRY L
	PALMER, PETER R
	POPOWICZ, CASSANDRA
	STRENN, DENNIS M
	VANNULAND, JOHN M
	WESLE, SUSANNE D
500	BESSETTE, ASHLEY
	BORCHARDT, EMILY M
	JANSEN, THOMAS C
	KUENZL, ANTHONY J
	MURRAY, W
	PENDERGRAFF, A

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2010 (Cont'd)

500 SCHIEDERMAYER, LEO M
SCHUMANN, ROBERT J
VANDELOO, LEO J
WATKINS, DEBORAH K
520 CALMES, JOHN H
KAHLER, KARLA F

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

FOX SHORES DR 2010

180	GHOST TOWN FITNESS CENTER
400	ANTLY
	BERKERS, COREY A
	BURMEISTER, LYLE D
	COMERFORD, ROBERT J
	DOBRZENSKI, DARCY M
	HAUTALA, KIM A
	JACQUES, JANE E
	JOHNSTON, ANDRZEJ M
	KILLIAN, MICHAEL D
	KILLIANS LAWNSCAPING INC
	MCGOWAN, KENT M
	MEYER, BOB E
	YAEGER, DAVID L
410	BAER, AGNES A
	BETTNER, LANCE
	DOERING, FLOYD J
	FELDKAMP, DOLORES A
	HESS, JULIE A
	HULL, MARJORY L
	JACOBSON, MARJORIE A
	LAMB, MARTHA J
	MITCHELL, RANDY E
	SCHOMMER, CAROL S

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2005

300	AHLEMEYER, FLORA
	ASHLEY, MELISSA S
	ASHTON, HAROLD J
	BARTELS, NORMAN
	BARTSCH, GAIL A
	BENISHEK, AUDERY
	BIESE, MARY
	BOGENSCHUTZ, ALICE H
	BOURASSA, BERNICE M
	BUSSE, ALVINA M
	COLLINS, MARGARET A
	CUMMINGS, CONNIE M
	DECOSTER, DEBORAH A
	DEKLEYN, MARY J
	EITING, MARGARET A
	EITING, THOMAS J
	FRIEBEL, JEROME J
	GRAFMEIER, RONALD
	HUNTER, CRYSTAL
	HUSS, REBECCA A
	JANSSEN, BETTY M
	JENSEN, MARY L
	JOHNSON, JOAN A
	JONES, MERLYN
	LAMERS, JOAN A
	LAMERS, SHIRLEY
	LEGAULT, SHIRLEY M
	LIEBERGEN, EILEEN M
	MADER, MARILYN F
	MCGRATH, HILDA H
	MEIDAM, LEORA E
	MONDRAGON, RAMIRO
	NELSON, EVELYN A
	NETTEKOVEN, LORETTA C
	OBERMEYER, ELIZABETH C
	RETIREMENT HOUSING FOUNDATION
	ROUND HOUSE MANOR INC
	SCHROEDER, BEVERLY
	STILP, BETTY J
	STORCH, MARY M
	TENNESSEN, HELEN T
	THOMPSON, KAYE A
	VANBEEK, STEVEN J
	VANWYK, BERYLE
	WALKER, PEARL M
	WIER, RUTH A
	WITTMAN, ELMER
	ZWICK, ROBERT G
380	HASHAGEN, TANYA M
	HUSS, LINDA J

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2005 (Cont'd)

380	SCHUH, BRIAN J
	THIEL, SHARI S
	VANDERLOOP, DANIEL L
390	ANDERSON, JUDITH A
	BEGROW, AMANDA M
	JAECKELS, JEFF A
	MARTINEZ, OMAR
	MICKE, HAROLD J
	RAI, RAMA
	TESSEN, JOHN
	UWUMARONGIE, GABRIEL
	WEDDE, MARY J
400	ARNOLDUSSEN, PATRICIA M
	LANKEY, MARC
	SCHEURER, BEN
	SEEFELDT, SHIRLEY M
	SMITS, GERALD D
410	KOBS, LISA J
	LACOUNT, LETITIA A
	NAGAN, MICHELLE D
	STOVER, MARY J
420	ANENDROTH, JUDY
	BABCOCK, JEFFREY W
	BARIL, TIFFANY M
	BELONGIN, JOHN
	DOTSON, ANDERSON
	ELLIOTT, CHARLES F
	GOLDAPSKE, JAMES J
	HEUVEL, JOSHUA A
	HULIN, THOMAS W
	KAMPS, KEVIN
	KNOTT, ORVILLE
	KUCHENBECK, ANDREW
	KURTZ, KAREN M
	LABINE, NICHOLAS
	LAFLEX, STEPHANIE
	LEITNER, JUSTIN
	MISCHLER, FRED
	MUSGRAVE, MARK
	OBRIEN, RICHARD W
	ZIBER PETER
440	BAXTER, STEVE W
	BIESE, J
	BLUM, R
	CASELTON, PAMELA M
	DOWELL, SHAWN S
	GARRISON, SHERRIE L
	GRISSMAN, MARY J
	HANSON, PETER J
	HURNING, NANCY

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2005 (Cont'd)

440	KOBS, DAVID C
	LABASH, DAN T
	LAROSS, ERICA
	LAUX, STEPHEN J
	LEVERANCE, MAYLEA M
	LUSARDI, MICHAEL J
	OLKOWSKI, LARRY L
	QUIST, CARYL H
	SARTORI, ELIZABETH
	VANEPEREN, JOSEPH M
	WESLE, SUSANNE D
	ZIBER, PETER
500	BORCHARDT, EMILY M
	FOX, DIANE M
	GIRTON, JEANNE M
	GROGAN, ROBERT S
	KENPAR, KURT
	KUENZL, ANTHONY J
	SCHUMANN, ROBERT J
	VANDELOO, LEO J
	WILLIS, SHELBY
520	ARNOLDUSSE, JOHN
	CALMES, JOHN H
	OTTO, JEFFREY L

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

FOX SHORES DR 2005

180	GHOST TOWN FITNESS CENTER
400	BUSS, JUDY
	CAGLE, JAMES L
	COMERFORD, ROBERT J
	EGAN, LORREEN F
	HAUTALA, KIM
	HIETPAS, JOAN
	HINKENS, CLIFFORD D
	HURST, G S
	JETTON, NICOLE L
	KINNEY, KIRBY G
	KNOEPKE, MATTHEW M
	MARTIN, MISTY M
	PUFALL, TAD A
	REICHL, JENNIFER
	SCHUH, ELEANOR E
410	BAER, AGNES A
	BAY, TOM E
	DOERING, FLOYD J
	FELDKAMP, DOLORES A
	HULL, MARJORY L
	JACOBSON, MARJORIE A
	MITCHELL, RANDY E
	MULLEN, HELEN C
	RADLOFF, VIRGINIA G

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2000

300	ASHTON, HAROLD
	BARTELS, NORMAN
	BENISHEK, CARL
	BEY, ELMYRA
	BIESE, MARY
	BOUCHE, L P
	BRUETTE, KELLY A
	BURNS, M A
	BUSSE, ALVINA
	CARPENTER, ESTHER L
	DECOSTER, DELORES
	DREIER, MARY J
	EITING, LILLIAN G
	EITING, M A
	EITING, T M
	FRIEBEL, JEROME J
	GONDEK, K R
	GRATHWOHL, MAYME G
	HIETPAS, M
	HUSS, REBECCA
	JANSSEN, BETTY
	JOHNSON, J A
	LAMERS, JOAN
	LIEBERGEN, EILEEN
	MARTZAHL, AGNES G
	MCCARTNEY, KATHRYN
	MCGRATH, HILDA
	MEIDAM, LEORA
	NELSON, E A
	NETTEKOVEN, LORETTA
	PITT, LILA
	RACH, BETTY
	RETIREMENT HOUSING FOUNDATION
	SHINABARGER, DOROTHY
	STILP, BETTY J
	STORCH, KENNETH
	TENNESSEN, HELEN
	THOMPSON, KAYE
	VANASTEN, C
	VANASTEN, P R
	VANDERVELDEN, M K
	VANDEVOORT, ROGER J
	VANDYKE, CLETA A
	VANELZEN, EDWARD
	VANWYK, BERYLE
	WAGNER, LAVERNE M
	WALKER, P M
	WIER, RUTH
	WILCOX, EUNICE
380	DILL, BRADY N

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 2000 (Cont'd)

380	HUSS, LINDA
	NIEUWENHUIS, PAT
	PETERS, DEBBIE
	SCHUH, BRIAN J
	SHIELDS, THOMAS P
	STRELCHECK, DAVID T
	VANDERAA, SUSAN
	VANEVENHOVEN, R H
390	ADAMS, DAN
	BLUM, IDETTE K
	GLASHEEN, ROBYN
	HUSS, M
	IDETTE, ADAMS
	JAECKELS, JEFF
	MICHELS, SCOTT
	MICKE, HAROLD J
	PARCZICK, VICKI L
	PAUL, RENEE A
	SCHROEDER, TRAVIS L
	STARY, MATTHEW T
400	SAMP, KELLY M
	SEEFELDT, SHIRLEY
	SMITS, RICHARD T
	WOLDT, GARY
410	BEHRENT, JOHN H
	KAVANAUGH, RAYMOND J
	KOBS, LISA J
	KOESTER, JAMIE
	LAUX, J P
	NAGAN, M
	PEEBLES, JACKIE H
	RECLA, ROBERT
	SIEBERS, JAMES A
420	DEBONVILLE, TOM
	DREGER, MARK W
	DREIER, KATHRYN
	ELLIOTT, C
	GOLDAPSKE, JAMES J
	KEMKES, CASEY J
	KURTZ, KAREN
	LAU, GREG
	MAHLIK, C
	MILLER, APRIL J
	OBRIEN, RICHARD
	OJA, PAUL R
	PETIT, SEAN R
	POSORSKI, PATRICI L
	STRENN, MEGHAN
	WOODS, ERIC
440	BENNETT, ANGELA J

BICENTENNIAL CT 2000 (Cont'd)

440	CHANDLER, ROBBY D
	CHRISTENSEN, DAVID
	GORECKI, S
	GRANBERG, FRANK
	GRISSMAN, MARY J
	HANSON, PETER J
	HERMAN, ANGELA
	HOWEN, CAROL A
	KISSEL, STEVE
	KOBS, DAVID C
	LAUX, STEPHEN J
	MARTIN, LYNN M
	MCFARLANE, JERRY
	MILLER, JOHN A
	OLKOWSKI, LARRY
	RAMSAY, JEFF
	RECLA, ROBERT
	ROYCRAFT, DENNIS L
	SCHERER, DARYL
	SCHREIBER, STEVEN
	SIMPSON, RICK R
	SPRISTER, BETSY
	STASKY, DARYL P
	VANDEWETTERING, DON
	VANKAUWENBERG, HUGH J
	WEILAND, DOROTHY R
500	BARTELS, ROBERT
	BORCHARDT, EMILY M
	CHRISTINE, B
	GILSON, TODD D
	GROGAN, ROBERT S
	JANSEN, JEANNE M
	LANDMANN, PAUL
	MOMBERG, ROBERT T
	NYMAN, DAVID
	PROMER, DICK
	WEBER, ANDREW
	WILLIAMSEN, KRISTEN M
520	ANDREWS, KAREN
	CALMES, JOHN H
	MOERICKE, JEFF
	OTTO, JEFF L

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

FOX SHORES DR 2000

180	EITTING JEFFREY
400	ALF, MARCEDA
	DOLLAR, CHRISTY
	EGAN, L
	GREATENS, CONNIE R
	JUETTEN, FRED A
	KAYE, JUDITH A
	KOBAL, KARL H
	KOHL, DAN J
	SCHOMMER, STACEY
	SCHUH, ELEANOR
	VANDERAA, MARTIN C
401	FELDKAMP, DOLORES A
410	BAER, AGNES
	FELDKAMP, DOLORES A
	HULL, M L
	JACOBSON, M
	MITCHELL, RANDY E
	MULLEN, HELEN C
	SCHMIDT, KAY
	SMITH, BETHANY M
	TREICHEL, MATTHEW

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 1995

300	ASHTON, HAROLD
	BAETEN, FRANCIS A
	BARTELS, NORMAN
	BARTMAN, MARIE
	BEY, ELMYRA
	BIESE, MARY
	BLAESE, RICHARD
	BOUCHE, L P
	BRUSS, G B
	CARPENTER, ESTHER
	COENEN, L M
	DEERING, ERLE J
	DIEDRICH, R M
	DREIER, M J
	EITING, T M
	FIANE, RUTH
	GONDEK, K R
	GRATHWOHL, MAYME G
	HANBY, H J
	HANSEN, B M
	HUSS, R
	JANSSEN, BETTY
	JOHNSON, J A
	KELLER, GERALD
	KENNEY, DON
	KESSLER, RAY
	LEIDER, L
	LIEBERGEN, E
	NELSON, E A
	NETTEKOVEN, L
	PITT, LILA
	POLZIN, ROBERT W
	PRUSYNSKI, CHICO
	RABIDEAU, LAVERNE
	REESE, P M
	RETIREMENT HOUSING FOUNDATION
	SCHROEDER, J K
	SHINABARGER, DOROTHY
	STILP, BETTY J
	TENNESSEN, H
	THOMPSON, KAYE
	THYES, MARIE G
	TISELING, H
	VANASTEN, C
	VANASTEN, ROBERT W
	VANDERVELDEN, M K
	VANDEVOORT, ROGER J
	VANDYKE, CLETA A
	VANELZEN, EDWARD
	WIER, RUTH

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 1995 (Cont'd)

300	WILCOX, EUNICE
380	BARTELS, TRAVIS J
	BRANDT, SALLY
	CLOHESEY, JOHN
	HUSS, LINDA
	LOOK, MARY B
	MOEDE, T H
	RAY, JOSEPH W JR
390	BROOKS, MARK H
	BUCHINGER, ALLAN
	INNEREBNER, BRIAN
	JAECKELS, CHERYL
	KRAFT, KAREN L
	LEMKE, ERIN
	PRESKE, THOMAS
	ROWE, SHANNON
400	BIESE, TIM
	EISCH, C C
	GRAY, TINA
	HURST, CHRIS
	KAMINSKI, KRISTY A
	MERWIN, ANDREW
	MORGAN, MARK S
	SCHROEDER, DONNA
	SIEBERS, GREG
	SMITS, RICHARD T
	VILS, LEE
410	BEHRENT, R C
	GRADY, CYNTHIA
	KARLS, RON
	KOSCH, TIM
	LAMB, THOMAS
	LAUTERBORN, JACK
	LEMKE, LISA J
	NAGAN, M
	SIEBERS, JAMES A
420	BEHRENT, JOHN
	BRANDT, BRENDA
	DEBONVILLE, TOM
	DREGER, MARK W
	FORIS, PAUL J
	GRANT, WILLIAM
	HALME, JEFF
	HAWK, S K
	HEUVEL, KRIS V
	LANDRETH, RANDY
	LEE, C K
	MOEN, JOHN G
	NETTEKOVEN, BRENDA
	SCHNEIDER, SCOTT L

BICENTENNIAL CT 1995 (Cont'd)

420	SENDEK, L
	URBAN, TAMMY
	VANDAALWYK, KEN
	VERKUILEN, DEBRA L
	WOODS, ERIC
	ZVOLSKY, RAY
440	BIRLING, SHARI L
	BORNEMANN, DELBERT E
	BRIEN, PAT
	DANIEL, LINDA
	DOLAN, S
	ERICKSON, KEVIN
	ERIKSON, KEVIN
	FRAHM, STEVE
	GLASHEEN, D W
	GRANBERG, FRANK JR
	HANSON, PETER J
	HEISLER, STACI
	JAROSINSKI, MARVIN
	KATCH, ROBERT JR
	KELLER, K
	KREMER, ROBERT
	KROLL, KEVIN
	LAMERS, TRISHA L
	LAUX, STEPHEN J
	MACAULEY, CYNDY
	MCCABE, DANIEL
	MCFARLANE, JERRY
	OLKOWSKI, LARRY
	OTTO, CORBIN M
	PASSANTINO, CAROLE A
	PETERSON, DAVID L
	PIASECKI, TIM
	POZZA, MARSHA
	RAUEN, SARAH
	REAGLES, DENNIS
	ROMENESKO, DAWN
	ROYCRAFT, DENNIS L
	SCHREIBER, HOLLY J
	SCHULTZ, HAROLD E
	SIKES, AMY M
	UNMUTH, BILL
	VANEPEREN, JOAN E
	VANKAUWENBERG, HUGH J
	VELLELLA, STEVE
	VOET, RAYMOND
	WARNER, RANDY
	WETENKAMP, HEATHER
500	ADKINS, PAMELA S
	GARCIA, JESSE

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 1995 (Cont'd)

500 LEWIS, TRACY
MACQUARRIE, DAVID

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

FOX SHORES DR 1995

180	EITTING JEFFREY
400	ALF, M
	CAGLE, JAMES
	ERDMAN, DAVE
	JUETTEN, FRED A
	KLEIN, CYRIL J
	KOBAL, KARL H
	LEATHERBURY, JOHN H
	MCCABE, K
	MIELKE, C
	MINK ENGINEERING INC
	MINKEBIGE, M
	PETERSON, HEIDI
	SCHUH, E E
	SCHUH, TIM
	SMITH, STEVE R
	WALKER, PEARL
	WATERS, TERRY
410	BAER, A
	DEGOEY, ROBERT J
	DEWITT, JOSEPH P
	JACOBSON, GORDON
	JANSSEN, PAULA K
	KOBUSSEN, WILBERT
	KOSS, MICHAEL C
	LEHRER, PAT
	MERENESS, I D
	NAGEL, JAMES
	SCHMIDT, PHILIP
	SCHOOL, B L
	TREICHEL, FLOYD
	TRINDAL RONALD J TRUCKING
	WEST, STAN
	WIEDENHAUPT, ANNA

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 1992

300	ALLGEYER, MARY J
	BAETEN, FRANCIS A
	BRUSS, G B
	DIEDRICH, R M
	HANSEN, B M
	HEITING, J
	HURST, M
	HUSS, R
	KELLER, GERALD
	REISINGER, D
	ROUND HOUSE MANOR
	SHINABARGER, DOROTHY
	THYES, MARIE G
	TISELING, H
	VANASTEN, C
	VANASTEN, ROBERT W
	VANELZEN, EDWARD
	WILCOX, EUNICE
	WOLF, RUTH F
	WURDINGER, J M
380	JANSEN, TRACY M
	LOOK, MARY
390	HELLESTAD, DAN
	HIETPAS, ALAN J
400	COTTER, S
	PRZYBYLSKI, SARAH M
410	HAESSLY, DAVID J
	LAUTERBORN, JACK
	VANROSSUM, KENNETH SR
420	DEGROOT, C
	DREGER, MARK W
	FORIS, PAUL J
	LECKRONE, GARRETT S
	LUDWIG, ANDREA
	LYND, L
	PEETERS, LISA
	PENTERMAN, WENDY
	RAAB, L J
	SEIF, DAN
	VANDEWETTERING, GREG
	VANEPEREN, J
	VERBOCKEL, K
	WENDT, H
440	APPLETON, DAVE
	BARKOW, DAVID L
	BERTRAND, JERRY
	HOFFMAN, JOHN
	HOOYMAN, JEFF
	HUFFAR, M
	KRUEGER, STEVE

BICENTENNIAL CT 1992 (Cont'd)

440	LAPLANT, DAVE
	LAUX, STEPHEN J
	LEICK, JEFFREY P
	LOOKER, TARI
	MACAULEY, CYNDY
	SIX, DEBRA
	WEIDMAN, JOHN P
3801	HUSS, LINDA
3806	RAY, JOSEPH W JR
3901	PARKER, LR
3904	FREDERICKSON, KURT
3908	VOET, ROBERT M
4003	MULVANEY, CARIN H
4004	NAGAN, M
4006	FRASSETTO, GARY
4008	SMITS, RICHARD T
4101	RASMUSON, CARLENE
4102	SIEBERS, JAMES A
4104	LEMKE, LISA J
4105	SWENTOR, MARY
4203	BLUMREICH, JAMES
	KATCH, ROBERT JR
4204	CURRIE, S
	DEGOEY, ROBERT J
4205	ASHBECK, JAMES
4207	INNEREBNER, BRIAN
4208	KARGUS, KRAIG
	KARLS, RON
	VOET, RAYMOND
4402	GIBSON, K
	PIEPER, THOMAS A
4404	REICHEL, E M
4405	SANDERFOOT, JEAN
44007	BORNEMANN, DELBERT E
44012	JONES, RANDY L
	LINZMEYER, S
44016	GRANBERG, FRANK JR
44025	LENNERT, GINA
44026	EGER, ROBERT C
44029	OLKOWSKI, LARRY
44031	KRUSE, DANIEL
	WEBER, RANDY
300102	DREIER, M J
	KENNEY, DON
300104	FIANE, RUTH
300109	JOHNSON, J A
300110	LIEBERGEN, E
300111	WIER, RUTH
300113	GARZ, ERWIN F
300115	VANDEVOORT, ROGER J

Target Street	Cross Street	Source
-	✓	EDR Digital Archive

BICENTENNIAL CT 1992 (Cont'd)

300116 WOODS, MIKE
300117 REESE, PAULA M
300119 ASHTON, HAROLD
PELKY, PENNY
300123 NELSON, E A
300201 PITT, LILA
300202 NETTEKOVEN, L
300204 BLAESE, RICHARD
300206 RABIDEAU, LUCILLE
300207 KESSLER, CARL F
KESSLER, RAY
300209 HANBY, H J
300210 GLASNAP, WILLIAM J
300215 THURK, DANIEL L
300216 PRUSYNSKI, CHICO
300219 JANSSEN, BETTY
300222 HEINDEL, AGNES
300223 HEIN, FRED
300225 VANDERVELDEN, M K

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

FOX SHORES DR 1992

180	PHYSICALLY FIT
400	ALF, M
410	BORCHERT, ANGELA
	FELLER, HAROLD P
	JACOBSON, GORDON
	JACOBSON, KAREN
	KRUG, MICHAEL M
	PAHL, K
	SANDHAR, HARJIT
	TREICHEL, FLOYD
	TRINDAL RONALD J TRUCKING
	TRINDAL, RON
	VAUBEL, JOAN
	WYMAN, D

BICENTENNIAL CT 1990

817 ZAHN Bertha E®.....766-1770
902 ERDMANN Nancy®.....766-1400
902 KNOT Dennis 766-1400
902 WYNGARD Jamie 766-1400
905 VANDERA Martin C® 766-5973
1005 FENSKE Marlin Mrs®.....766-1967
1008 UNITED STATES GOVERNMENT OF.....766-3531
1008 WISCONSIN STATE OF 766-9098
1013 WUYTS Sally A.....766-7956
1017 WUYTS Robert G®.....766-2818
1021 WUYTS Jack D®.....766-1973
1025 BARTELS Norman 766-4800
1025 BARTELS William®.....766-4800
1029 GAGNOW Robert S®.....766-5681
1111 VERHAGEN David J®.....766-3801
1111 VERHAGEN David Jr.....766-3801
1111 VERHAGEN Kevin 766-3801
1313 GRIGNON MANSION 766-3122
1313 OUTAGAMIE CTY GRIGNON MANSION 766-3122
1700 GANZYK E®.....766-5557
1901 JONES R R®.....766-1384
2000 JONES Marvin R®.....766-4425
2000 JONES Reid M 766-4425
2005 KOCH David A®.....766-7002
2016 DUNN Gary A.....766-4972
2016 GEARY Edyth F® 766-4972
2020 No Information
2059 LEMKE Shelby 766-4357

BADGER RD

NE CURVING E FROM DELANGLADE ST TO E HYLAND AV, 5 NW OF LAWE ST ZIP CODE 54130

1151 VALLEY SPAS & TUBS 766-1447
1151 WAYNE'S WOOD STOVE SALES INC.....766-1447
1601 BELL-BILT MANUFACTURING INC.....766-9622
2000 SCHUH TRANSPORT 766-7733
2100 SAFETY KLEEN CORP 766-4266

BANK AV

E THEN SE FROM HWY 55 TO COUNTY TRUNK HWY S, 5 N OF GREINER RD ZIP CODE 54130

No listings on this street

BEL AIR CT

N FROM W 7TH ST TO DEAD END, 6 W OF MAIN AV ZIP CODE 54130

501 WILLIS Robert D®.....766-9370
504 (res)BREITBACH R E DC®.....766-3490
505 SEIFERT LeRoy W®.....766-2735
508 LENZ Gregory®.....766-9628
601 EISCH Dennis J®.....766-7011
604 KRONFORST Gene A®.....766-3275
606 SANDERS Barbara M®.....766-5930
609 BALL Joseph N®.....766-7360

BELL CT

NE FROM ELK LN TO DEAD END, 1 SE OF COUNTY TRUNK HWY E ZIP CODE 54130

11889 No Information
11892 VANOEHEY Nicholas®.....788-4364
11899 SCHUH James L®.....788-9603
11905 ARCAND Jeff 788-4651
11905 ARCAND Roger A®.....788-4651
11905 ARCAND Scott A 788-4651
11912 STICHA Kenneth R®.....788-4972
11916 No Information
11918 ZULEGER David L®.....788-9525
11921 VANDEHEI Richard R®.....788-5046
11922 COLLAR Stephen P®.....788-9211
11922 COLLAR Susan 788-9211
11925 COLWELL Frank A®.....788-9647

BICENTENNIAL CT

NW FROM REAUME AV TO DEAD END, 1 NE OF W 2ND ST ZIP CODE 54130

300 ROUND HOUSE MANOR INC.....766-2233
300 DIEDRICH Ruth M 766-4191
300 GLASNAP William J 766-4534
300 GREMORE Carl H 766-0409
300 HUSS Ruth A 766-4321
300 PITT Lila 766-3951
300 REISINGER D.....766-3823
300 VandeVOORT Roger J 766-0822
300 WULGAERT Louise M 766-2094
300 (#101)ASHTON Harold.....766-0711
300 (#102)No Information
300 (#104)FIANE Ruth.....766-7576
300 (#105)THYES Marie G.....766-9689
300 (#106)HEITING Josephine M.....766-3443
300 (#107)JANSSEN Betty.....766-0770
300 (#109)JOHNSON J A.....766-3455
300 (#110)LIEBERGEN Eileen M.....766-3393
300 (#111)WIER Ruth.....766-9723
300 (#112)ALLGEYER Mary J.....766-4431
300 (#113)GARZ Erwin F.....766-3847
300 (#114)No Information
300 (#116)WOODS Michael.....766-5857
300 (#117)REESE P M 766-5641
300 (#118)KENNEY Don Mrs.....766-1136
300 (#120)HANSEN Blanche M.....766-3714
300 (#121)SHINABARGAR Dorothy E 766-5966
300 (#122)VANASTEN C.....766-2533
300 (#123)NELSON E A.....766-4444
300 (#125)VanELZEN Edward.....766-7214
300 (#202)LOM Helen M.....766-9685
300 (#203)MILLER Marie H Mrs.....766-5259
300 (#204)BLAESE Richard Mrs 766-0059
300 (#206)RABIDEAU L L.....766-3320
300 (#207)KESSLER Elizabeth.....766-3071
300 (#208)TISELING Helen M.....766-7146
300 (#209)HANBY H J.....766-7498
300 (#212)VANASTEN Patricia R 766-0495
300 (#215)AWISHUS Phyllis A.....766-7028
300 (#216)PRUSYNSKI Chico 766-7660
300 (#217)BAETEN Francis A Mrs.....766-2943
300 (#218)WOLF R F 766-1178
300 (#220)KESSLER Antonette.....766-1709
300 (#222)McDANIEL Gertrude M.....766-7678
300 (#223)KRUEGER Irene G 766-1004
300 (#224)BRUSS Gloria B.....766-9558
300 (#225)VANDERVELDEN Margaret Kohl 766-1681
300 (#227)VANSCHYNDEL E M.....766-9075
380 BARTELS Paula 766-2275
380 JANSEN T M 766-0499
380 LEON William J 766-7719
380 LOOK Mary B 766-9087
390 BIESE Sally 766-3028
390 CHANDLER Kim D.....766-9022
390 DELROW Judy.....766-7477
390 GEURTS Randy 766-3028
390 HELLESTAD Dan J 766-1729
390 JACOBSON Karen 766-9022
390 (#3C)HOFFMAN Barry.....766-1522
390 (#3C)LeROY Lisa.....766-1522
390 (#8C)VOET Robert M.....766-3481
400 FRASSETTO Gary J.....766-7993
400 (#2)PRZYBYLSKI S M.....766-2505
400 (#3)VandenHEUVEL Dave.....766-2199
400 (#4)ASHAUER Douglas.....766-1517
400 (#4)NAGAN Michelle 766-1517
400 (#5)COTTER Shirley M 766-2440
400 (#8)SMITS Richard T.....766-1081
400 (#16)GRANBERG Andy O 766-3834
404 No Information
410 HAESSLY David J 766-2599
410 (#2)SIEBERS James A.....766-3302
410 (#3)LAUTERBORN Jack.....766-0732
410 (#4)LEMKE Lisa J 766-9486
410 (#6)No Information
420 BRITTEN Kenneth J.....766-7826
420 FORIS Paul J 766-3579
420 KATCH Robert A Jr 766-4286
420 RAAB L J 766-7729
420 (#1C)ANDREINI Lisa.....766-7053
420 (#1C)ERICKSON Dale.....766-7053
420 (#5A)HILL Susan J.....766-3386
420 (#5C)No Information
420 (#8B)VOET Raymond 'Pork'.....766-1897
440 LeMAY Cherri C 766-7945
440 NAGAN Dan 766-7609
440 PINTAR D 766-7790
440 WEBER Randy J.....766-7945
440 (#2)PIEPER Thomas A.....766-4167
440 (#3)RICHTER Robert.....766-3368
440 (#4)JAHNKE Allan L.....766-1274
440 (#5)SANDERFOOT Jean.....766-0475
440 (#7)BORNEMANN Delbert E.....766-2696
440 (#11)CAUSEY Clifford W.....766-0291
440 (#11)SIX Debra A.....766-0291
440 (#12)HEIN Fred 766-1976
440 (#13)No Information
440 (#16)GRANBERG Frank Jr.....766-3834
440 (#19)WEIDMAN John P.....766-9537
440 (#20)No Information
440 (#23)JANSSEN Bill D.....766-7934
440 (#25)BAKER Patrick J.....766-0406
440 (#28)HILL Richard C.....766-2279
440 (#29)BIESE Sara.....766-0037
440 (#29)LANDREMAN Vicki L.....766-0037
440 (#32)GEROMANN Jeff L.....766-0366

BIRCH TRL

N FROM COUNTY TRUNK HWY S TO OEAD END BEYOND MALLARD LN, 1 W OF HWY 55 ZIP COOE 54130

11268 BROCKMAN Gary®.....788-9313
11300 STURM Steve®.....788-6796
11325 FEISTEL Dennis L®.....788-3790
11325 FEISTEL Greg L.....788-3790
11325 FEISTEL Stacy M 788-3790
11332 VANDENBERG Terry J®.....788-4663
11357 LEIGH Paul G®.....788-6979
11364 HAEN Darrel D 788-7110
11364 HAEN David B®.....788-7110
11396 BOWERS David D®.....788-6960
11421 JANKOWSKI Daniel K®.....788-6895
11428 GREENWOOD Thomas J®.....788-3424
11475 SCHULTZ Robert F®.....788-9656
11476 GOALEY Joseph A®.....788-7279
11509 JOCHMAN Paul®.....788-5040
11510 KEOUGH Irving L®.....788-6173
11550 GONNERING Donald P®.....788-3332

BLACK

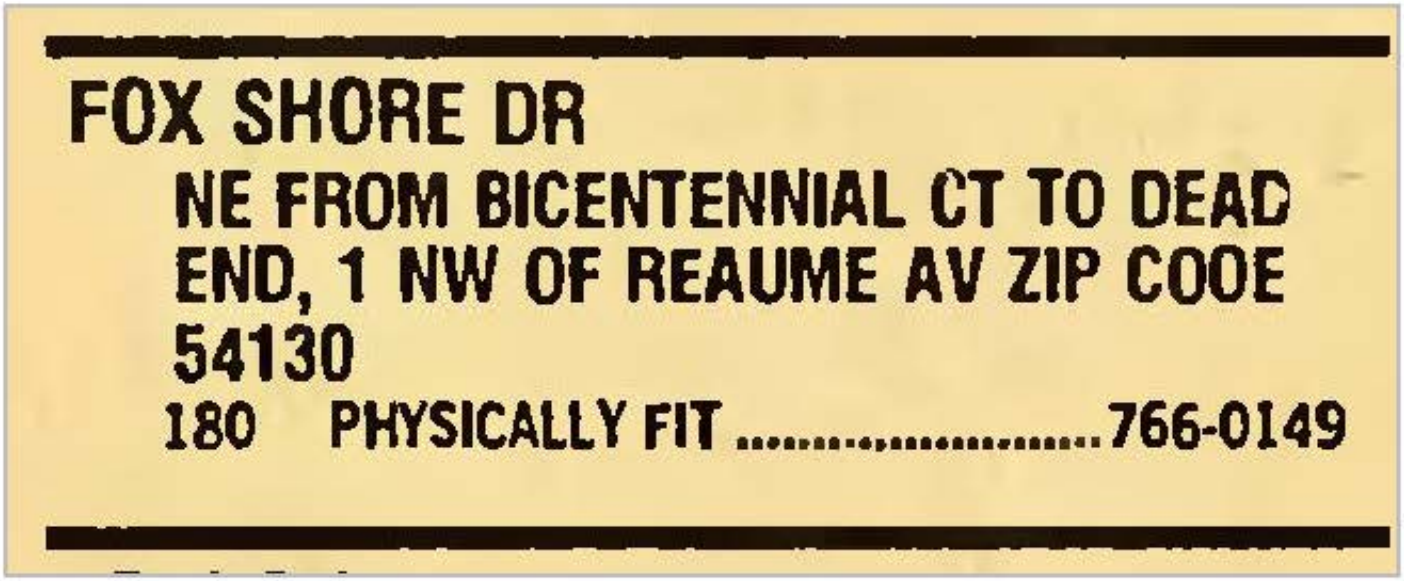
N THEN NE FROM WISCONSIN AV TO HAEN DR, UNOPENED AT RR TRACKS, 8 NW OF LAWE ST ZIP CODE 54130

205 VANDERHEYDEN Henry A®.....766-3493

(Cont)

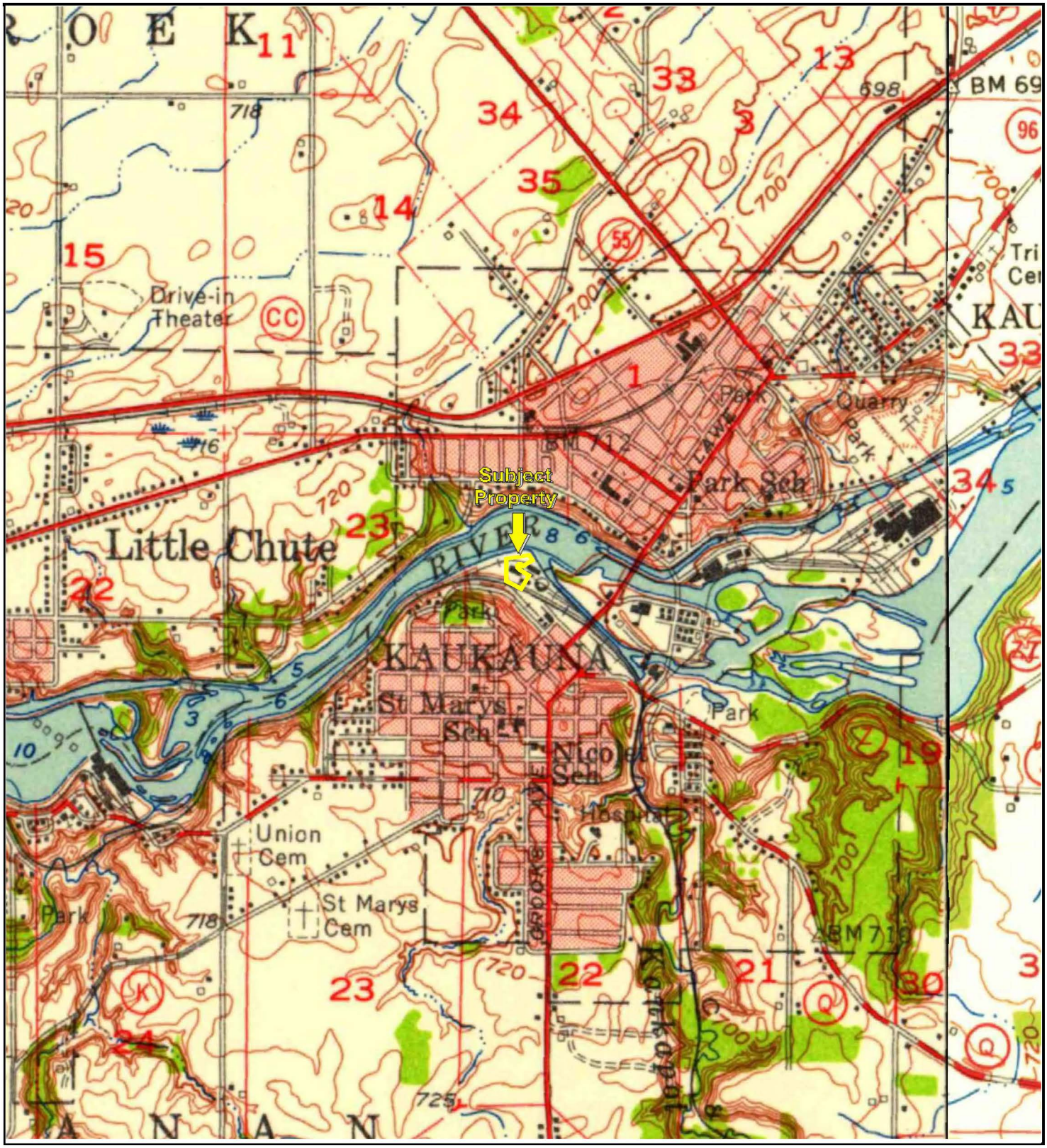
Target Street	Cross Street	Source
✔	-	Johnson's City Directory

FOX SHORES DR 1990


FOX SHORE DR

NE FROM BICENTENNIAL CT TO DEAD END, 1 NW OF REAUME AV ZIP COOE 54130

180 PHYSICALLY FIT 766-0149

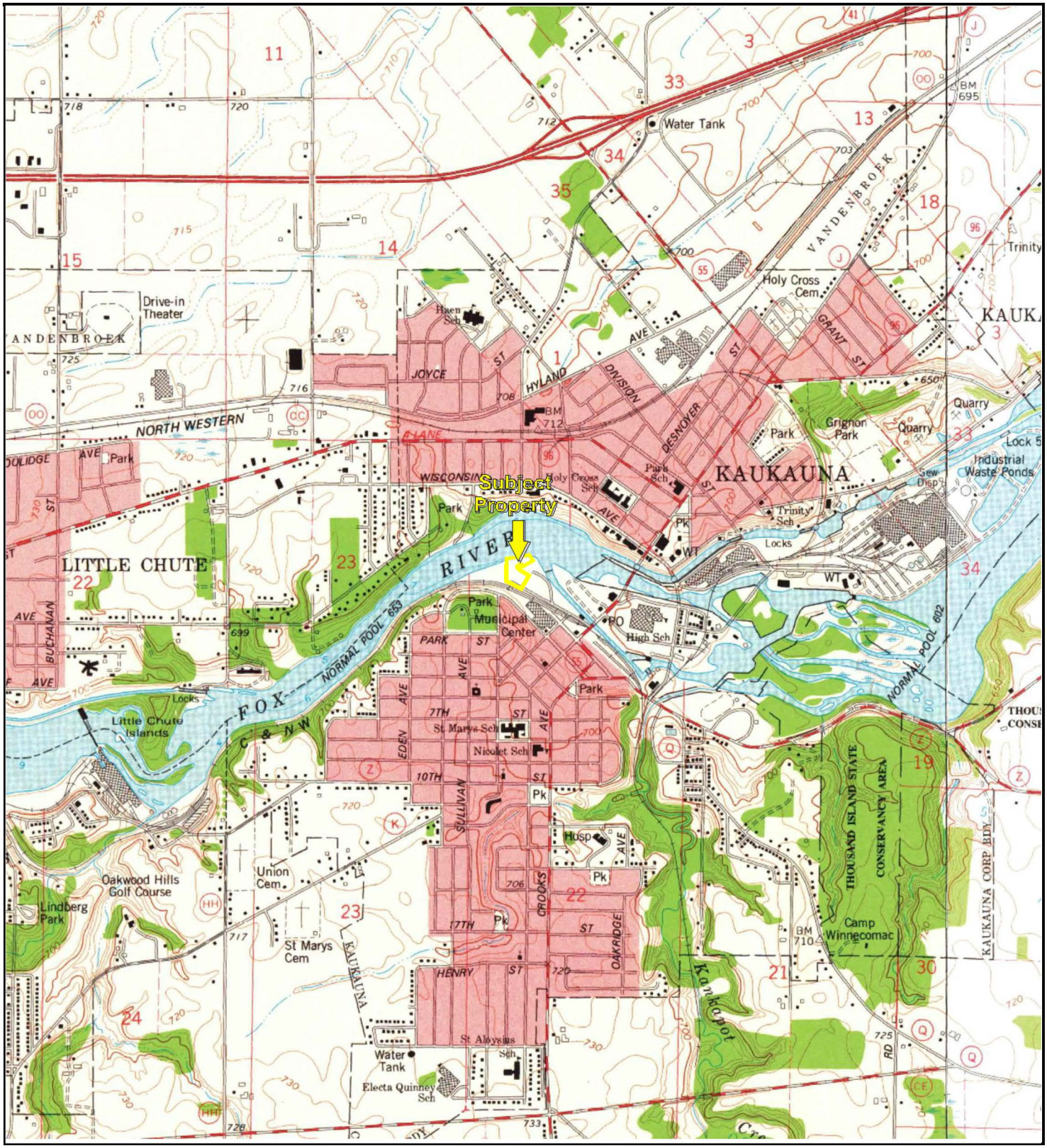


TP, Appleton, 1955, 15-minute
NE, De Pere, 1954, 15-minute

0 Miles 0.25 0.5 1 1.5

N

Key: Subject Property



TP, Kaukauna, 1974, 7.5-minute
NE, Wrightstown, 1974, 7.5-minute

0 Miles 0.25 0.5 1 1.5

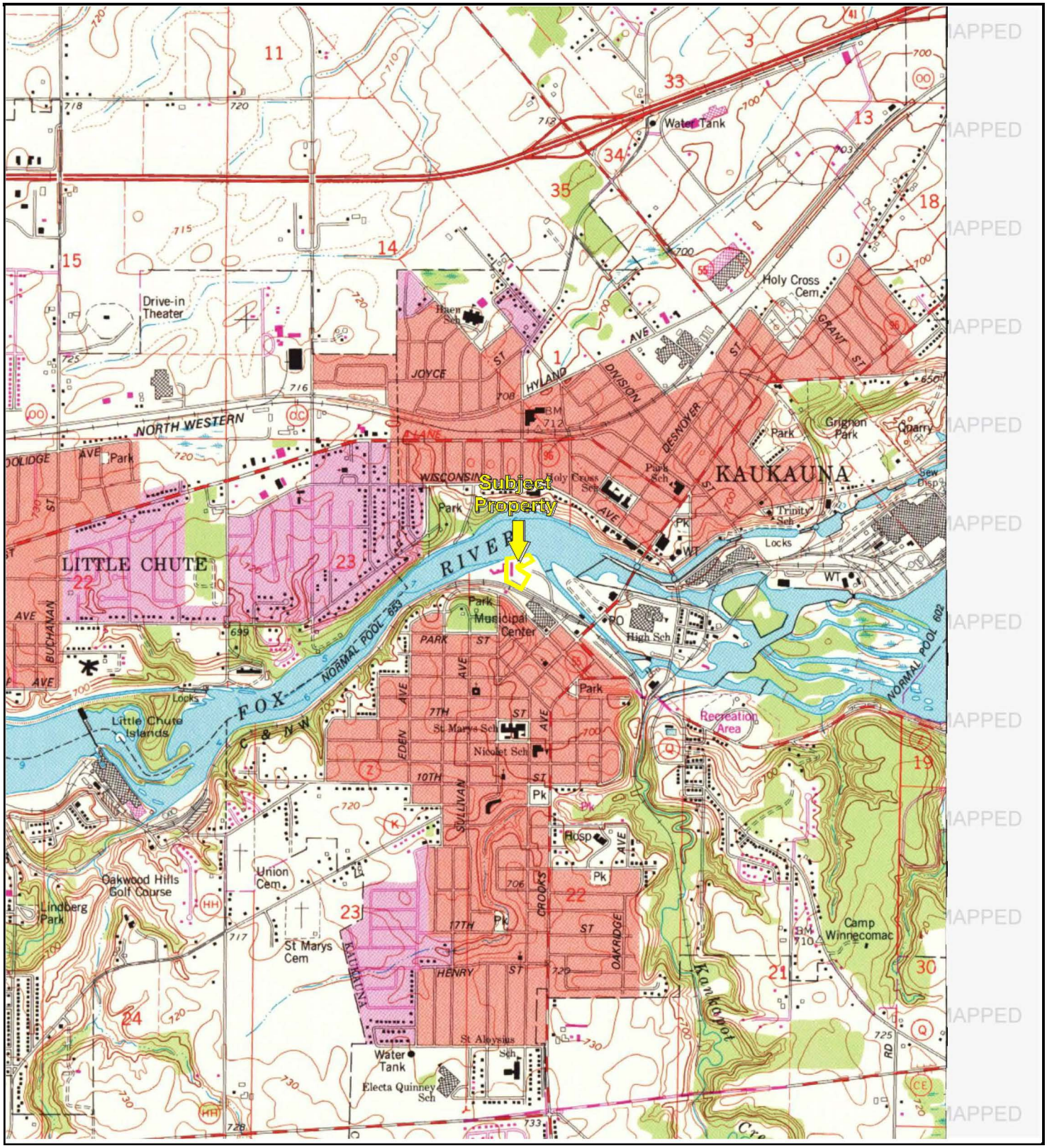
N

Key: Subject Property

APPENDIX B: Topographic Maps

Project No. 18-215232.1

PARTNER

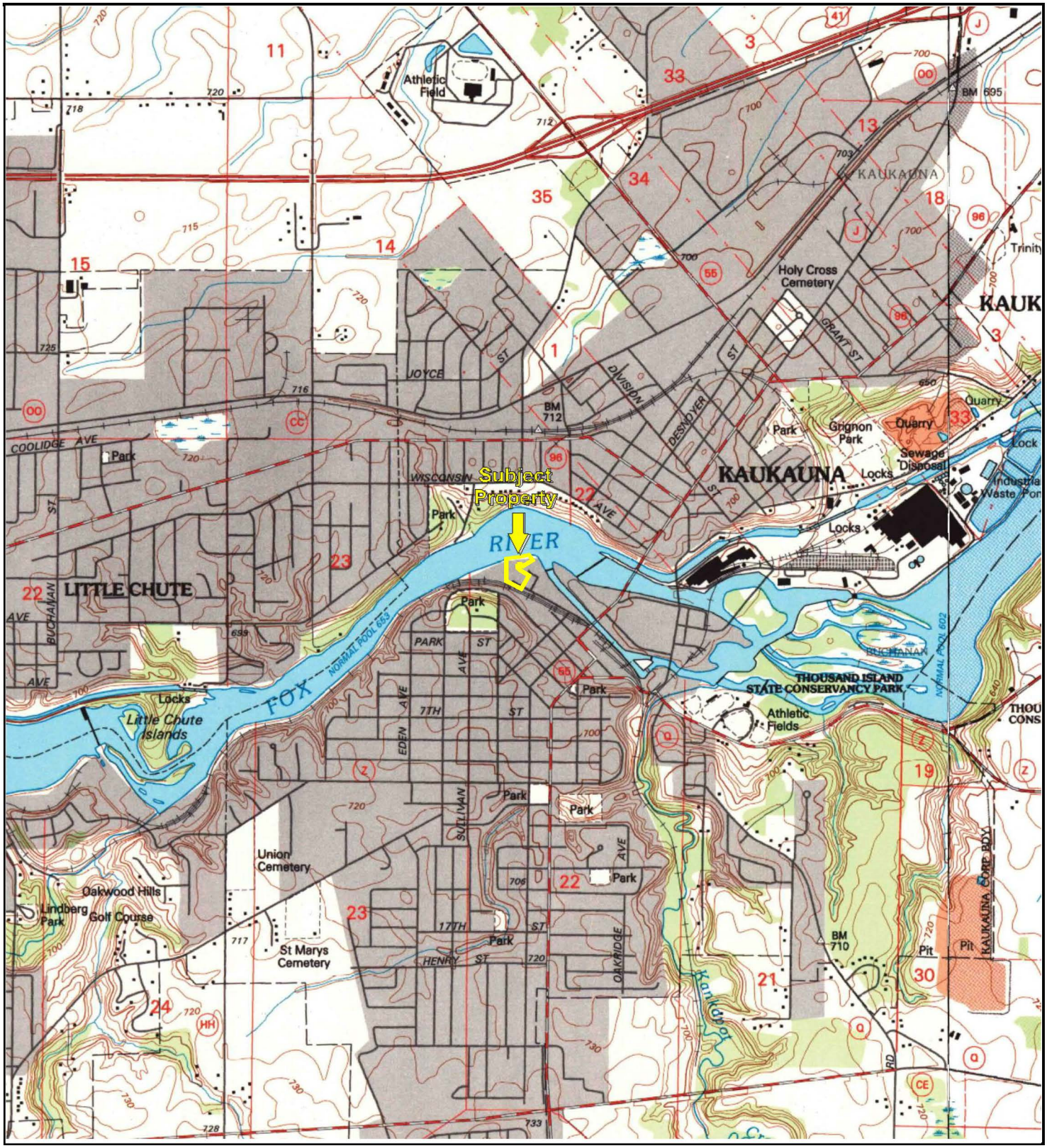


TP, Kaukauna, 1984, 7.5-minute

0 Miles 0.25 0.5 1 1.5

N

Key: Subject Property



TP, Kaukauna, 1995, 7.5-minute
NE, Wrightstown, 1995, 7.5-minute

0 Miles 0.25 0.5 1 1.5

N

Key: Subject Property

APPENDIX B: Topographic Maps

Project No. 18-215232.1

PARTNER



TP, Kaukauna, 2013, 7.5-minute
NE, Wrightstown, 2013, 7.5-minute

0 Miles 0.25 0.5 1 1.5

N

Key: Subject Property

APPENDIX B: Topographic Maps

Project No. 18-215232.1

PARTNER

Nestled on the shores of the Fox River...



Fox Shores Apartments

Professionally managed by Versatile Management, Inc.

Inside...
5 Sensational Reasons to call your new home Fox Shores Apartments

Drive a little, get a lot!

380-410 Bicentennial Court • 400/410 Foxshores Drive
Mailing Address: P.O. Box 3122 • Appleton, WI 54914-0122
Phone (920)766-4739 • Fax (920)749-0996
www.startrenting.com/moreinfo/foxshores

5 Sensational Reasons to call your

1.

Surrounded by Beauty

Enjoy calming waters and the beautiful shores of the Fox River every season of the year from our riverside benches. Bordered by the beautiful Fox River, Fox Shores Apartments is located seconds from downtown Kaukauna and within easy walking distance from the beauty and serenity of Riverside Park, LaFollette Park, Central Park and Thousand Islands Nature Preserve.

2.

Spacious, Modern Apartments

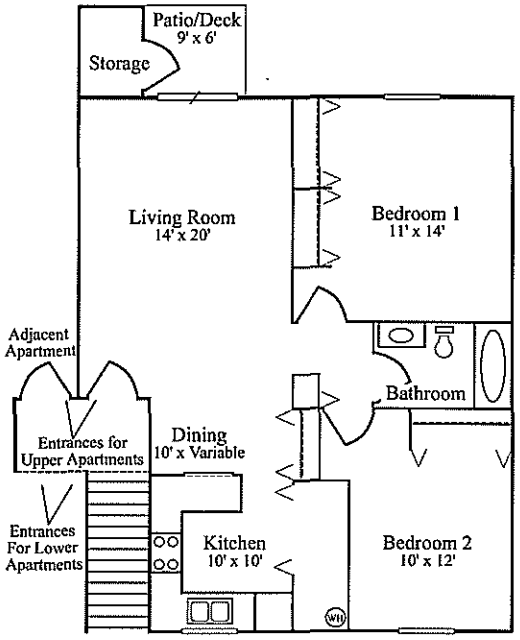
Fox Shores Apartments can provide you with all the features you require for easy, carefree living. Each apartment includes a spacious, well designed floor plan with two large bedrooms, a contemporary kitchen open to the dining area, open to a spacious living room, open to the patio with a beautiful view.

Because our units **are not** back to back, enjoy the benefits of having windows on both sides of your apartment and the security of a private entrance. Conveniences include storage closets, air conditioning, garbage disposals, window treatments, cable in both bedrooms and the living room, ceiling fans, laundry hookups (laundry included in some), and dishwashers in most.

3.

Professionally Managed

The Fox Shores Apartments management team knows that excellent customer service is both our mission and our goal. We're sure you'll find our courteous staff friendly and helpful. Professional maintenance is provided within 48 hours. Most times, maintenance is done within 24 hours! We are also available to handle any emergency 24 hours a day, 7 days a week.



930 Square Feet

380-410 Bicentennial Court (off water)

Unit # _____ Rent $ _____

Garage # _____ Rent $ _____

4.

Amenities Galore

Garages are included with on-water apartments and optional for off-water apartments, but you won't have to use your car to find things to do. Fox Shores residents have easy access to the adjacent Ghost Town Fitness Center. And after a hardy workout, many places to dine are only a short walk away. After dining, relax in the many parks surrounding our community or just relax and fish at our very own parklike river's edge.

5.

The Rest of the Story

With all that Fox Shores has to offer, calling your new home Fox Shores Apartments is a wise choice. Each Fox Shores apartment, as well as the community itself, was designed with your convenience and comfort in mind. Here is the rest of the story...

new home Fox Shores Apartments

- Excellent location
- Spacious, well designed floor plan with two bedrooms
- Windows on both sides of your apartment
- Inexpensive Kaukauna Electric electricity
- Linen closet
- Patio or balcony with storage closet
- Contemporary kitchen
- Blinds throughout
- Dining room ceiling fan
- Smoke alarms—hard wired (batteryless)
- Phone jacks in bedrooms, kitchen and living room
- Air conditioning
- Cats allowed with some restrictions
- Assigned parking
- Adjacent Ghost Town Fitness Center
- Fish only a cast away
- Parklike area along our own shores
- Professional owner management with friendly, helpful staff
- Lawn care and snow removal
- Prompt, trained maintenance crew with 24 hour emergency service
- Fun, year round activities with residents

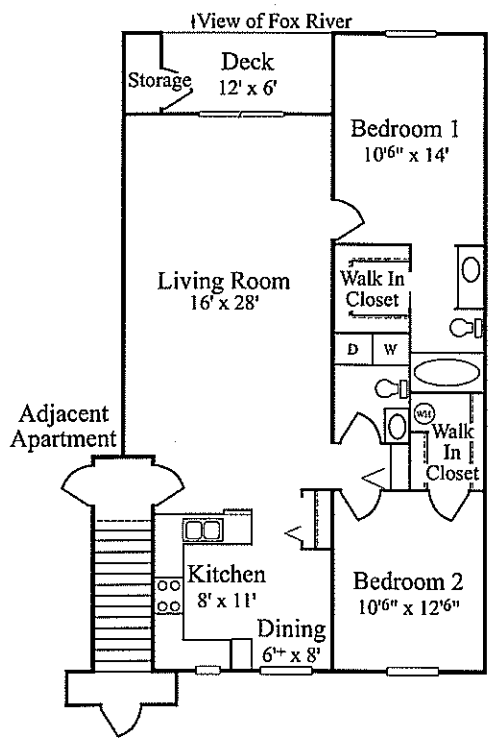
Off Water Apartments also include:

- Large bathroom
- Some with dishwashers
- Optional garage
- Private entries
- Laundry hookups

On Water Apartments also include:

- Dishwashers
- Garages
- Private and almost private entries
- Walk-in closets
- Laundry in most
- Second bath, half or full

WE WANT YOU TO LIVE HERE!

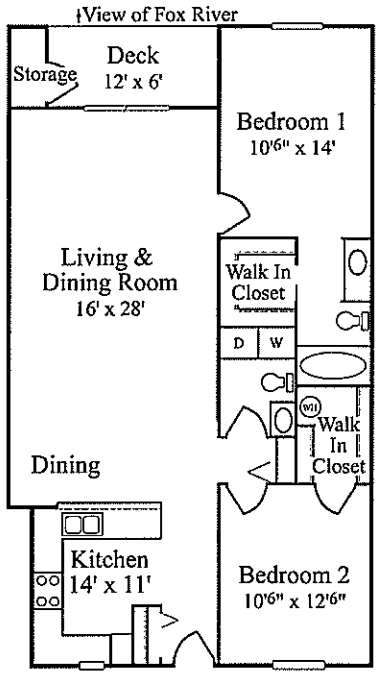


On Water (Upper)

Unit # _____ Rent $ _____

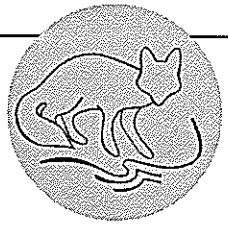
* Units with stacked washer/dryer and full second bath not shown.

400/410 Foxshores Drive
1200 Square Feet



On Water (Lower)

Unit # _____ Rent $ _____



Call Today! (920)766-4739

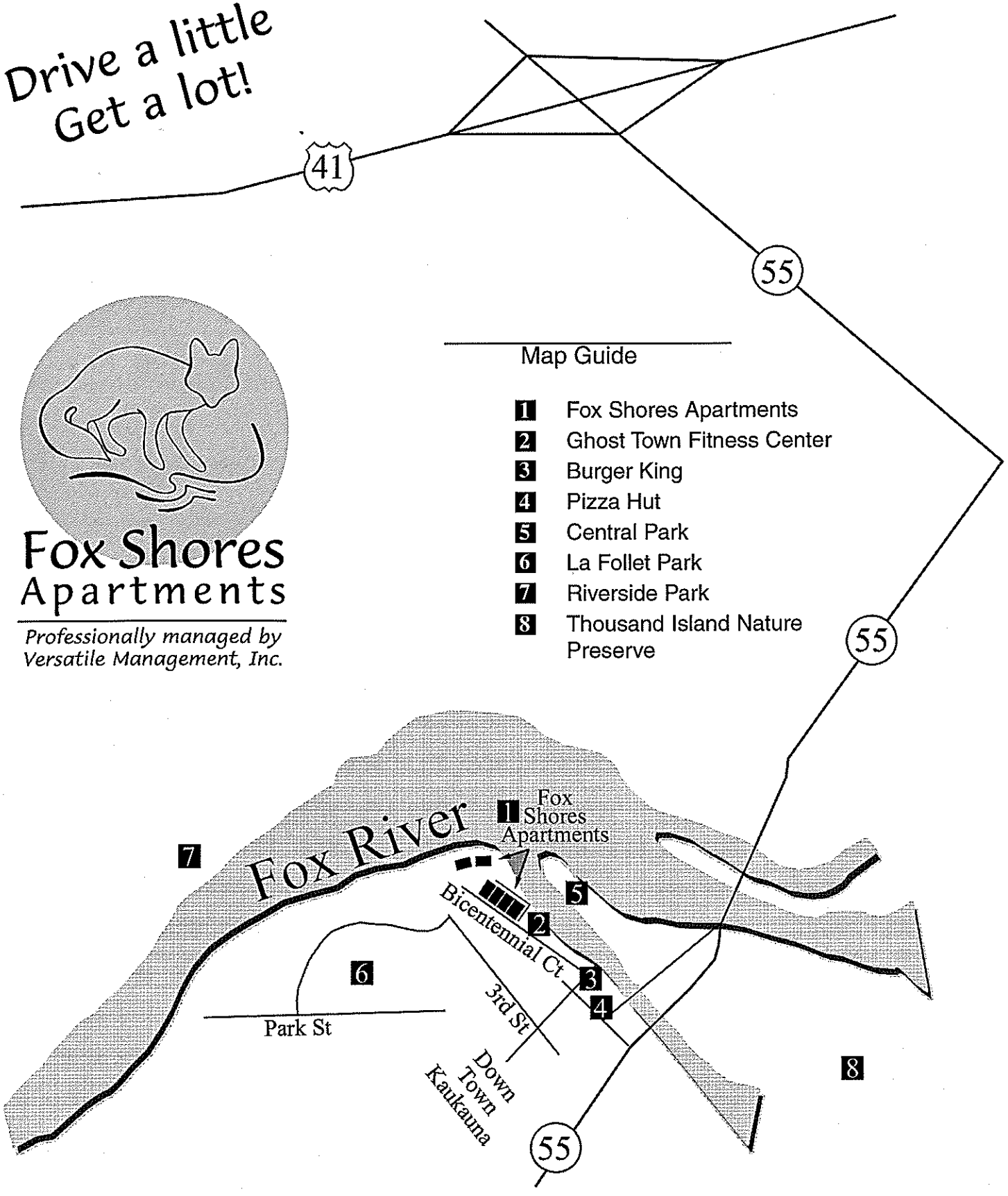
Drive a little
Get a lot!

Fox Shores Apartments

Professionally managed by Versatile Management, Inc.

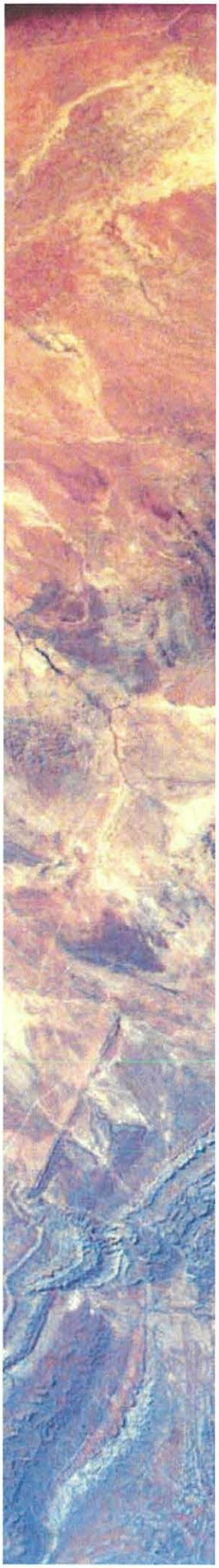
Map Guide

1. Fox Shores Apartments
2. Ghost Town Fitness Center
3. Burger King
4. Pizza Hut
5. Central Park
6. La Follet Park
7. Riverside Park
8. Thousand Island Nature Preserve



Call today for an appointment!

(920)766-4739



GRS GROUP

FINAL

GLOBAL REALTY SERVICES GROUP

Phase I Environmental Site Assessment

Prepared for:

Alliant Capital LLC
4746 11th Avenue NE, Suite 102
Seattle, WA 98105

Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI 54310

RESTRICTED USE AND RELIANCE – THIS REPORT WAS PREPARED BY GLOBAL REALTY SERVICES FOR THE SOLE USE AND BENEFIT OF OUR CLIENT AND MAY NOT BE USED OR RELIED UPON BY ANY THIRD-PARTY WITHOUT THE EXPRESS WRITTEN CONSENT OF GLOBAL REALTY SERVICES.

January 26, 2010

TABLE OF CONTENTS

Overview **1**

Data Gaps 1

Limiting Conditions 2

Findings and Opinions 2

Conclusions 3

Recognized Environmental Conditions 3

Historical Recognized Environmental Conditions 3

De Minimis Environmental Conditions 3

Additional Services 4

Recommendations 4

1.0 Introduction **5**

1.1 Purpose and Use 5

1.2 Scope of Assessment 5

1.3 Additional Services 6

1.4 Reliance 7

1.5 Methodology 8

1.6 Terminology 8

1.7 Deviations 8

1.8 Special Terms and Conditions 9

2.0 Property Description **10**

2.1 Legal Description 10

2.2 Reconciliation of Property Data 10

2.3 Site and Vicinity General Characteristics 10

2.4 Current Use 10

2.5 Description of Improvements 10

2.6 Potentially Sensitive Improvements 11

2.7 Adjoining Properties 11

3.0 Client Provided Information **12**

3.1 Owner, Property Manager, and Occupant Information 12

4.0 Records Review **13**

4.1 Regulatory Records 13

4.1.1 Subject Property 13

4.1.2 Off-Site Properties 13

4.1.3 Additional Environmental Record Sources 14

4.2 Physical Setting 15

4.2.1 Topography 15

4.2.2 Geology 15

4.2.3 Hydrology 15

4.3 Historical Use 15

4.3.1 Summary 15

4.3.2 Aerial Photographs 16

4.3.3 Fire Insurance Maps 17

4.3.4 Property Tax Files 17

4.3.5 Recorded Land Title Records 17

4.3.6 USGS Topographic Maps 17

4.3.7 Local Street Directories 18

4.3.8 Building Department Records 18

4.3.9 Zoning/Land Use Records 18

TABLE OF CONTENTS

4.3.10 Other Historical Sources 18
4.3.11 Prior Assessments 18
4.3.12 Data Failure 19
5.0 Site Reconnaissance 20
5.1 Common Concerns 20
5.2 Additional Concerns 20
5.3 Adjoining Properties 20
6.0 Interviews 22
7.0 Additional Services 23
Asbestos Containing Building Materials 23
Lead-Based Paint 23
Drinking Water 23
Radon 23
Mold 24
Wetlands 24
Indoor Air Quality 24
Compliance 24
8.0 Certification 25
Appendices
Appendix A: Site Location and Site Plan 26
Appendix B: Photographs 30
Appendix C: Limitations of ESA Standard 39
Appendix D: Supporting Documentation 43
Appendix E: Qualifications 567

Overview

Property Name	Fox Shores Apartments
Property Address	400 Fox Shores Drive, Kaukauna, WI 54915
Building Area	Approximately 80,000 Square Feet (SF)
Units	56
Property Area	Approximately 2.815 acres
Year Built	1983-1992
Current Use	Multi-Family Residential
Historical Use	Rail Yard
Known Release	None
Suspected Release	None
Regulatory Records	No Regulatory Records were identified for the subject Property.
AULs	No Activity and Use Limitations were identified.
Engineering Controls	No Engineering Controls were identified.
Environmental Liens	Research of Environmental Liens was beyond the scope of this Assessment.

Conclusions	**Summary**	**Action Recommended?**	**Cost**
REC	None	None	$0
HREC	Prior use of subject property and surrounding properties as a railyard and railroad roundhouse. Groundwater testing confirmed that any contamination present is below applicable action levels.	None	$0
Opinion	Identified conditions do not indicate environmental impact to the Property.	None	$0
Data Gaps	No data gaps were identified which would be likely to impact our conclusions.	None	$0

ADDITIONAL SERVICES			
Issue	**Summary**	**Action Recommended?**	**Cost**
Asbestos	No friable or damaged suspect ACM observed.	None	$0
Lead-Based Paint	Based on age, LBP is not a concern.	None	$0
Drinking Water	No concerns identified.	None	$0
Radon	No concerns identified.	None	$0
Mold	No concerns identified.	None	$0
Wetlands	No concerns identified.	None	$0
Indoor Air Quality	No concerns identified.	None	$0
Compliance	No concerns identified.	None	$0

Data Gaps

No significant data gaps were encountered during completion of this assessment. Data gaps occur when, despite good faith efforts, the consultant is unable to identify information required to satisfy objectives of the assessment. Data gaps may result from incompleteness in any of the activities required by the ESA Standard, or by limiting conditions encountered during completion of the work. The ESA Standard requires that data gaps be identified in the report when they significantly impact the ability of the consultant to identify Recognized Environmental Conditions at the Property. Limiting Conditions identified in this report are not considered to significantly impact our ability to satisfy the objectives of this assessment.

Limiting Conditions

GRS Group encountered the following limiting conditions in completion of the work:

- Observation of the living units was contractually limited to 10% of those present. Unidentified conditions may exist in units not observed.

- Our view of the ground surface was partially obstructed by snow cover and the presence of parked automobiles. This circumstance was limited in extent. Some conditions may have been concealed at the time of our assessment, however the extent of those conditions is likely to be minimal and no additional action is recommended at this time.

Findings and Opinions

No RECs were identified as a result of our assessment. The Property is currently used for multi-family residential purposes. No activities involving the use, storage, treatment, disposal or emission of hazardous materials are known to occur on-site.

Current subject property improvements consist of six two-story apartment building containing 56 living units totaling approximately 80,000 Gross Square Feet (GSF) . Additional improvements include four garage buildings, cast in place concrete sidewalks, asphalt paved driveways and parking areas, and landscaped areas.

Prior to the development of the current improvements between 1983 and 1992, the subject property was utilized as a railroad yard, and was historically improved with structures identified as the Chicago & Northwestern Railway Shops, including a Kimberly-Clark Paper Mill warehouse, a small warehouse, a blacksmith shop and a supply shed. No other features of environmental concern are located at the Property. No historical activities suspected of involving the use, storage, treatment, disposal or emission of hazardous materials, were identified during this assessment. The subject property was not identified on any of the environmental agency databases reviewed in association with its former usage.

The adjoining property to the east, currently Ghost-Town Fitness Center, is included on the WI ERP database. The inclusion is due to this site's prior use as a railroad roundhouse. According to a Limited Site Assessment of the site, groundwater was tested in an area that would be considered centrally located on the railyard. The sample collected was found to be below applicable action levels for Volatile Organic Compounds (VOCs), Diesel Range Organics (DRO), and RCRA metals. The database indicates that the Wisconsin Department of Natural Resources (WDNR) closed this WI ERP site on October 9, 2006. Therefore, the historical use of the adjoining property as a railyard and roundhouse is considered an off-site Historical REC (HREC) for which no further actions are required.

Additionally, eighteen (18) LUST sites and six (6) UST sites were identified within the study radii. Seventeen (17) of the identified LUST sites have been closed by the WDNR, indicating that no further actions are required. Therefore, these LUST sites are not considered RECs. The remaining open site, identified as City of Kaukauna Property, is located approximately 0.19 mile to the southeast, and potentially up-gradient of the subject property. This site is also known as the former Gunderson's Cleaners. According to the EDR report, all of the USTs at this have been abandoned in place or removed from the ground. Ongoing remedial activities have been performed at the site since 2002 and currently include groundwater monitoring. Numerous Site Assessment Grants (SAG) have been awarded to cover the costs accociated with the remedial activities at this site. Based on the remedial actions taken at this site, and the results of the recent groundwater sampling performed in the immediate vicinity of the subject property, this site is not considered an REC.

Conclusions

Recognized Environmental Conditions

A Recognized Environmental Condition (REC) is identified when the Assessment finds the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, ground water, or surface water of the property.

We have performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Practice E 1527-05 of 400 Fox Shore Drive in Kaukauna, WI (the Property). Any exceptions to or deletions from this practice are described in Section 1.7 of this report. This assessment has revealed no evidence of RECs in connection with the Property.

On-Site Recognized Environmental Conditions

No Recognized Environmental Conditions were identified as a result of on-site activities or conditions.

Off-site Recognized Environmental Conditions

No Recognized Environmental Conditions were identified as a result of activities or conditions at nearby properties.

Historical Recognized Environmental Conditions

On-Site Historical Recognized Environmental Conditions

Historical Recognized Environmental Conditions were identified as a result of on-site activities or conditions as follows:

- The prior use history of the subject property as a railroad yard is considered an HREC.

Off-site Historical Recognized Environmental Conditions

Historical Recognized Environmental Conditions were identified as a result of activities or conditions at nearby properties as follows:

- The prior use history of the adjoining property to the east as a railroad yard and roundhouse is considered an HREC.

De Minimis Environmental Conditions

De minimis environmental conditions indicate a release which generally would not represent a threat to human health and would generally not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies.

No de minimis environmental conditions were identified as a result of activities or conditions at the subject or nearby properties.

Additional Services

Additional services were provided to evaluate the presence of asbestos containing materials (ACMs), radon, lead-based paint, lead in drinking water, mold, indoor air quality, wetlands and compliance. No evidence of related conditions of concern was identified during completion of the Assessment.

Recommendations

No addition action or assessment is recommended as a result of this Assessment.

1.0 Introduction

This Phase I Environmental Site Assessment was performed by Global Realty Services Group (GRS Group) for Alliant Capital, LLC, and was prepared by Andy Bryan, one of GRS Group's Field Professionals and was reviewed by one of our senior reviewers, Anthony Mueller.

1.1 Purpose and Use

This assessment along with findings, conclusions and recommendations (collectively, the Assessment) is intended to support evaluation of the property by our Client prior to acceptance of the Property as collateral to support a real estate secured loan. Global has performed the agreed services in order to identify Recognized Environmental Conditions (RECs); the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, ground water, or surface water of the property. The supporting work was not intended to be exhaustive or to guarantee of the identification of every possible issue of potential concern, and may not be construed as a warranty or guarantee of any kind.

Unless expressly identified herein, all opinions, conclusions, and recommendations provided presume that the property occupancy and use will remain as observed at the time of our site reconnaissance and that no significant renovation, subdivision, conversion to condominiums or similar change will occur. This report will be invalidated in the event of such activities.

This report is the intellectual property of Global Realty Services, Global, and may not be used without Global's express written authorization. Unauthorized use of this report is a violation of Global's legal rights. Any unauthorized user of this report shall be subject to civil and criminal penalties and shall be responsible to indemnify, defend and hold Global harmless from any and all losses, damages and claims arising, in any part, from such use.

1.2 Scope of Assessment

This assessment was conducted in accordance with an agreement governing the nature, scope intent and purpose of the work and in general accordance with ASTM E 1527-05, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, the ESA Standard and any additional requirements identified in the agreement under which the work was performed.

Since GRS Group's responsibilities are limited by the agreed scope of work, an understanding of activities not included within that scope of work is important to proper use of the information contained in this Report. Some clarification of the work performed is provided below, but a more complete list of inherent limitations is provided at Appendix C.

- No environmental site assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions in connection with a property. The ESA Standard identifies a balance between competing goals to reduce uncertainties within reasonable constraints of time and cost, and this assessment is intended to reduce, but not eliminate, uncertainty regarding the potential for recognized environmental conditions in connection with a property within reasonable limits of time and cost. The reader should be thoroughly familiar with the ESA Standard in order to assure an appropriate understanding of limitations inherent in the agreed scope of services.

- In some cases conditions encountered during completion of the Assessment, for example limited access portions of the Property, can influence our ability to fulfill the objectives of

the assessment. Where applicable, such limiting conditions are identified later in this section of the report. Also, certain work is specifically excluded by the ESA Standard. Unless the expressly identified in the agreed proposal for services, all tasks identified by the ESA Standard as "Non-Scope Considerations" are excluded from this Assessment.

- Reconnaissance conducted during this assessment was limited to accessible areas of the property and specific areas identified in this Report. Accordingly, conditions may exist which were not identified as a result of our assessment and which may impact our conclusions concerning the condition of the Property. Any conditions known or discovered which were not identified during the completion of this assessment should be reported to GRS Group upon discovery and may impact the conclusions and recommendations of this Report.

- When provided by the client, GRS Group has considered "User Provided Information" in completion of this Assessment; however GRS Group has no control over such information and cannot guarantee the User's satisfaction of requirements for All Appropriate inquiry.

- Limited information concerning regulatory compliance was utilized in preparation of this Assessment; however the work is not intended as a compliance audit and may not be relied upon or utilized as evidence regulatory compliance.

1.3 Additional Services

The presence of 'environmental' conditions such as the asbestos containing materials, lead-based paint, lead in drinking water, indoor air quality (including vapor intrusion), wetlands, mold, endangered species, elevated radon concentrations and compliance, among others, can result in liabilities for property owners and disrupt planned operations or cash flow and is generally beyond the scope of a Phase I assessment as defined by the ESA standard. The following additional services have been performed at the request of our Client. All work described is in the context of and subject to the principles underlying the ESA Standard. A more complete description of specific actions taken to address these concerns is included in the report along with a summary of our related findings.

Recommendations

The ESA Standard requires the consultant to provide recommendations when the consultant is unable to obtain information which they would expect to significantly impact their ability to identify recognized environmental conditions. Many clients also look to the consultant for recommendations to address business risks. This can be problematic since the reason for engaging the assessment and risk appetite can vary significantly from client to client. Some clients are primarily concerned with the identification of direct evidence of a release, while others are concerned to understand every possibility of a release. This distinction can significantly impact the consultant's recommendations. In simplified form, the ESA Standard defines a recognized environmental condition as the likely release of hazardous substances. A recognized environmental condition is neither restricted to known releases nor intended to include any possibility of a release. Unless otherwise requested by the client, our report will include recommendations as required by the ESA Standard along with our opinion of additional assessment necessary to assess the significant release or likely release of a hazardous substance or petroleum product at the property. The Client should carefully review and consider all recommendations to assure an understanding of the underlying concerns and verify that any recommendations are consistent with their unique appetite for risk.

Asbestos Containing Building Materials

During completion of the site reconnaissance, Global looked for building materials commonly believed to contain asbestos. This assessment provides a screening for the presence of

asbestos containing materials to assist in understanding of business risks associated with the property, but is not intended and may not be used for the satisfaction of regulatory requirements and is not a suitable replacement for pre-demolition or other more in-depth studies.

Radon

Global has reviewed Radon maps and other necessary and readily available information concerning average radon concentrations in the area of the property. Site-specific sampling was completed to verify radon concentrations at the Property.

Lead-Based Paint

During completion of the site reconnaissance, Global looked for finished surfaces to which lead-based paint (LBP) is commonly applied. This assessment provides a screening for the presence of lead-based paint to assist in understanding of business risks associated with the property, but is not intended and may not be used for satisfaction of regulatory requirements and is not a suitable replacement for pre-demolition or other more in-depth studies.

Mold

Material and readily apparent evidence of the presence of mold which is identified during completion of the Assessment is described in the report.

Drinking Water

Global contacted the drinking water supplier to obtain information concerning compliance with applicable Federal regulations.

Indoor Air Quality

This assessment includes an interview with the Key Site Manager to obtain information concerning existing indoor air quality complaints, and, when soil or groundwater contamination is known to have affected the Property, a Tier 1 evaluation of the potential for vapor intrusion, in accordance with the applicable ASTM standard.

Wetlands

The National Wetlands Inventory has been reviewed to assess the presence of wetlands at the Property.

Compliance

Material regulatory requirements governing environmentally sensitive operations and conditions at the Property will be identified and Global will interview the Key Site Manager to assess compliance. No full compliance audit, or review of supporting documentation or regulatory files has been conducted.

1.4 Reliance

RESTRICTED USE AND RELIANCE - THIS REPORT WAS PREPARED BY GLOBAL REALTY SERVICES FOR THE SOLE USE AND BENEFIT OF OUR CLIENT AND THE FEDERAL NATIONAL MORTGAGE ASSOCIATION (FANNIE MAE) IN ACCORDANCE WITH THE PROVISIONS OF OUR CONTRACT AND MAY NOT BE USED OR RELIED UPON BY ANY OTHER PARTY WITHOUT THE EXPRESS WRITTEN CONSENT OF GLOBAL REALTY SERVICES.

1.5 Methodology

Recognized Environmental Condition

Criteria for the identification of Recognized Environmental Conditions vary substantially across the industry. Some Environmental Professionals identify Recognized Environmental Conditions whenever there is a possibility of impact to a property, while others recognize Recognized Environmental Conditions only when presented with direct evidence that a release has occurred. The ESA Standard defines a REC in terms of the "presence or likely presence" of hazardous materials under conditions that indicate an existing, past, or threatened release. By this definition the mere possibility of a release fails to fulfill the definition of a REC. A requirement for the discovery of direct evidence before identification of a REC is equally unsupportable. GRS Group considers both the known and likely presence and release of hazardous materials in identifying Recognized Environmental Conditions.

Historical Recognized Environmental Condition

The ESA Standard allows for reclassification of RECs as Historical Recognized Environmental Conditions. By example, the ESA Standard cites a situation in which a release was identified, cleanup has occurred and regulatory approval of cleanup operations has been granted, though the ESA Standard is careful to leave the final determination of HREC status to the discretion of the environmental professional. It is also possible to reclassify a REC when additional assessment reveals no evidence of a release. Since the definition of a REC requires the presence or likely presence of a release, the demonstration that no release has occurred would expunge the initial classification.

1.6 Terminology

Hazardous Material - The ESA Standard defines the terms *hazardous substance* and petroleum products, however the terms are often used in conjunction, resulting in an awkward phrase where a simpler term would be desirable. The term hazardous material is used in this report to include both hazardous substances and petroleum products as those terms are defined by the ESA Standard.

Material Threat of a Release - There is sometimes confusion regarding the meaning of the phrase "material threat of release." A *material threat* is defined within the context of the ESA Standard as "a physically observable or obvious threat which is reasonably likely to lead to a release..." The material threat of a release is used in consideration of the likelihood of a future release and has no application in consideration of an historical release.

1.7 Deviations

The ESA Standard characterizes issues which are beyond the scope of assessment as Non-Scope Considerations. Any inclusion of these issues or considerations in this assessment is described earlier in this Section: Scope of Assessment. Inclusion of this work is limited to the scope identified in the agreement under which the work was performed, is subject to underlying principles and limitations of the ESA Standard, and shall not be construed as evidence of a responsibility to evaluate other such issues or considerations.

1.8 Special Terms and Conditions

This Assessment has been performed in accordance with an agreement governing the nature, scope, extent and purpose of the work. Any conflicting provisions of that agreement supersede the provisions of other requirements referenced herein.

2.0 Property Description

The subject property consists of a rectangular-shaped parcel of land totaling approximately 2.815 acres. It is improved with six (6) two-story apartment buildings totaling approximately 80,000 GSF and containing 56 living units. The buildings, which were constructed between 1983 and 1992, are of wood-frame construction with exterior walls consisting of brick veneer facades with wood trim or vinyl siding. All of the buildings are provided with pitched asphalt composition shingled roofs. Additional improvements include four garage buildings, concrete sidewalks, asphalt-paved driveways and parking areas, and landscaped areas.

Property Name	Fox Shores Apartments
Property Address	400 Fox Shores Drive, Kaukauna, WI 54915
Building Area	Approximately 80,000 Square Feet (SF)
Property Area	Approximately 2.815 acres
Year Built	1983-1992
Current Use	Multi-Family Residential
Number of Buildings	26
Access	Driveways off of Lynndale Avenue to the west, Pershing Street to the north, and Glendale Avenue to the south.

2.1 Legal Description

Parcel 323-0408-00: CSM 59 LOT 3 LESS 961R345 LESSCSM 307, CSM 348, 5056M10
Parcel 323-0408-01: COM SE COR LT 1 CSM 155 N10D E43.02FT TO POB N10D E203.23FTS79D E104.54FT S54D E110FT S35D W225.23FT TO ST N 55D W76.22FT N57D W40.80FT TO POB ALSO D ESC AS LOT 1 CSM VOL 2 PG 307 .83AC

Parcel 323-0408-02: CSM 307 LOT 2 (PLATTED OUT OF PRT LOT 1 CSM 59) .83AC M/L #1256329

2.2 Reconciliation of Property Data

Improvements observed at the property are consistent with information provided at the time of our engagement. No significant deviations were identified.

2.3 Site and Vicinity General Characteristics

The property is located in a mixed use residential and commercial area. The terrain is generally level. The Fox River is located along the northern boundary of the subject property.

2.4 Current Use

No environmentally sensitive activities are conducted at the property. The property is used for multi-family residential purposes.

2.5 Description of Improvements

DESCRIPTION OF IMPROVEMENTS	
Building	Six 2-story apartment buildings
Construction	Type II - Non-rated. The buildings are constructed of CMU load-bearing walls and interior wood framing.
Exterior Finishes	Brick veneer or vinyl siding
Interior Finishes	Painted drywall walls and ceilings

Parking	Surface parking and four garage buildings are provided on-site.
Amenities	None
Heating Fuel	Natural gas
Source of Drinking Water	Municipal (City of Kaukauna)
Waste Water Disposal	Municipal (City of Kaukauna)
Solid Waste Disposal	Contracted disposal

2.6 Potentially Sensitive Improvements

No improvements of environmental concern were identified at the Property.

POTENTIALLY SENSITIVE IMPROVEMENTS	
Above Ground Storage Tank	None
Clarifier	None
Dry Well	None
Floor Drain	None
Ponds, Pits and Lagoons	None
Septic System	None
Settlement Tank	None
Underground Pipeline	None
Underground Storage Tank	None
Wells	None

2.7 Adjoining Properties

The following activities were observed at adjoining properties.

Direction	Activities	Comments
North	The Fox River	No impact is expected.
South	Bicentennial Court, beyond which are railroad tracks and the City of Kaukauna Municipal Service Department.	No impact is expected.
East	A commercial building occupied by Ghost-Town Fitness Center and a vacant parcel of land owned by Versatile Developments, and intended for future development of the subject property	No impact is expected.
West	Multi-family residences	No impact is expected.

3.0 Client Provided Information

In order to qualify for defenses to CERCLA liability, a defendant must demonstrate the completion of "all appropriate inquiry." As defined by EPA, all appropriate inquiry includes an assessment performed by an environmental professional, in addition to the identification and consideration of certain information not within the scope of a Phase I assessment. The ESA Standard requires the client to provide this information to the environmental professional. When not provided, the missing information must be considered as a possible Data Gap. Information required to be provided by the client includes:

- Research into the existence of environmental cleanup liens and Activity and Use Limitations
- Any specialized knowledge or experience of the "user"
- Commonly known or reasonably ascertainable information about the property
- Relationship of the purchase price to fair market value, and
- The degree of obviousness of the presence or likely presence of contamination.

No related information was provided by the Client. As a lender, the client would not be expected to possess significant information concerning the property. As a result, GRS Group does not view the lack of client-provided information as a significant data gap.

3.1 Owner, Property Manager, and Occupant Information

The following additional information, discussed in relevant sections of the report, was provided by the Property Owner:

- Limited Site Assessment (of Ghost-Town Fitness Center), Terracon, August 10, 2006
- Completed Pre-Survey Questionnaire
- Property Brochure
- A current rent roll

4.0 Records Review

4.1 Regulatory Records

Regulatory records provide an important source of information concerning the current and historical use of hazardous materials at the subject and nearby properties. In order to satisfy ESA Standard requirements for the review of regulatory information, GRS Group obtained aggregated data from a commercial service specializing in the organization and reporting of regulatory information.

Map Findings Summary

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
NPL		1	0	0	0	0	NR	0
DELISTED NPL		1	0	0	0	0	NR	0
CERCLIS		0.5	0	0	0	NR	NR	0
CERCLIS- NFRAP		0.5	0	0	0	NR	NR	0
CORRACTS		1	0	0	0	1	NR	1
RCRA- TSDF		0.5	0	0	0	NR	NR	0
RCRA- LQG		0.25	0	0	NR	NR	NR	0
RCRA- SQG		0.25	0	0	NR	NR	NR	0
US ENG CONTROLS		0.5	0	0	0	NR	NR	0
US INST CONTROL		0.5	0	0	0	NR	NR	0
ERNS		TP	NR	NR	NR	NR	NR	0
US BROWNFIELDS		0.5	0	0	0	NR	NR	0
SHWS		1	0	0	0	0	NR	0
LUST		0.5	0	4	14	NR	NR	18
UST		0.25	0	6	NR	NR	NR	6
LAST		0.5	0	0	1	NR	NR	1
AST		0.25	0	2	NR	NR	NR	2
VCP		0.5	0	0	1	NR	NR	1
BROWNFIELDS		0.5	0	1	1	NR	NR	2
INDIAN LUST		0.5	0	0	0	NR	NR	0
INDIAN UST		0.25	0	0	NR	NR	NR	0
INDIAN VCP		0.5	0	0	0	NR	NR	0
INDIAN ODI		0.5	0	0	0	NR	NR	0
INDIAN RESERV		1	0	0	0	0	NR	0

The column for Target Property is blank if no records were found.

4.1.1 Subject Property

No regulatory records for the subject Property were identified during our review. Further, no information was discovered during completion of this Assessment which would lead GRS Group to suspect that records should have been included in the information reviewed. As a result, no additional related Assessment appears warranted.

4.1.2 Off- Site Properties

A release resulting from activities at nearby properties can sometimes impact surrounding properties. Regulatory records concerning nearby properties is reviewed in order to identify a release of hazardous materials which would be expected to impact conditions at the subject Property. The evaluation of nearby properties is a two- fold process, evaluating both identified

releases of hazardous materials, and the potential for such releases to impact the subject Property.

The adjoining property to the east, identified as Ghost-Town Fitness Center, is included on the WI ERP database. The inclusion is due to the site's prior use as a railroad roundhouse. According to a Limited Site Assessment of the site, groundwater was tested in an area that would be considered centrally located on the railyard. The sample collected was found to be below applicable action levels for Volatile Organic Compounds (VOCs), Diesel Range Organics (DRO), and RCRA metals. Based on this information, the Wisconsin Department of Natural Resources (WDNR) closed the WI ERP site on October 9, 2006. Therefore, the historical use of the subject and adjoining property as a railroad yard and roundhouse is considered an on-site and off-site Historical REC (HREC) for which no further actions are required.

Additionally, eighteen (18) LUST sites and six (6) UST sites were identified within the study radii. Seventeen (17) of the identified LUST sites have been closed by the WDNR, indicating that no further actions are required. Therefore, these LUST sites are not considered RECs. The remaining open site, identified as City of Kaukauna Property, is located approximately 0.19 mile to the southeast, and potentially up-gradient of the subject property. This site is also known as the former Gunderson's Cleaners. According to the EDR report, all of the USTs at this have been abandoned in place or removed from the ground. Ongoing remedial activities have been performed at the site since 2002 and currently include groundwater monitoring. Numerous Site Assessment Grants (SAG) have been awarded to cover the costs associated with the remedial activities at this site. Based on the remedial actions taken at this site, and the results of the recent groundwater sampling performed in the immediate vicinity of the subject property, this site is not considered an REC.

Properties of Potential Concern

No properties were identified which are considered likely to result in a release of hazardous materials to the subject Property.

Properties of No Further Concern

No other regulatory listings were identified in completion of our Assessment.

Unmapped Records

Reports of regulatory records for the subject and surrounding Properties are compiled from data files published by public agencies. Data contained in those records is not always adequate to allow available mapping programs to correctly identify the property.

Review of the names and address information for unmapped properties revealed no evidence of records likely to be associated with the subject Property.

4.1.3 Additional Environmental Record Sources

The following additional environmental record sources were reviewed:

Source	Comments
Fire Department	Global contacted the Kaukauna Fire Department for information regarding records of USTs or other potential environmental concerns at the subject property. According to Assistant Chief, Don Grindheim, there are no records of USTs or environmental concerns on file for the subject property.

4.2 Physical Setting

4.2.1 Topography

Topography		
Description	**Findings**	**Source**
Configuration	Relatively flat	Site Observations and topographic map
Elevation	790 feet above mean sea level	Topographic Maps
Surface Water	No water bodies are located on the subject property.	Site Observations and topographic map

4.2.2 Geology

Geology		
Description	**Findings**	**Source**
Formation	Paleozoic Ordovician	P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S.
Description	Grays silt loam, consisting of deep and moderately deep, moderately well and well drained soils with moderately coarse textures.	Soil Survey of Outagamie County
Permeability	Moderate	Soil Survey of Outagamie County

4.2.3 Hydrology

Hydrology		
Description	**Findings**	**Source**
Primary Aquifer	Unconsolidated sand and gravel deposits of Quaternary age and consolidated sandstone, limestone, and dolomite of Paleozoic age.	Groundwater Atlas of the United States, reviewed on-line
Estimated first depth to groundwater	Approximately 11-12 feet below ground surface (bgs)	Soil Survey of Outagamie County
Gradient	Toward the west	Inferred from elevation, site observations and proximity to surface water.

4.3 Historical Use

4.3.1 Summary

Immediately prior to the development of the current improvements between 1983 and 1992, the subject property was undeveloped land since the early 1970s. Prior to that date, the subject property was developed with several buildings that were part of a Chicago & Northwestern Railway Shops, according to the review of aerial photographs, Sanborn maps, and historical topographic maps. The railway shops were present since the late 1890s. Specifically, the buildings that comprised the railway shops were a Kimberly-Clark Paper Mill warehouse, a blacksmith shop, and two small outbuildings identified as a warehouse and a supply shed. No direct evidence of a release of hazardous materials was identified.

Activities in the vicinity of the Property have primarily included residential and railyard uses, as well. The adjacent property to the east was developed with the railway roundhouse from the late 1890s through the early 1970s. The adjacent property to the north was part of the

previously mentioned railway shops and was also a paper mill. The railroad tracks have been present on the adjacent property to the south since the late 1880s. As previously discussed, as part of a previous assessment of the adjacent property to the east, groundwater sampling have confirmed that contamination levels are below applicable action levels. The sampling was performed on the adjacent property to the east, in what would be considered a centrally located area of the entire railyard. Therefore, the presence of this former railyard is considered an HREC.

Heating Fuel - Natural gas is the fuel source for the HVAC system at the subject property. There is no evidence that heating oil has ever been used at the Property.

Fill Materials - No evidence of the historical placement of fill materials was identified during our review of historical information. Though the placement of fill materials cannot be ruled out, no significant depressions, pits or other features suggestive of the likely placement of fill were identified in review of historical topographic maps and aerial photos.

Standard Historical Source	Reviewed?	Concerns?	Description of Concerns
Aerial Photographs	Yes	Yes	Former railyard at subject and adjoining properties is considered an HREC, for which no further actions are required.
Fire Insurance Maps	Yes	Yes	Former railyard at subject and adjoining properties is considered an HREC, for which no further actions are required.
Property Tax Files	Yes	No	
Recorded Land Title Records	No		
USGS Topographic Map	Yes	Yes	Former railyard at subject and adjoining properties is considered an HREC, for which no further actions are required.
Local Street Directories	No		
Building Department Records	Yes	No	
Zoning/Land Use Records	Yes	No	
Other Historical Sources	No		
Prior Assessments	Yes	No	Groundwater sampling verified that contamination levels are below applicable action levels.

4.3.2 Aerial Photographs

The following aerial photographs were reviewed:

Source	Year	Scale
EDR	1952	500
EDR	1957	750
EDR	1964	500
EDR	1971	750
EDR	1981	750
EDR	1986	1000
EDR	1992	750
EDR	2005	604

Subject Property

The property was undeveloped between the early 1970s and the construction of the existing structures beginning in 1983. Development of the subject property improvements occurred in phases through 1992, as was evident on the aerial photographs. A railroad yard was present at the subject property between the 1890s and the early 1970s.

Nearby Properties

The general vicinity of the Property included the aforementioned railyard and the associated roundhouse from the 1890s through the early 1970s. Commercial and residential development of the area, began in the early to mid 1970s. As previously discussed, the former railyard and roundhouse are considered HRECs for which no further actions are required. No other improvements or conditions of concern were identified as a result of this review of aerial photographs.

4.3.3 Fire Insurance Maps

Fire insurance maps were reviewed for 1885, 1890, 1894, 1900, 1906, 1913, 1925, 1945, and 1956.

Source	Year
EDR- Sanborn	1885
EDR- Sanborn	1890
EDR- Sanborn	1894
EDR- Sanborn	1900
EDR- Sanborn	1906
EDR- Sanborn	1913
EDR- Sanborn	1925
EDR- Sanborn	1945
EDR- Sanborn	1956

Subject Property - The property is not depicted on the 1885 through 1900 Sanborn Maps. The 1906 through 1956 maps depict the subject property as being developed with several structures identified as the Chicago & Northwestern Railway Shops. These buildings are identified as a Kimberly- Clark Paper Mill warehouse and a blacksmith shop, as well as two smaller outbuildings used as a warehouse and a supply shed.

Nearby Properties - The railroad roundhouse and a building identified as the Combined Locks Paper Company (old telephone book paper warehouse), are evident at properties immediately adjacent to the north and east of the subject Property in the 1884 through the 1956 maps. The adjacent property to the south is shown as railroad tracks on all of the maps reviewed.

4.3.4 Property Tax Files

According to records reviewed at the City of Kaukauna Assessor's website, the subject property consists of three parcels of land which total approximately 2.815 acres. The assessment files did not indicate the age of square footage of the improvements at the subject property. Additionally, no information was found in the assessment files regarding the age of several of the buildings at the subject property.

4.3.5 Recorded Land Title Records

Research and review of recorded land title records was beyond the scope of our assessment.

4.3.6 USGS Topographic Maps

The following topographic maps were reviewed:

Quad	Year	Scale
APPLETON	1955	1:62500
KAUKAUNA	1974	1:24000
KAUKAUNA	1984	1:24000
KAUKAUNA	1992	1:24000

Subject Property

The 1992 map showed the subject property to be in an area where only landmark structures are shown. The subject property was depicted as undeveloped land on the 1974 and 1984 topographic maps. The previously discussed railyard buildings are evident on the 1955 topographic map.

Nearby Properties

Multi-family residential buildings are depicted on the adjacent property to the west on the 1974 and 1984 maps. The previously discussed railyard buildings are evident on the 1955 topographic map. The 1992 map showed the adjoining properties to be in an area where only landmark structures are shown.

4.3.7 Local Street Directories

Based on the historical information obtained from other sources, local street directories were not reviewed as part of this assessment.

4.3.8 Building Department Records

GRS Group contacted the local building department for information regarding any records of file for the subject Property. According to Mr. Dave Raymond, Building Inspector with the Kaukauna Community Development Department, Certificates of Occupancy (COs) were issued for the subject buildings beginning in 1983. Building Department files indicated that the last CO was issued in 2004. Copies of the COs were not available. No records were found that indicated any environmental concerns at the subject property.

4.3.9 Zoning/Land Use Records

Zoning maps reviewed on-line show the Property to be zoned CCD, Commercial Core District. The current use of the property for multi-family residential purposes is consistent with the zoning.

Global contacted the City of Kaukauna Zoning Department for information pertaining to historical zoning of the property. No information was available concerning historical zoning of the Property.

4.3.10 Other Historical Sources

GRS Group researched the Property on-line. No listings of interest were identified.

4.3.11 Prior Assessments

The following prior assessments were provided for our consideration:

- Limited Site Assessment (for Ghost-Town Fitness Center) - Terracon - 2006

Based on the prior use history results of a Transaction Screen, also performed by Terracon and attached to the above referenced report as an appendix, the prior use history of the site as a railyard and roundhouse warranted a subsurface investigation. One soil boring was advanced in an area centrally located on the former railyard. One groundwater sample was collected and analyzed for VOCs, DRO, and RCRA metals. Based on the laboratory results, the levels of all three contaminants were below all applicable action levels.

Terracon concluded "Reported concentrations of VOCs, DRO, and RCRA Metals are generally below applicable standards and do not appear to indicate that a significant historical release occurred on the property. Terracon does not recommend additional assessment. However, as a precautionary measure, due to the detection of DRO in groundwater and also detections of arsenic, lead, and selenium exceeding NR 140 PALs, Terracon recommends the site owner report the detections to the WDNR as required by Section 292.11 of the Wisconsin Statutes, which is also known as the spills law. The statute requires that a person who posses or controls a hazardous substance which is discharged or who causes the discharge of a hazardous substance shall notify the department immediately of any discharge not exempted by law."

4.3.12 Data Failure

No data failure was encountered during the review of historical information. Historical use of the property was researched to 1885, prior to development of the existing structures and before the required cutoff date established by the ESA Standard, 1940. Several periods of more than five years appear among data sources reviewed, however improvements and activities at the property during these periods appears to have been the previously discussed railroad buildings. In accordance with the ESA Standard, such periods are not considered to constitute data failure.

5.0 Site Reconnaissance

No conditions or improvements of environmental concern were observed during our reconnaissance of the property. The site reconnaissance was performed by Andy Bryan on December 7, 2009. We were accompanied by the Key Site Manager, Mr. Tom Vandeyacht, the Property Owner. Weather at that time was clear and provided no obstacle to completion of the reconnaissance.

GRS Group's site reconnaissance of exterior areas included observation of the Property from nearby streets, and along the perimeter of the property and periphery of each building. Open areas of the property were traversed at intervals of approximately 100 feet. Interior observations included all common, maintenance and storage areas and GRS Group's site reconnaissance of exterior areas included observation of the Property from nearby streets, and along the perimeter of the property and periphery of each building. Open areas of the property were traversed at intervals of approximately 100 feet. Interior observations included all common, maintenance and storage areas and units B400-6, B300-6, B400-, B410-1, F400-4, F410-3, and F410-5.

5.1 Common Concerns

No improvements, features or activities were identified which would be expected to indicate the use, storage or disposal of hazardous materials.

Concern	Present?	Comments
Above Ground Storage Tanks	No	
Discharge Features	No	
Equipment Likely to Contain PCBs	No	
Hazardous Material Use	Minor	Building maintenance products, paints, and janitorial products.
Other Suspect Containers	No	
Petroleum Products	No	
Pits, Ponds, and Lagoons	No	
Processes of Concern	No	
Solid Waste Dumping/Landfills	No	
Stained Soil/Stressed Vegetation	No	
Staining/Corrosion	No	
Stockpiled Soils	No	
Subsidence	No	
Surface Repairs (e.g. UST removal)	No	
Underground Storage Tanks	No	
Wells	No	

No concerns were identified that are expected to impact the subject property.

5.2 Additional Concerns

No additional concerns were identified.

5.3 Adjoining Properties

The following activities and improvements were observed at adjoining properties.

North - The Fox River.

South - Railroad tracks and Bicentennial Court, beyond which are City of Kaukauna Municipal Service buildings..

East - The Ghost-Town Fitness Center.

West - Multi-family residences.

No activities or improvements were observed which would be expected to have resulted in impact to environmental conditions at the subject Property.

6.0 Interviews

Interviews were conducted with the following persons and/or agencies:

Position	Name	Company	Title	Contact Information	Interview Date
Current Owner	Mr. Tom Vandeyacht (also Key Site Manager)	Versatile Developments Company, LLC	Owner.Managing Member	920-213-7145	December 7, 2009
Local Government Official	Mr. Dave Raymond	City of Kaukauna Community Development Department	Building Inspector	920-766-6325	December 9, 2009

Key Site Manager

Mr. Tom Vandeyacht, the Property Owner, is also the Key Site Manager for the subject property. He has owned the Property since the early 1990s and stated that he was not aware of any environmental concerns at the site. Mr. Vandeyacht provided Global with a previous environmental report for the site, as well as a completed Pre-Survey Questionnaire, a current rent roll, and a property brochure. Copies of the reports that were provided for review have been discussed above.

Current Occupants

Interview of current occupants is not required for residential properties. Since GRS Group found no areas in which such interviews would be expected to provide meaningful information, interviews were not conducted with current and past occupants.

Local Government Officials

Building Department - GRS Group interviewed Mr. Dave Raymond, Building Inspector with the Kaukauna Community Development Department. According to Mr. Raymond, COs were issued for the subject buildings beginning in 1983. Copies of the COs were not available. No records were found that indicated any environmental concerns at the subject property.

7.0 Additional Services

Additional services were provided as follows:

Asbestos Containing Building Materials

During completion of the site reconnaissance, GRS Group looked for building materials commonly believed to contain asbestos. Where appropriate, samples of suspect ACM were collected and submitted for laboratory analysis by polarized light microscopy. This assessment provides a screening for the presence of asbestos containing materials to assist in understanding of business risks associated with the property, but is not intended and may not be used for the satisfaction of regulatory requirements and is not a suitable replacement for pre-demolition or other more in-depth studies.

Asbestos-containing building materials may be present at the Property. Asbestos has historically been present in a wide variety of building materials, though the use of asbestos containing materials has significantly decreased since 1981. The Property was constructed after the use of most friable ACMs had been discontinued. During completion of our site reconnaissance, GRS Group identified materials which may contain asbestos, including vinyl floor tile, drywall, joint compound, exterior shingles, as well as roofing felt and coatings. These materials were not sampled since they were found to be in good condition at the time of our Assessment. No friable or damaged suspect ACM was observed at the Property.

All suspect materials should be handled with due caution and in accordance with applicable regulations.

Lead-Based Paint

No suspect lead-based paint was identified at the Property. The use of lead-based was banned in 1978, prior to construction of improvements at the Property.

Drinking Water

Drinking water is supplied by the City of Kaukauna and is reported to be in compliance with applicable regulations.

Radon

The USEPA has prepared a map to assist National, State, and local organizations to target their resources and to implement radon-resistant building codes. The map divides the country into three Radon Zones, Zone 1 being those areas with the average predicted indoor radon concentration in residential dwellings exceeding the EPA Action limit of 4.0 picoCuries per Liter (pCi/L). It is important to note that the EPA has found homes with elevated levels of radon in all three zones, and the EPA recommends site specific testing in order to determine radon levels at a specific location. However, the map does give a valuable indication of the propensity of radon gas accumulation in structures. Review of the EPA Map of Radon Zones places the Property in Zone 2, where average predicted radon levels are between 2.0 and 4.0 pCi/L.

At the time of site reconnaissance, five radon canisters were placed in residential units located on the ground floor of the building. The canisters were retrieved by the property contact and forwarded for analysis. The results of the analyses are provided below:

Location	Sample #	Results	Comments
F400-4, Kitchen	2106841	1.3	Below the EPA Action Level of 4.0 Pcl/L
F410-5, Kitchen	2106841	1.0	Below the EPA Action Level of 4.0 Pcl/L
B410-1, Kitchen	2106840	1.7	Below the EPA Action Level of 4.0 Pcl/L

Based on the laboratory results and radon zone, radon is not considered a concern at the subject property.

Mold

Mr. Vandeyacht was interviewed during our assessment, and had no knowledge of past or present areas of mold growth or moisture intrusion at the Property or of related tenant complaints. During our site reconnaissance, no significant evidence was identified to indicate current or past mold growth or moisture intrusion likely to result in mold growth. Minor mold growth, due to humidity, was observed in a utility room housing the water softening equipment. The mold can cleaned with bleach as part of routine maintenance.

Wetlands

No wetlands were identified at the subject property.

Indoor Air Quality

In accordance with Tier I vapor intrusion evaluation criteria, the evaluation of potential vapor intrusion into buildings is appropriate when soil or groundwater impacted by volatile organic hydrocarbons is located within 90 feet of a structure, or hydrocarbon impacts to soil or groundwater are identified within 30 feet of a structure. Global has conducted a Tier I evaluation of vapor intrusion consisting of interview of the key site manager and consideration of other results of this Assessment.

No suspected release of hazardous materials to soil or ground water has been identified within critical distances established by Tier I ASTM criteria. As a result, no additional assessment of potential indoor air quality impacts is indicated by Tier I ASTM criteria.

Compliance

No activities or conditions requiring compliance with environmental regulation were identified.

8.0 Certification

We declare that, to the best of our professional knowledge and belief, we meet the definition of Environmental Professional as defined in section 312.10 of 40 CFR 312, and we have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject Property. We have developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in 40 CFR Part 312 except as follows:

- The results of additional inquiries required under section 312.22 of 40 CFR 312 were not provided to the environmental professional. All appropriate inquiry does not require submission of this information to the environmental professional, but without this information we are unable to make a declaration regarding related conformance with the requirements of 40 CFR 312.

In order to qualify for innocent landowner, contiguous property owner, or bona fide prospective purchaser protections under CERCLA, any user of this assessment should assure conformance with these requirements.

Andy Bryan
Field Professional

Anthony Mueller
Project Manager

Appendix A:

Site Location and Site Plan



GRS GROUP

AERIAL PHOTOGRAPH
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

SITE LOCATION MAP
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



MAP DATE: July 1, 1995

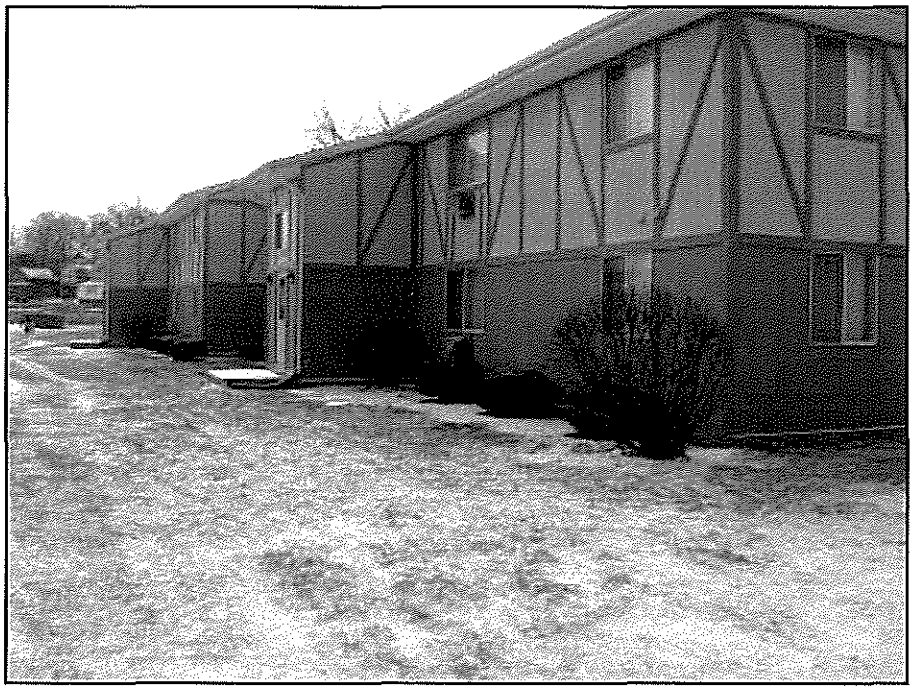
GRS GROUP

TOPOGRAPHIC MAP
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

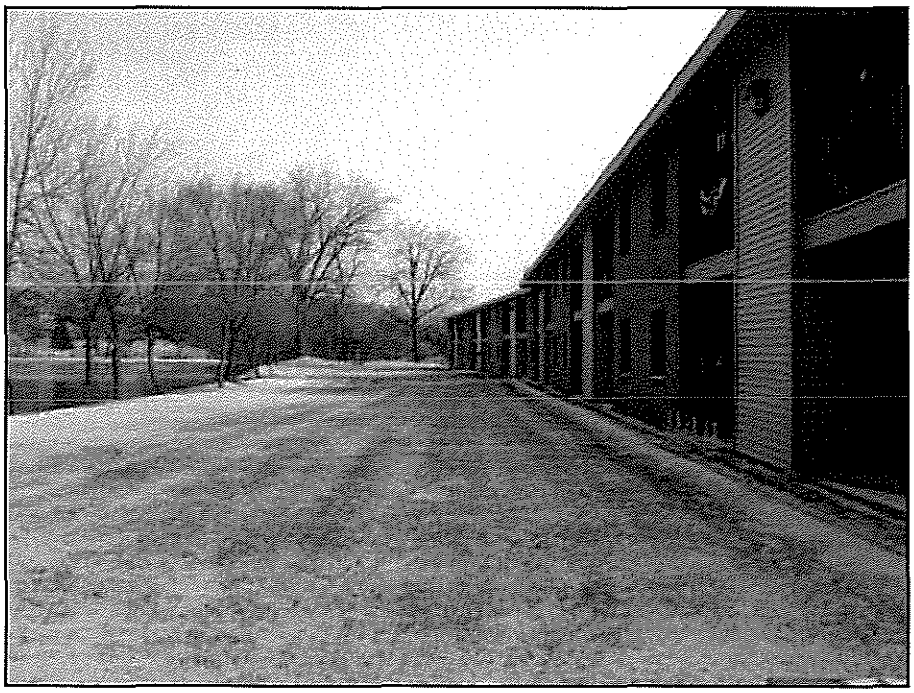
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009

Appendix B:

Photographs



Front elevation of Bicentennial Court building



Rear building elevations



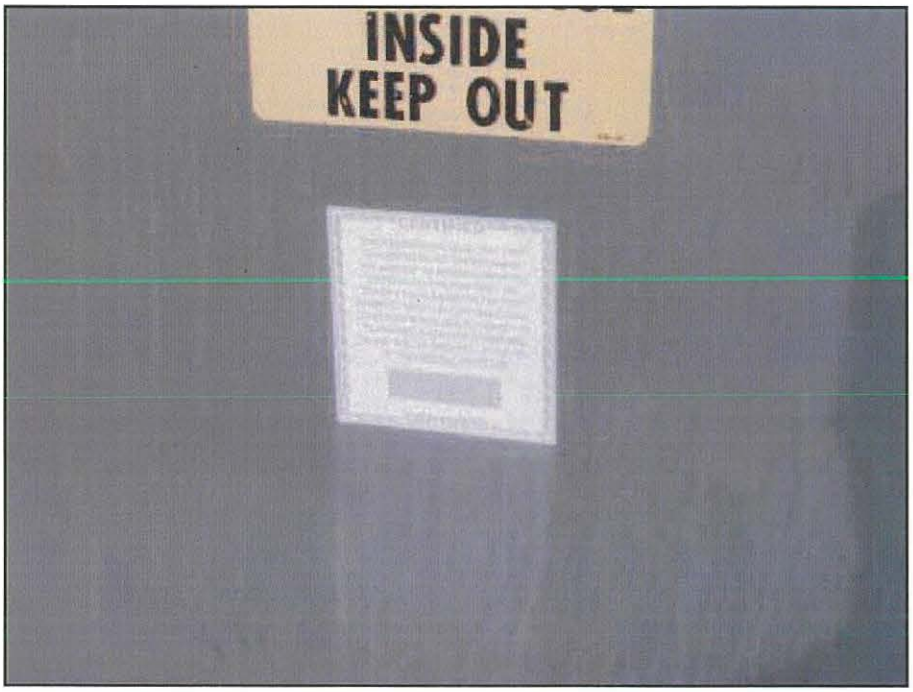
Side elevations of Bicentennial Court buildings



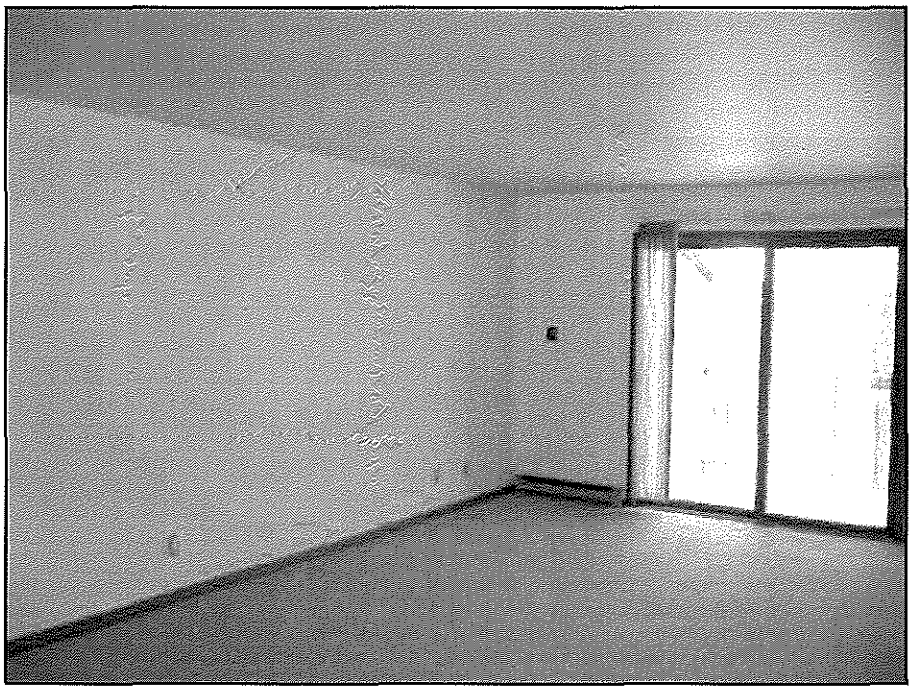
View of parking garages



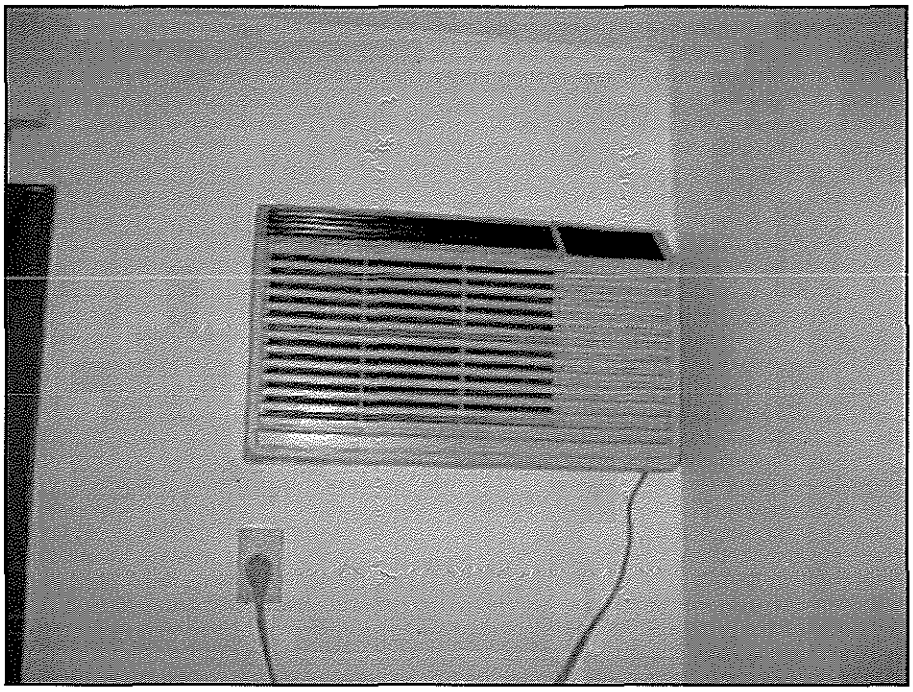
View of parking area



Non- PCB transformer signage on transformer



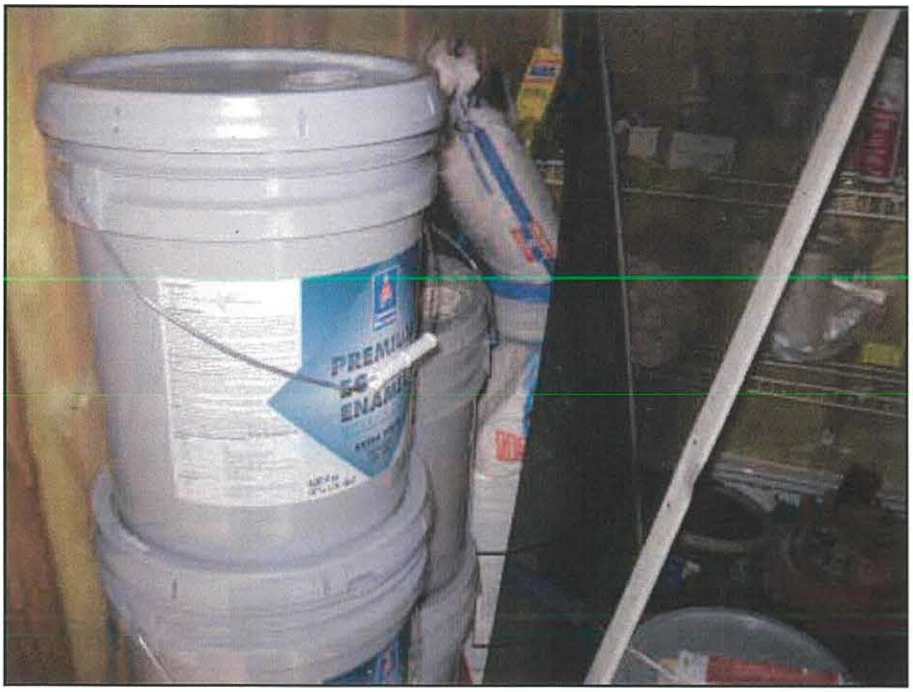
Interior finishes in apartment



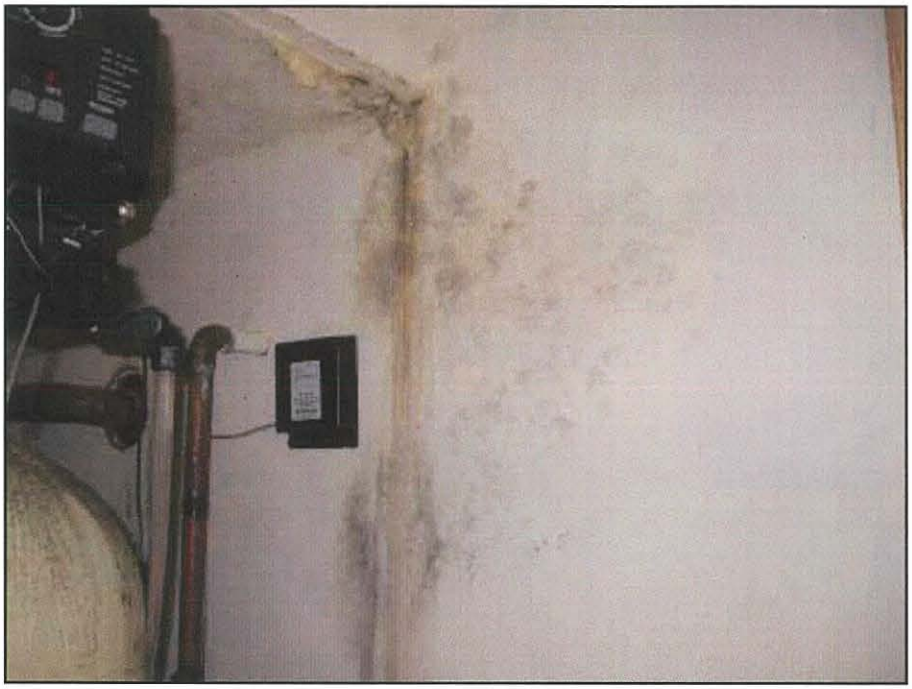
Through wall A/C unit



Building maintenance product storage



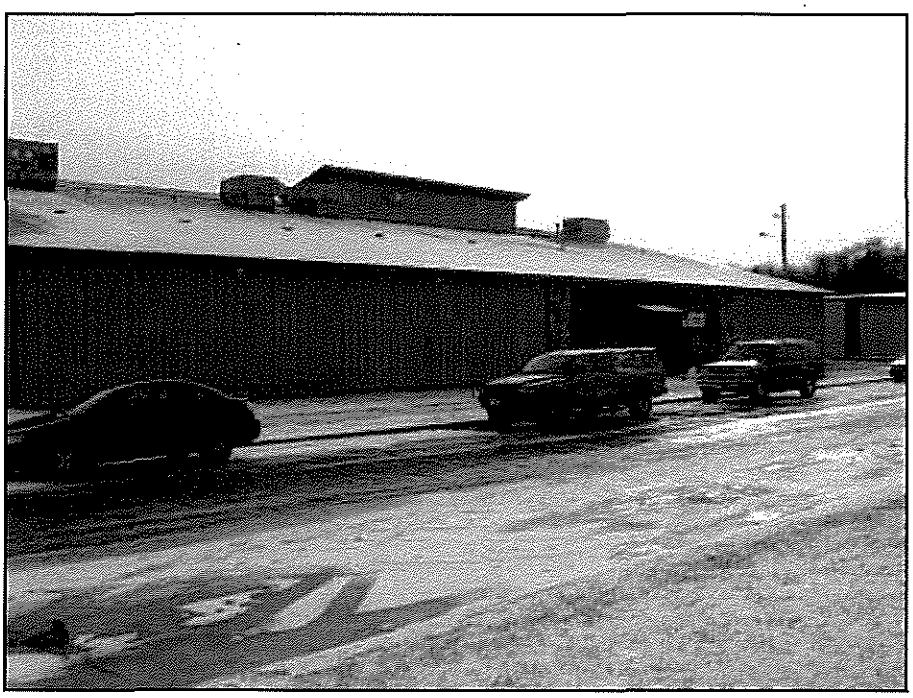
Building maintenance product storage



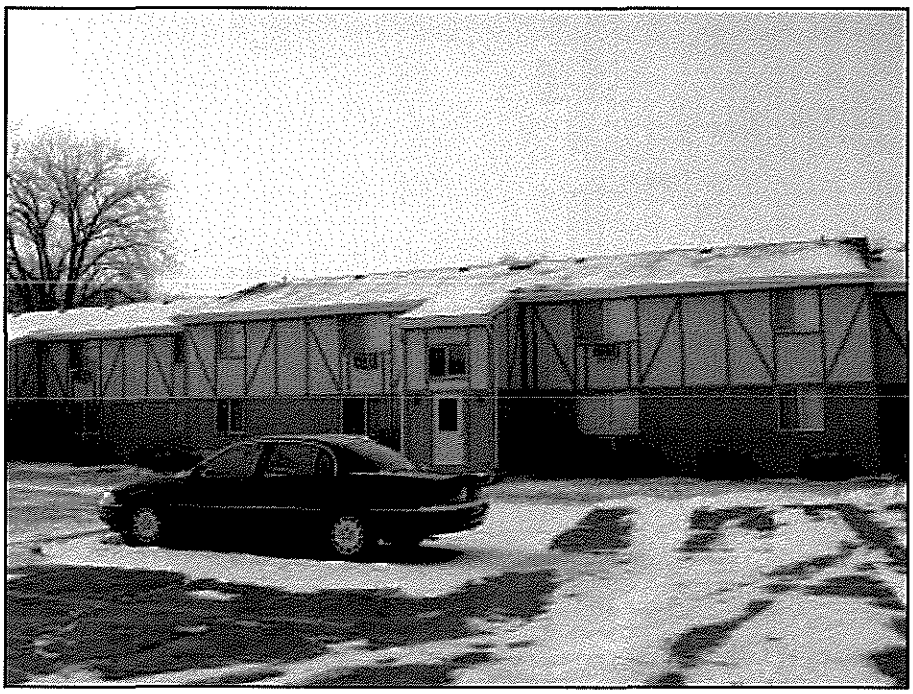
Minor mold growth in utility room



Adjacent property to the north



Adjacent property to the east



Adjacent property to the west



Adjacent property to the south



Adjacent property to the south

Appendix C:

Limitations of ESA Standard

Exclusions from and Limitations of the ESA Standard

General

The following information concerning exclusions from the ESA standard is provided for clarification and is not intended to reduce or limit similar clarifications contained within the ESA Standard. Certain inherent limitations in the ESA Standard are discussed here; however the reader should review the full standard in order to assure an appropriate understanding of work.

Principles of the ESA Standard

Considerations Beyond Scope—The use of this practice is strictly limited to the scope set forth in this section. Section 13 of this practice identifies, for informational purposes, certain environmental conditions (not an all-inclusive list) that may exist on a property that are beyond the scope of this practice but may warrant consideration by parties to a commercial real estate transaction. The need to include an investigation of any such conditions in the environmental professional's scope of services should be evaluated based upon, among other factors, the nature of the property and the reasons for performing the assessment (for example, a more comprehensive evaluation of business environmental risk) and should be agreed upon between the user and environmental professional as additional services beyond the scope of this practice prior to initiation of the environmental site assessment process

CERCLA Requirements Other Than Appropriate Inquiry—This practice does not address whether requirements in addition to all appropriate inquiry have been met in order to qualify for the LLPs (for example, the duties specified in 42 U.S.C. §9607(b)(3)(a) and (b) and cited in Appendix X1, including the continuing obligation not to impede the integrity and effectiveness of activity and use limitations (AULs), or the duty to take reasonable steps to prevent releases, or the duty to comply with legally required release reporting obligations).

Other Federal, State, and Local Environmental Laws—This practice does not address requirements of any state or local laws or of any federal laws other than the all appropriate inquiry provisions of the LLPs. Users are cautioned that federal, state, and local laws may impose environmental assessment obligations that are beyond the scope of this practice. Users should also be aware that there are likely to be other legal obligations with regard to hazardous substances or petroleum products discovered on the property that are not addressed in this practice and that may pose risks of civil and/or criminal sanctions for non-compliance.

Practically Reviewable—information that is practically reviewable means that the information is provided by the source in a manner and in a form that, upon examination, yields information relevant to the property without the need for extraordinary analysis of irrelevant data. The form of the information shall be such that the user can review the records for a limited geographic area. Records that cannot be feasibly retrieved by reference to the location of the property or a geographic area in which the property is located are not generally practically reviewable. Most databases of public records are practically reviewable if they can be obtained from the source agency by the county, city, zip code, or other geographic area of the facilities listed in the record system. Records that are sorted, filed, organized, or maintained by the source agency only chronologically are not generally practically reviewable. Listings in publicly available records which do not have adequate address information to be located geographically are not generally considered practically reviewable. For large databases with numerous records (such as RCRA hazardous waste generators and registered underground storage tanks), the records are not practically reviewable unless they can be obtained from the source agency in the smaller geographic area of zip codes. Even when information is provided by zip code for some large

databases, it is common for an unmanageable number of sites to be identified within a given zip code. In these cases, it is not necessary to review the impact of all of the sites that are likely to be listed in any given zip code because that information would not be practically reviewable. In other words, when so much data is generated that it cannot be feasibly reviewed for its impact on the property, it is not practically reviewable.

Reasonably Ascertainable—information that is (1) publicly available, (2) obtainable from its source within reasonable time and cost constraints, and (3) practically reviewable.

Non-Scope Considerations

(Excerpted from the ESA Standard)

The following are identified as "Non-Scope Considerations under the ESA Standard. Unless the expressly identified in the agreed proposal for services, all tasks identified below are excluded from this Assessment.

13.1 General:

13.1.1 Additional Issues—There may be environmental issues or conditions at a property that parties may wish to assess in connection with commercial real estate that are outside the scope of this practice (the non-scope considerations). As noted by the legal analysis in Appendix X1 of this practice, some substances may be present on a property in quantities and under conditions that may lead to contamination of the property or of nearby properties but are not included in CERCLA's definition of hazardous substances (42 U.S.C. §9601(14)) or do not otherwise present potential CERCLA liability. In any case, they are beyond the scope of this practice.

13.1.2 Outside Standard Practices—Whether or not a user elects to inquire into non-scope considerations in connection with this practice or any other environmental site assessment, no assessment of such non-scope considerations is required for appropriate inquiry as defined by this practice.

13.1.3 Other Standards—There may be standards or protocols for assessment of potential hazards and conditions associated with non-scope conditions developed by governmental entities, professional organizations, or other private entities.

13.1.4 Compliance With AULs—Parties who wish to qualify for one of the LLPs will need to know whether they are in compliance with AULs, including land use restrictions that were relied upon in connection with a response action. A determination of compliance with AULs is beyond the scope of this practice.

13.1.5 List of Additional Issues—Following are several non-scope considerations that persons may want to assess in connection with commercial real estate. No implication is intended as to the relative importance of inquiry into such non-scope considerations, and this list of non-scope considerations is not intended to be all-inclusive:

13.1.5.1 Asbestos-Containing Building Materials,

13.1.5.8 Industrial hygiene,

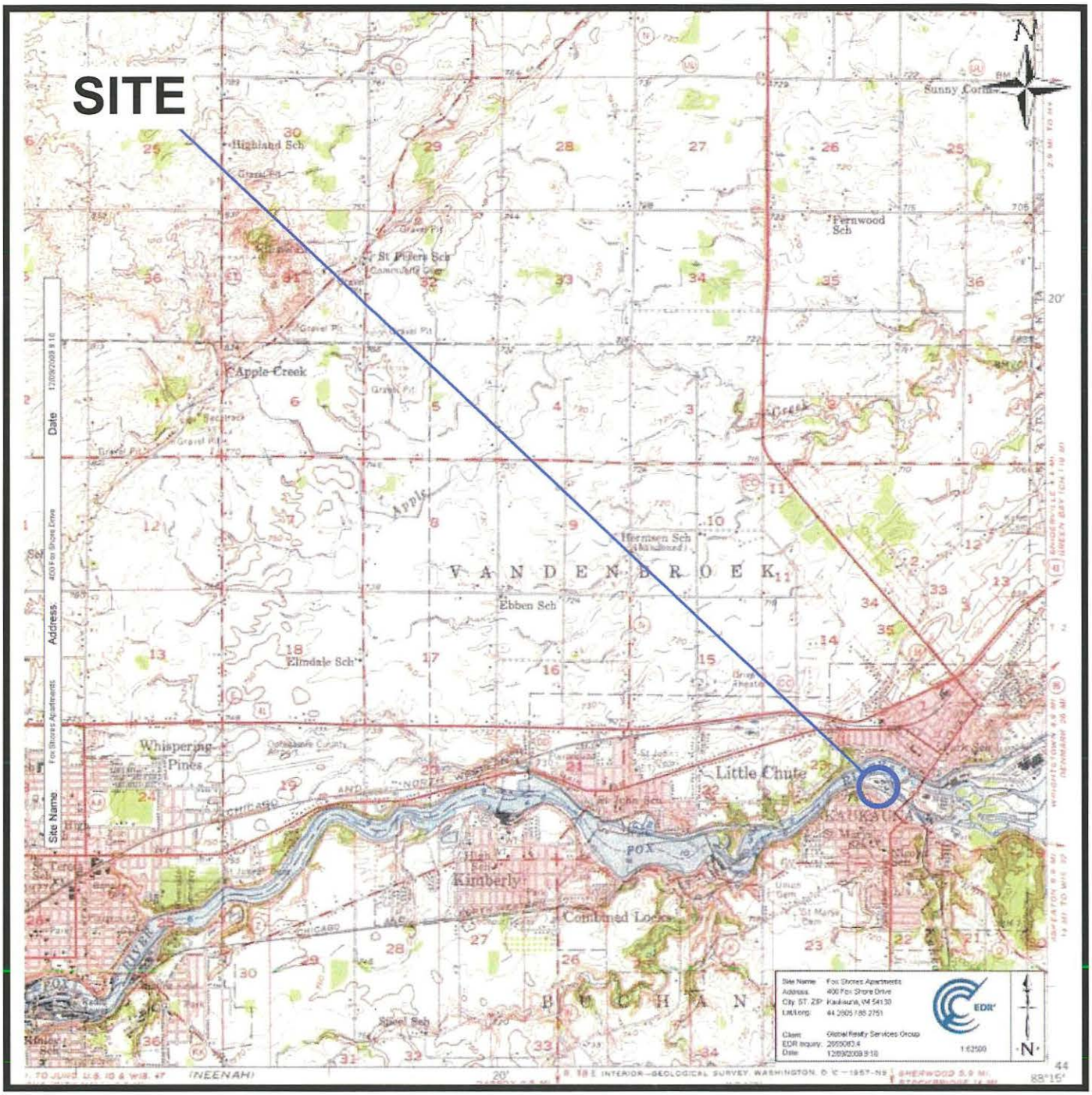
13.1.5.2 Radon,
13.1.5.3 Lead-Based Paint,
13.1.5.4 Lead in Drinking Water,
13.1.5.5 Wetlands,
13.1.5.6 Regulatory compliance,
13.1.5.7 Cultural and historic resources,
13.1.5.9 Health and safety,
13.1.5.10 Ecological resources,
13.1.5.11 Endangered species,
13.1.5.12 Indoor air quality,
13.1.5.13 Biological agents, and
13.1.5.14 Mold.

Activity Exclusions

- Accessing manholes or utility pit
- Entering of plenum, crawl, or confined space areas (however, the field observer should observe conditions to the extent easily visible from the point of access to the crawl or confined space areas, provided such points of access are readily accessible), determination of previous substructure flooding or water penetration unless easily visible or if such information is provided
- Walking on pitched roofs, or any roof areas that appear to be unsafe, or roofs with no built-in access, or determining any roofing design criteria
- Testing and design of equipment
- Collection of samples except as identified in the agreement under which the work is performed.
- Removing, relocating, or repositioning of materials, ceiling, wall, or equipment panels, furniture, storage containers, personal effects, debris material or finishes; conducting exploratory probing or testing; dismantling or operating of equipment; or disturbing personal items or property, that obstructs access or visibility,
- Preparing engineering calculations to determine any the adequacy or compliance of systems and components,
- Reporting on subterranean conditions
- Entering or accessing any area of the premises deemed to potentially pose a threat of dangerous or adverse conditions with respect to the field observer's health or safety, or to perform any procedure, that may damage or impair the physical integrity of the property, any system, or component.
- Compliance with any federal, state, or local statute, ordinance, rule or regulation including, but not limited to, fire and building codes, life safety codes, environmental regulations, health codes, zoning ordinances, compliance with trade design standards, or standards developed by the insurance industry.
- Compliance of any material, equipment, or system with any certification or actuation rate program, vendor's or manufacturer's warranty provisions, or provisions established by any standards that are related to insurance industry acceptance/approval, such as FM, State Board of Fire Under- writers, etc.

Appendix D:

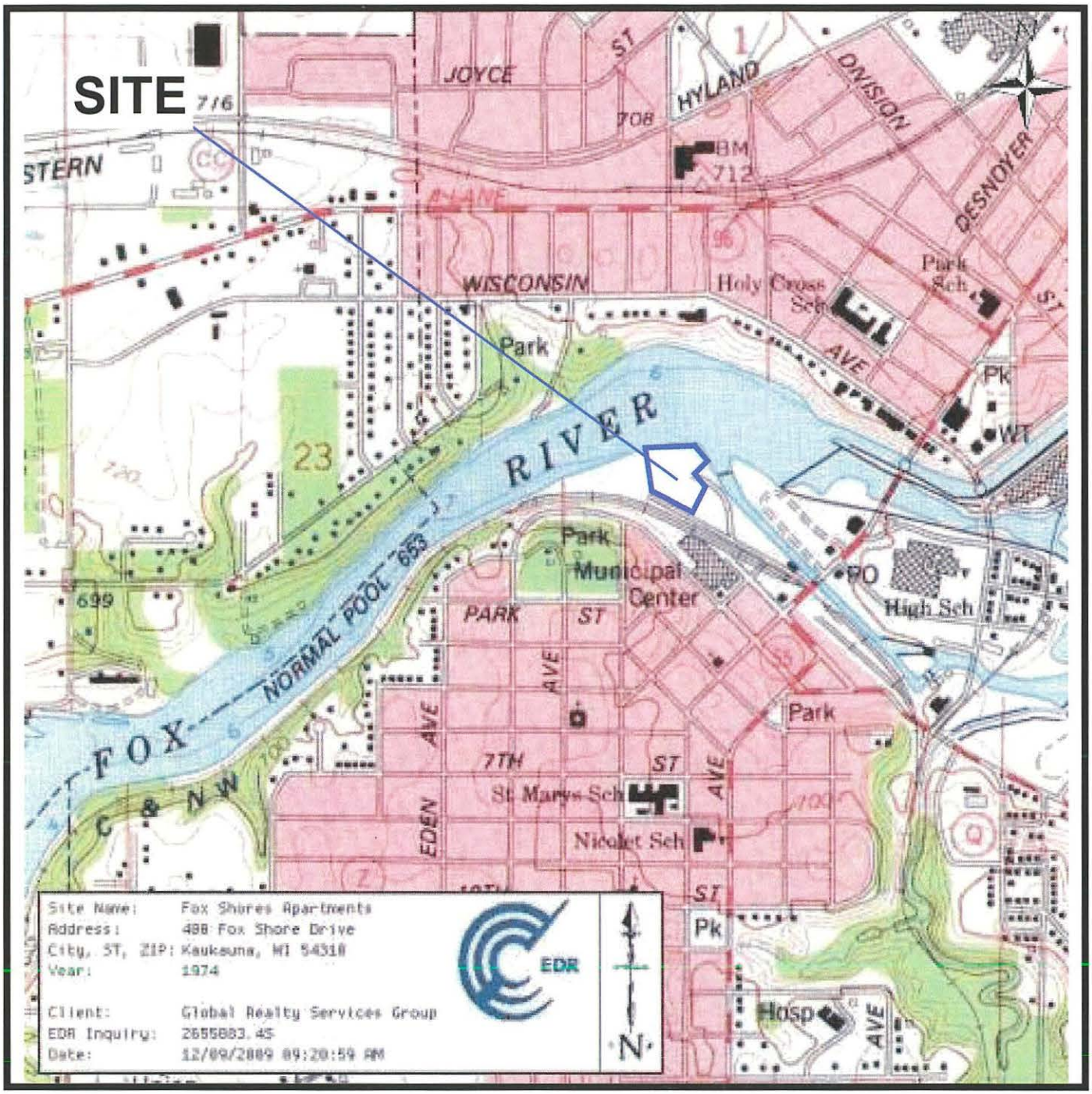
Supporting Documentation



GRS GROUP

1955 Topographic Map
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/18/2009



GRS GROUP

1974 Topographic Map
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

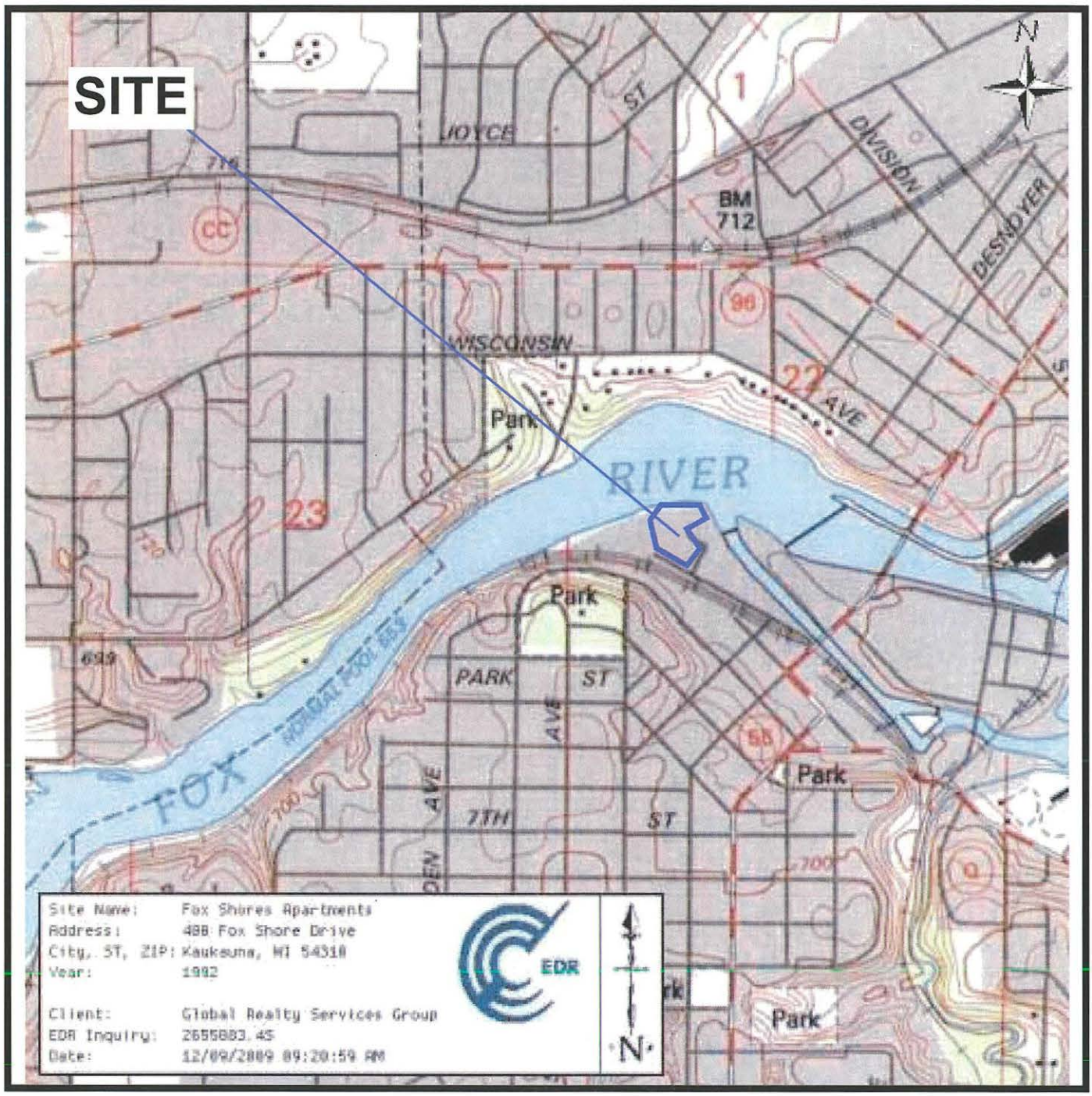
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/18/2009



GRS GROUP

1984 Topographic Map
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/18/2009



GRS GROUP

1992 Topographic Map
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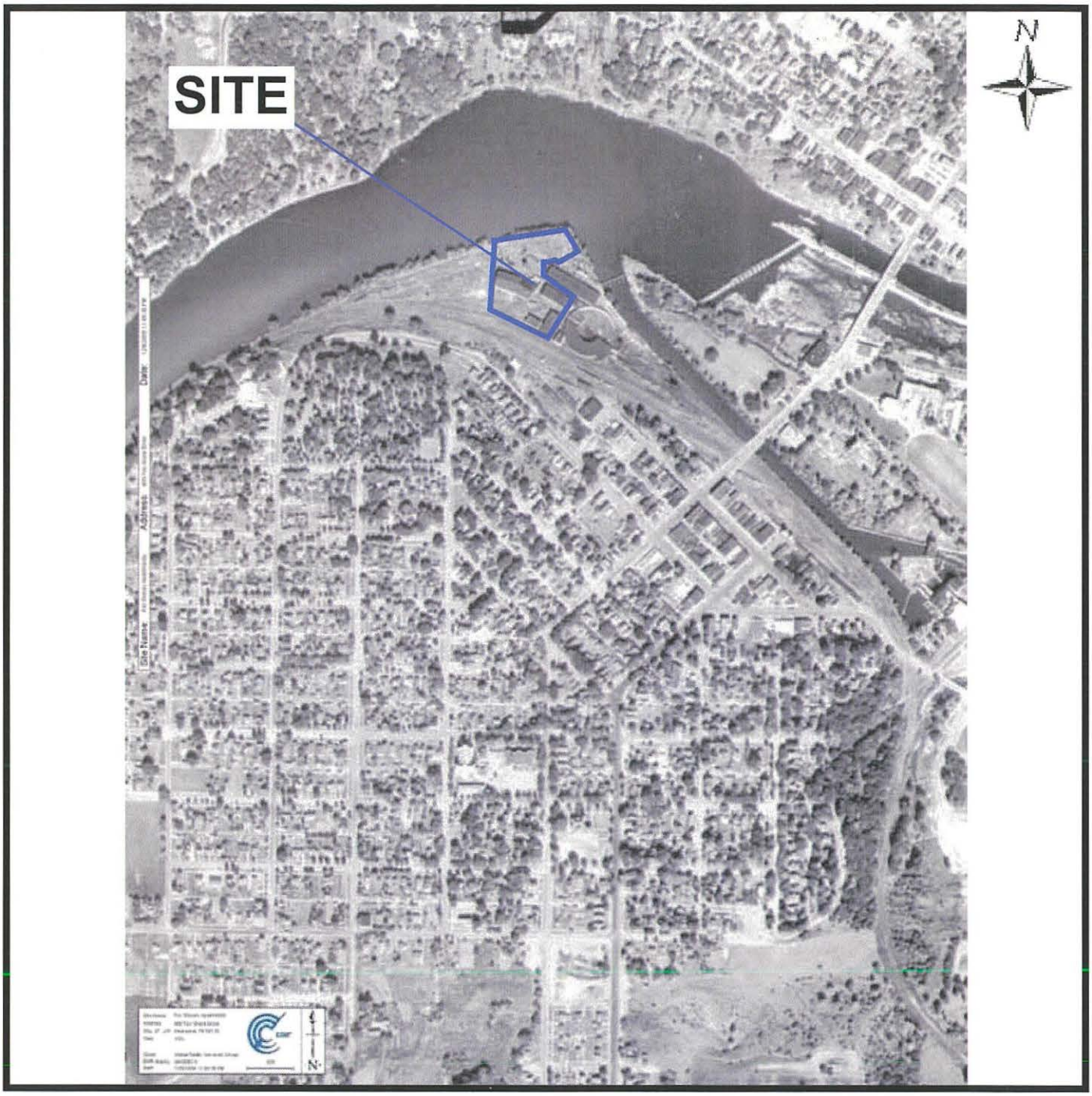
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/18/2009



GRS GROUP

1952 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

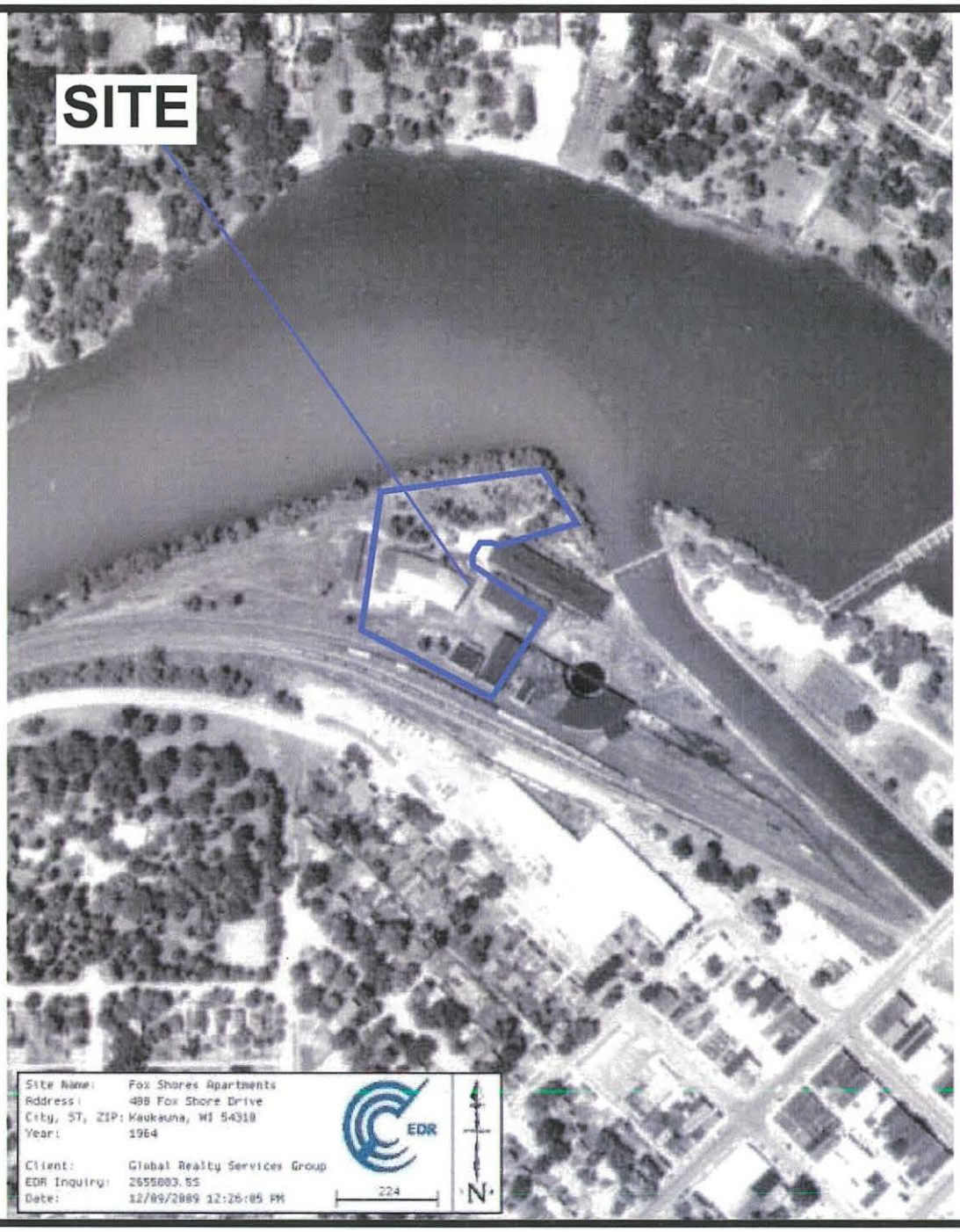
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

1957 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

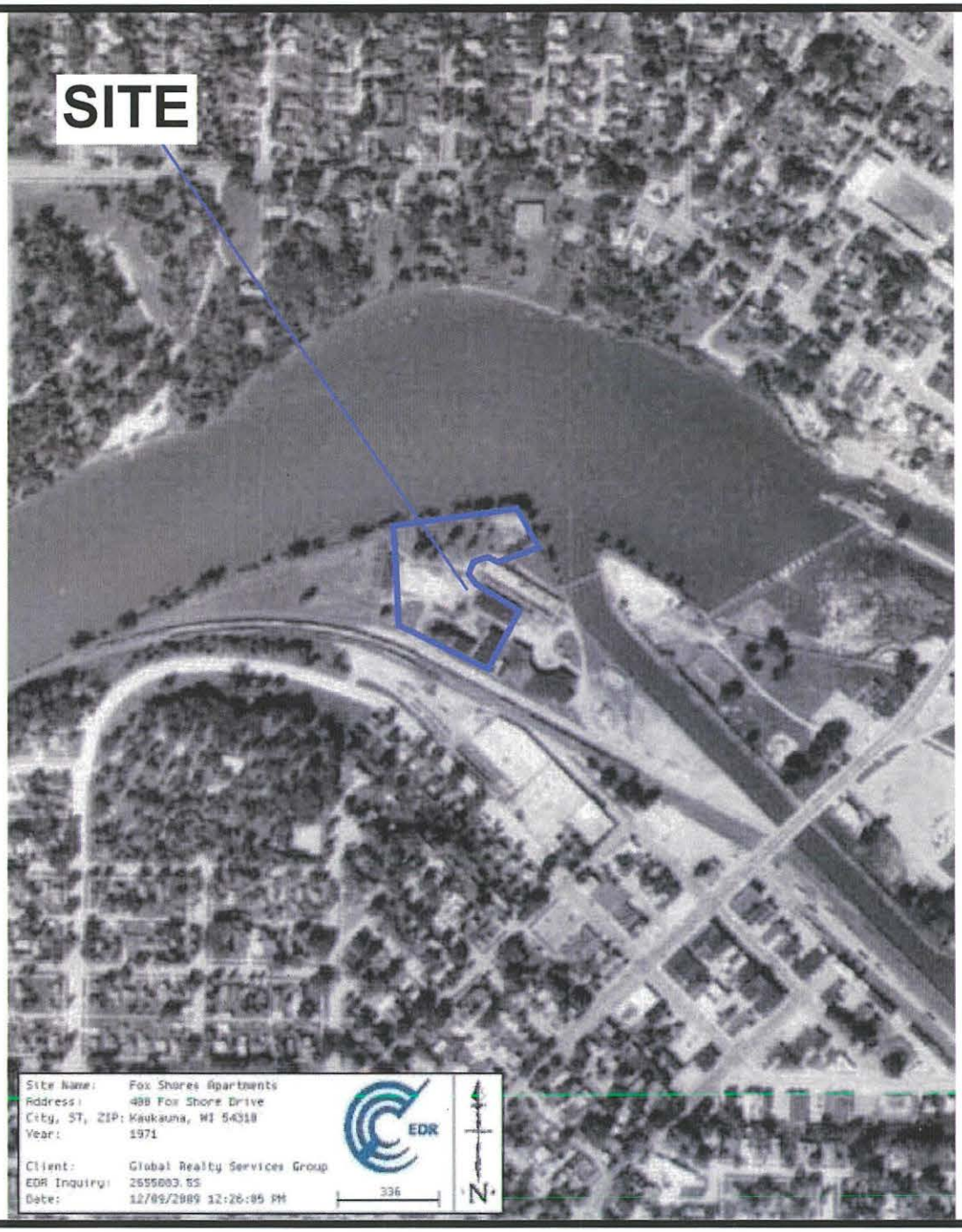
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

1964 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

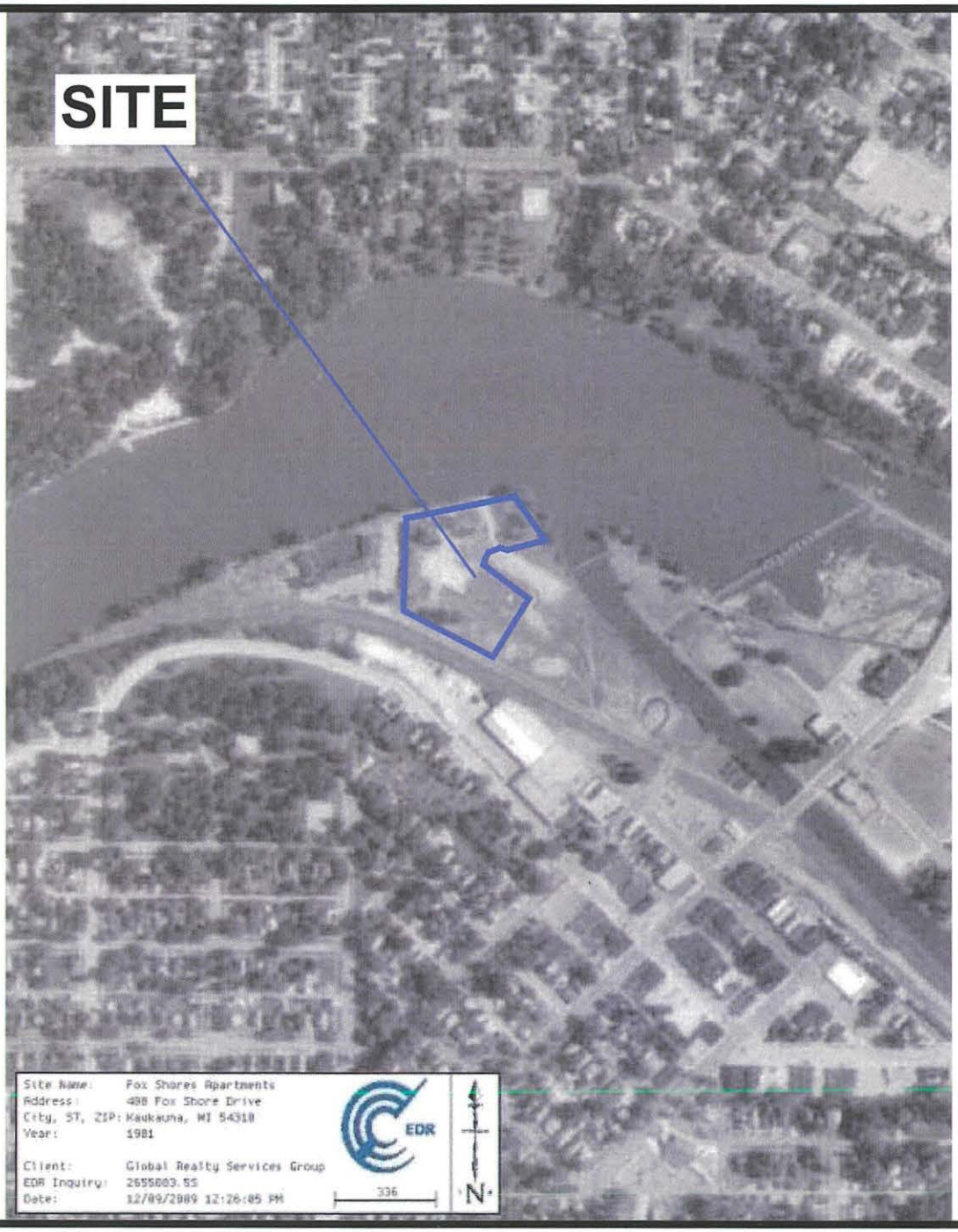
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

1971 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

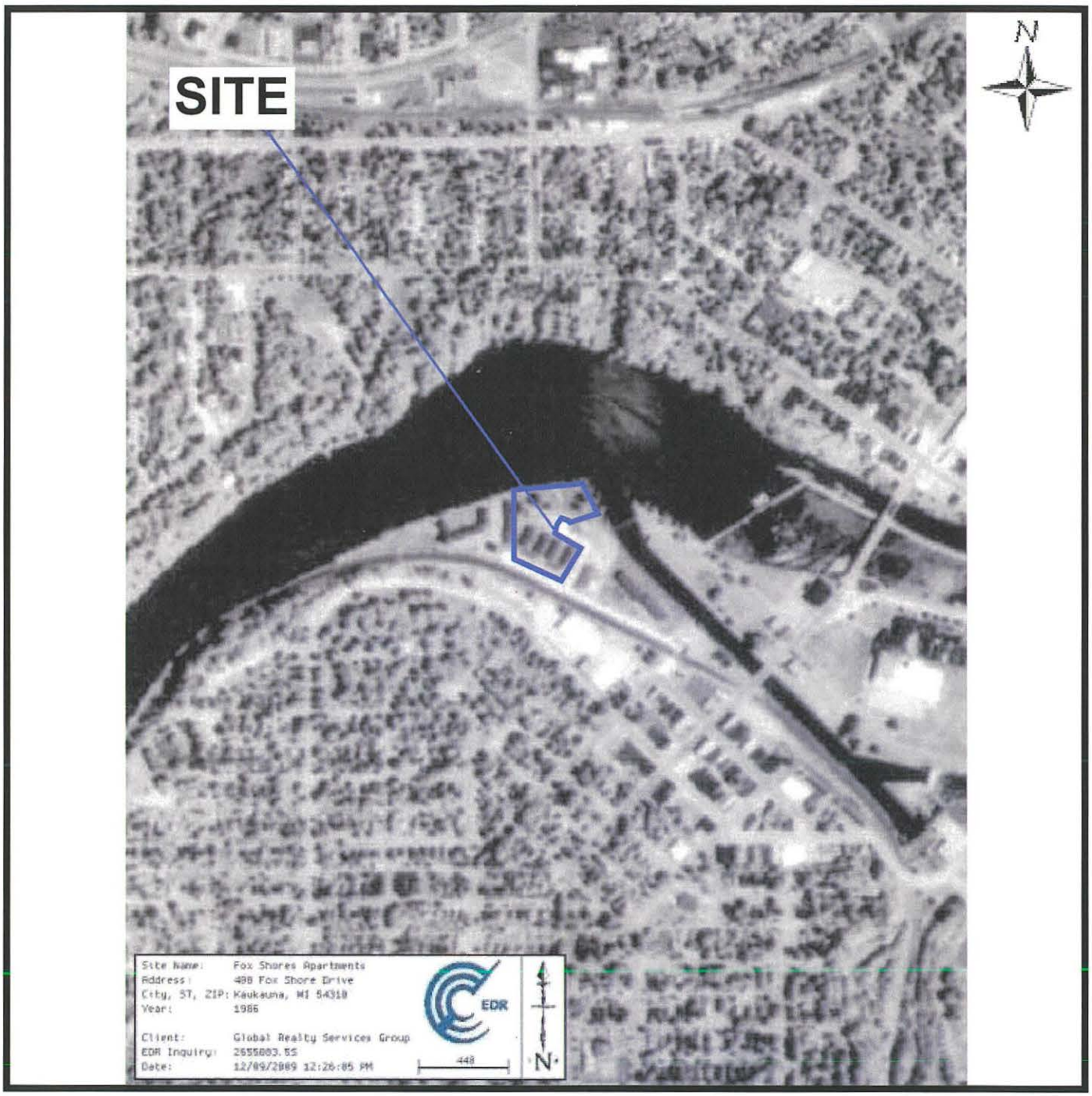
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

1981 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

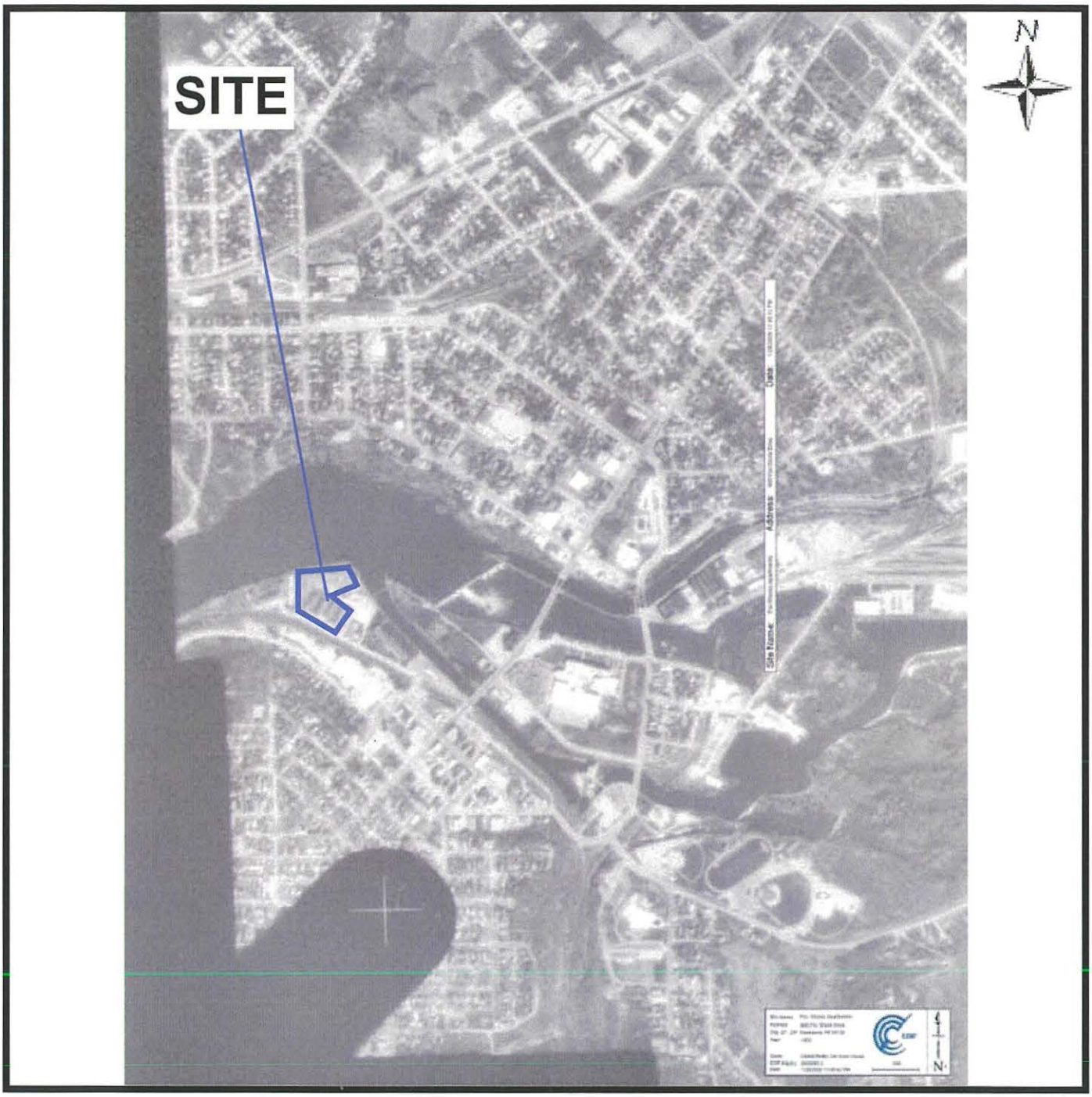
PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

1986 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

1992 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009



GRS GROUP

2005 Aerial Photo
Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI

PROJ. #: 003-09-3469
DRAWN BY: Andy Bryan
DATE: 12/17/2009

Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI 54130

Inquiry Number: 2655083.5
December 09, 2009

The EDR Aerial Photo Decade Package

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
800.352.0050
www.edrnet.com

Date EDR Searched Historical Sources:

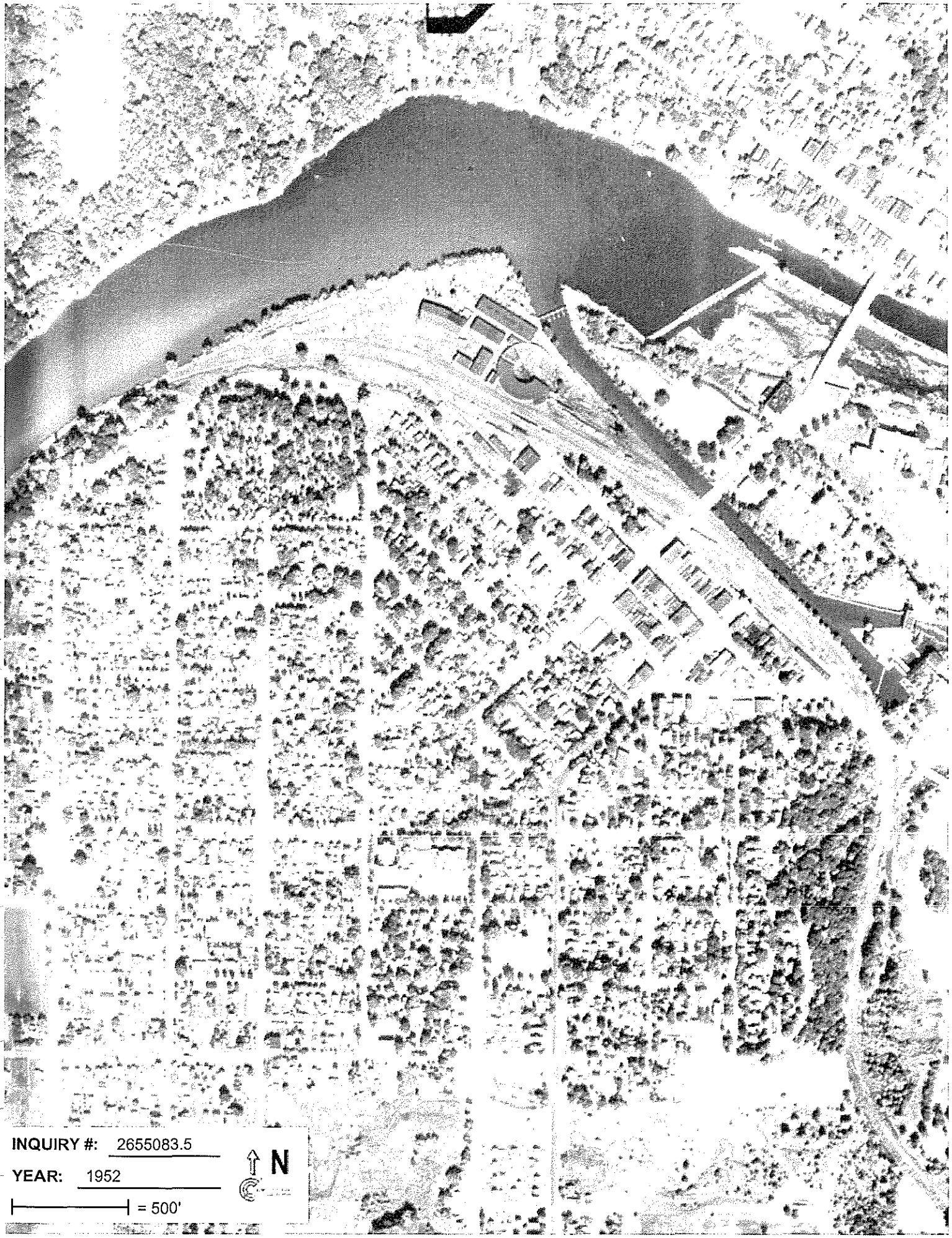
Aerial Photography December 09, 2009

Target Property:

400 Fox Shore Drive

Kaukauna, WI 54130

Year	*Scale*	*Details*	*Source*
1952	Aerial Photograph. Scale: 1"=500'	Panel #: 2444088-C3/Flight Date: September 26, 1952	EDR
1957	Aerial Photograph. Scale: 1"=750'	Panel #: 2444088 C3/Flight Date: September 29, 1957	EDR
1964	Aerial Photograph. Scale: 1"=500'	Panel #: 2444088-C3/Flight Date: June 10, 1964	EDR
1971	Aerial Photograph. Scale: 1"=750'	Panel #: 2444088-C3/Flight Date: August 28, 1971	EDR
1981	Aerial Photograph. Scale: 1"=750'	Panel #: 2444088-C3/Flight Date: July 07, 1981	EDR
1986	Aerial Photograph. Scale: 1"=1000'	Panel #: 2444088-C3/Flight Date: June 08, 1986	EDR
1992	Aerial Photograph. Scale: 1"=750'	Panel #: 2444088-C3/Flight Date: May 06, 1992	EDR
2005	Aerial Photograph. 1" = 604'	Flight Year: 2005	EDR


INQUIRY #: 2655083.5
YEAR: 1952
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N


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YEAR: 1957
= 750'
N


INQUIRY #: 2655083.5
YEAR: 1964
= 500'
N


INQUIRY #: 2655083.5
YEAR: 1971
= 750'
N


INQUIRY #: 2655083.5
YEAR: 1981
= 750'
N


INQUIRY #: 2655083.5
YEAR: 1986
= 1000'
N



INQUIRY #: 2655083.5

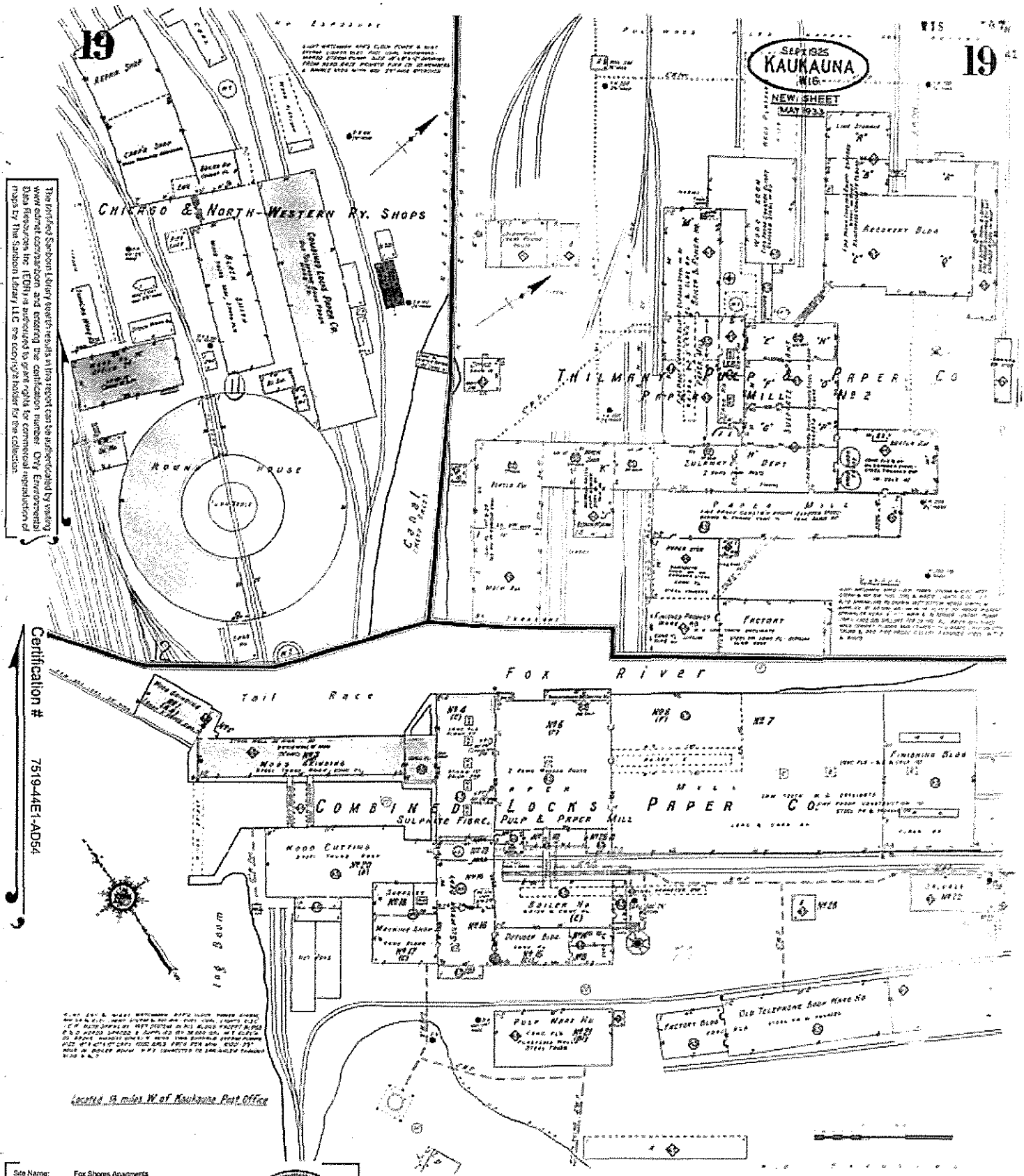
YEAR: 1992

= 750'

N


INQUIRY #: 2655083.5
YEAR: 2005
= 604'
N

1945 Certified Sanborn Map



Certification # 7519-44E1-AD54

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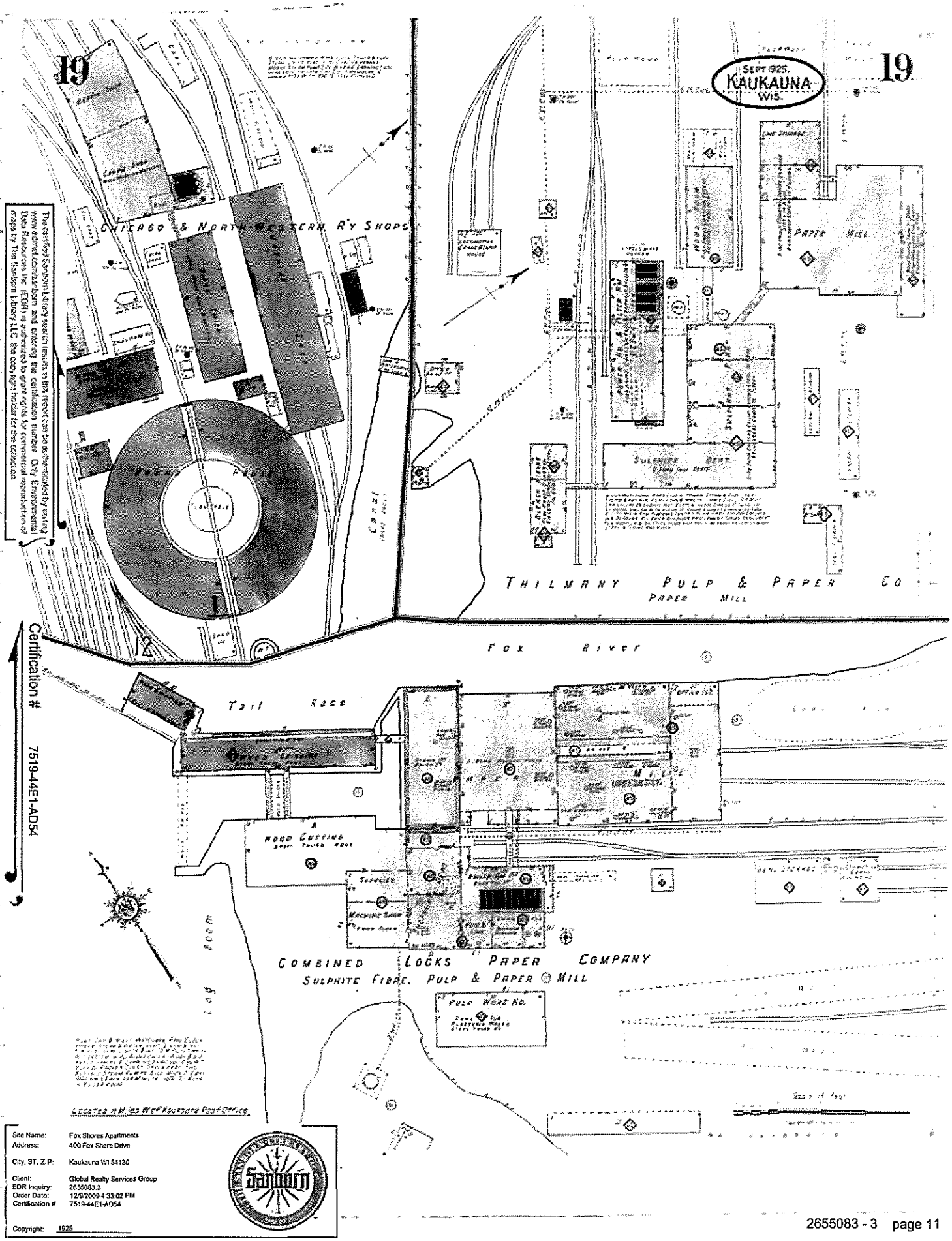
Site Name:	Fox Shores Apartments
Address:	400 Fox Shore Drive
City, ST, ZIP:	Kaukauna WI 54130
Client:	Global Realty Services Group
EDR Inquiry:	2655083.3
Order Date:	12/9/2009 4:33:02 PM
Certification #	7519-44E1-AD54

Copyright: 1945

1925 Certified Sanborn Map



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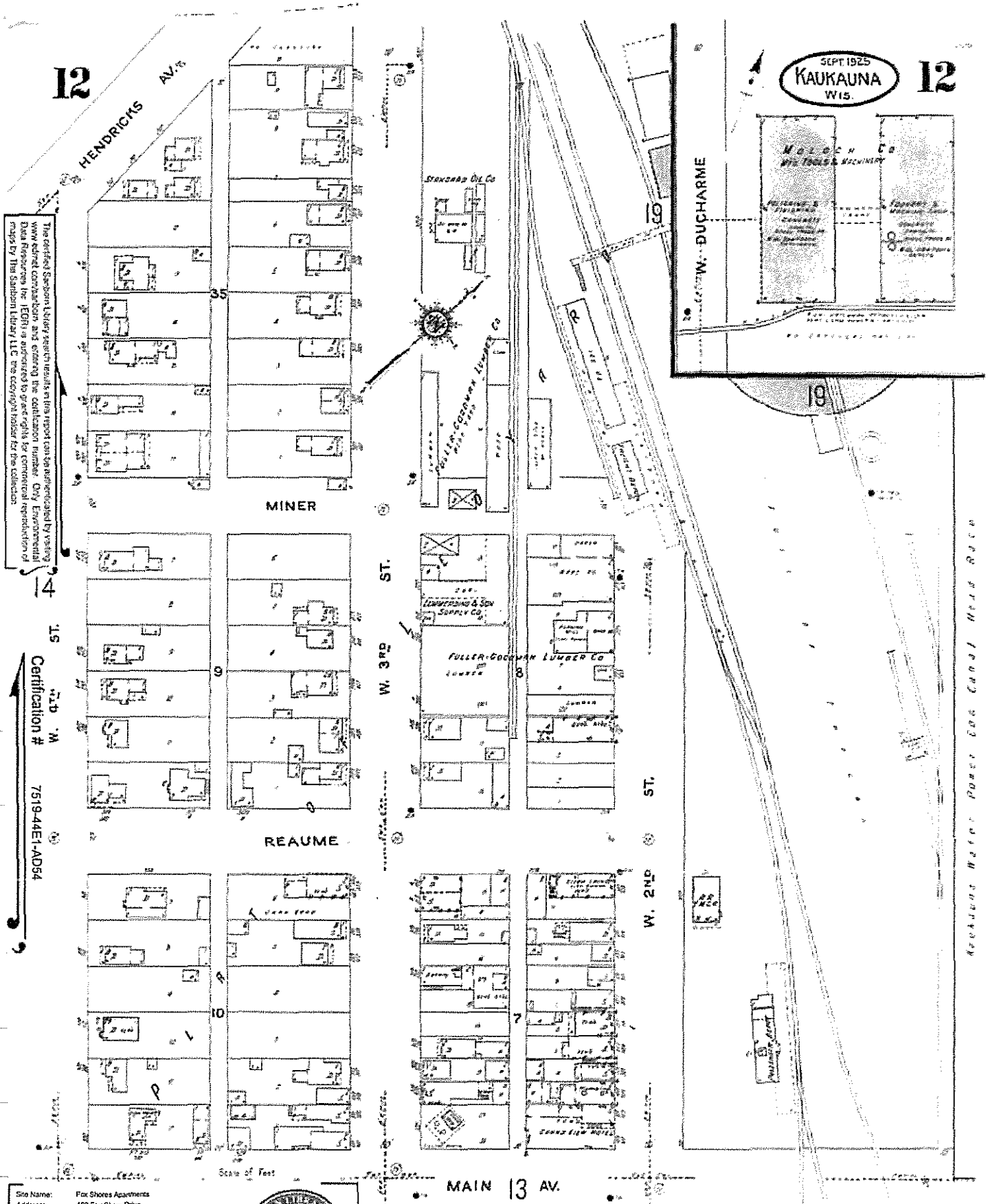
Site Name: Fox Shores Apartments
Address: 400 Fox Shore Drive
City, ST, ZIP: Kaukauna WI 54130

Client: Global Realty Services Group
EDR Inquiry: 2655083.3
Order Date: 12/9/2009 4:33:02 PM
Certification #: 7519-44E1-AD54

Copyright: 1925

1925 Certified Sanborn Map



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Client:	Global Realty Services Group
EDR Inquiry:	2655083.3
Order Date:	12/9/2009 4:33:02 PM
Certification #	7519-44E1-AD54

Copyright: 1925

AccuStar Labs
INFORMATION FORM - Large Buildings - Projects - Apartments

Read instructions carefully
Discrepancies will invalidate tests
48 hr exposure recommended

Do not use this form in New Jersey or Florida Call for correct forms.

Test Site Info

Name of Building/Project or Owner: FOX STONES APARTMENTS
Site Address: 400 FOX STONE DR
City: KAUKAUNA State: WI Zip: 54130 County:
Projects Contact Name: ANDY BRYAN Phone: 847-475-7108 Email: andy_bryan@comcast.net

Multi-Page Report Y-N

Detector Serial#	ROOM NAME & NUMBER - LOCATION OF DETECTOR IN ROOM (Indicate duplicates and blanks)	Floor	Start Date	Start Time Include AM/PM	Stop Date	Stop Time Include AM/PM	LAB USE ONLY Wgt. Gain	LAB USE ONLY pCi/L
2106841	F400-4, KITCHEN	1	12-7-09	11:17 AM	12-9-09			
2106842	F410-5, KITCHEN	1	12-7-09	11:30 AM	12-9-09			
2106840	B410-1, KITCHEN	1	12-7-09	12:03 PM	12-9-09			

Structure Type: (circle one or more) Basement - Crawlspace - Slab on Grade - Other

Test Purpose: (circle all that apply) Initial Screening - Follow Up Test - Post Mitigation - Real Estate - Other

Building Type: Circle One Residential - Non Residential; Private Day Care - Private School; Day Care in Public School - Public School

Both Placed by and Retrieved by signatures are required

Canisters placed by: ANDY BRYAN

Canisters retrieved by: TOM VANDEVENTER

Certified Testers Provide #

#

#

Were general operating conditions maintained? Yes - No explain if NO

Were closed building conditions maintained? Yes - No explain if NO

Normal Temp. Yes - No
Normal Humidity Yes - No
Windy Y - Rainy Y

write explanations on back of form

Send Results To:

Company Name: GLOBAL REALTY SERVICES Attention: TONY MUELLER
Address: 2 NORTH LASALLE ST, SUITE 1300
City: CHICAGO State: IL Zip: 60602
Phone: 312-476-7621 Fax: 888-207-2017
EMAIL Results to: tmueller@grs-global.net

Make sure information is complete and correct.

If a recalculation is requested there is a $10.00 recalc fee PER Canister.

Mailing: PO Box 562 Jonestown,PA 17038
Shipping: 929 Mt Zion Road, Lebanon, PA 17046
800-523-4964 fax 717-274-5662

Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI 54130

Inquiry Number: 2655083.2s
December 08, 2009

The EDR Radius Map™ Report with GeoCheck®

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
Toll Free: 800.352.0050
www.edrnet.com

TABLE OF CONTENTS

SECTION	PAGE
Executive Summary	ES1
Overview Map	2
Detail Map	3
Map Findings Summary	4
Map Findings	7
Orphan Summary	368
Government Records Searched/Data Currency Tracking	GR-1

GEOCHECK ADDENDUM

Physical Setting Source Addendum	A-1
Physical Setting Source Summary	A-2
Physical Setting SSURGO Soil Map	A-5
Physical Setting Source Map	A-11
Physical Setting Source Map Findings	A-12
Physical Setting Source Records Searched	A-86

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-05) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

400 FOX SHORE DRIVE
KAUKAUNA, WI 54130

COORDINATES

Latitude (North):	44.280500 - 44° 16' 49.8"
Longitude (West):	88.275100 - 88° 16' 30.4"
Universal Tranverse Mercator:	Zone 16
UTM X (Meters):	398249.7
UTM Y (Meters):	4903602.0
Elevation:	657 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	44088-C3 KAUKAUNA, WI
Most Recent Revision:	1995

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	2006, 2005
Source:	USDA

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL---------- National Priority List

EXECUTIVE SUMMARY

Proposed NPL..... Proposed National Priority List Sites
NPL LIENS..... Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL..... National Priority List Deletions

Federal CERCLIS list

CERCLIS..... Comprehensive Environmental Response, Compensation, and Liability Information System

Federal CERCLIS NFRAP site List

CERC-NFRAP..... CERCLIS No Further Remedial Action Planned

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF..... RCRA - Transporters, Storage and Disposal

Federal RCRA generators list

RCRA-LQG..... RCRA - Large Quantity Generators
RCRA-SQG..... RCRA - Small Quantity Generators

Federal institutional controls / engineering controls registries

US ENG CONTROLS..... Engineering Controls Sites List
US INST CONTROL..... Sites with Institutional Controls

Federal ERNS list

ERNS..... Emergency Response Notification System

State- and tribal - equivalent CERCLIS

SHWS..... Hazard Ranking List

State and tribal landfill and/or solid waste disposal site lists

SWF/LF..... List of Licensed Landfills
WI WDS..... Registry of Waste Disposal Sites
SHWIMS..... Solid & Hazardous Waste Information Management System

State and tribal leaking storage tank lists

INDIAN LUST..... Leaking Underground Storage Tanks on Indian Land

State and tribal registered storage tank lists

INDIAN UST..... Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

CRS..... Closed Remediation Sites

State and tribal voluntary cleanup sites

INDIAN VCP..... Voluntary Cleanup Priority Listing

EXECUTIVE SUMMARY

State and tribal Brownfields sites

BEAP..... Brownfields Environmental Assessment Program

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS..... A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

ODI..... Open Dump Inventory
DEBRIS REGION 9..... Torres Martinez Reservation Illegal Dump Site Locations
INDIAN ODI..... Report on the Status of Open Dumps on Indian Lands

Local Lists of Hazardous waste / Contaminated Sites

US CDL..... Clandestine Drug Labs
CDL..... Clandestine Drug Lab Listing
US HIST CDL..... National Clandestine Laboratory Register

Local Land Records

LIENS 2..... CERCLA Lien Information
LUCIS..... Land Use Control Information System

Records of Emergency Release Reports

HMIRS..... Hazardous Materials Information Reporting System
SPILLS..... Spills Database
AGSPILLS..... Agricultural Spill Cases

Other Ascertainable Records

DOT OPS..... Incident and Accident Data
DOD..... Department of Defense Sites
FUDS..... Formerly Used Defense Sites
CONSENT..... Superfund (CERCLA) Consent Decrees
ROD..... Records Of Decision
UMTRA..... Uranium Mill Tailings Sites
MINES..... Mines Master Index File
TRIS..... Toxic Chemical Release Inventory System
TSCA..... Toxic Substances Control Act
FTTS..... FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
HIST FTTS..... FIFRA/TSCA Tracking System Administrative Case Listing
SSTS..... Section 7 Tracking Systems
ICIS..... Integrated Compliance Information System
PADS..... PCB Activity Database System
MLTS..... Material Licensing Tracking System
RADINFO..... Radiation Information Database
FINDS..... Facility Index System/Facility Registry System

EXECUTIVE SUMMARY

RAATS..... RCRA Administrative Action Tracking System
BRRTS..... Bureau of Remediation & Redevelopment Tracking System
DRYCLEANERS..... Five Star Recognition Program Sites
WI WRRSER..... Wisconsin Remedial Response Site Evaluation Report
AIRS..... Air Permit Program Listing
TIER 2..... Tier 2 Facility Listing
LEAD..... Lead Inspection Data
INDIAN RESERV..... Indian Reservations
SCRD DRYCLEANERS..... State Coalition for Remediation of Drycleaners Listing
PCB TRANSFORMER..... PCB Transformer Registration Database

EDR PROPRIETARY RECORDS

EDR Proprietary Records

Manufactured Gas Plants..... EDR Proprietary Manufactured Gas Plants

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

Federal RCRA CORRACTS facilities list

CORRACTS: CORRACTS is a list of handlers with RCRA Corrective Action Activity. This report shows which nationally-defined corrective action core events have occurred for every handler that has had corrective action activity.

A review of the CORRACTS list, as provided by EDR, and dated 09/15/2009 has revealed that there is 1 CORRACTS site within approximately 1 mile of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
K R WEST COMPANY INCORPORATED	*909 HYLAND AVENUE*	*NNW 1/2 - 1 (0.574 mi.)*	*35*	*363*

EXECUTIVE SUMMARY

Federal RCRA generators list

RCRA-CESQG: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

A review of the RCRA-CESQG list, as provided by EDR, and dated 11/12/2008 has revealed that there are 3 RCRA-CESQG sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
PECKMAN PROFESSIONAL IMAGING	*106 E 2ND ST*	*SE 1/8 - 1/4 (0.230 mi.)*	*14*	*90*
Lower Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
KAUKAUNA CITY BLDG	*201 W 2ND ST*	*SE 1/8 - 1/4 (0.156 mi.)*	*B5*	*12*
VANHOOF OIL AND SERVICE	*179 MAIN AVE*	*SE 1/8 - 1/4 (0.226 mi.)*	*E11*	*41*

State and tribal leaking storage tank lists

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Natural Resource's LUST Database.

A review of the LUST list, as provided by EDR, and dated 10/22/2009 has revealed that there are 18 LUST sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CITY OF KAUKAUNA PROPERTY Facility Status: OPEN	*147 W SECOND ST*	*SE 1/8 - 1/4 (0.191 mi.)*	*C6*	*14*
AUTOMOTIVE SUPPLY Facility Status: CLOSED	116 W THIRD ST	SSE 1/8 - 1/4 (0.226 mi.)	D10	40
JIMS CAR WASH Facility Status: CLOSED	100 W 3RD	SSE 1/8 - 1/4 (0.236 mi.)	D15	92
BALZA DX SVC STATION Facility Status: CLOSED	*200 DODGE ST*	*SSE 1/4 - 1/2 (0.321 mi.)*	*H20*	*134*
KAUKAUNA CTY Facility Status: CLOSED	*215 DODGE ST*	*SSE 1/4 - 1/2 (0.332 mi.)*	*H22*	*210*
KAUKAUNA CTY PROPERTY Facility Status: CLOSED	*225 DODGE ST*	*SSE 1/4 - 1/2 (0.338 mi.)*	*23*	*223*
COONENS QUIK STOP Facility Status: CLOSED	*200 LAWE ST*	*ENE 1/4 - 1/2 (0.366 mi.)*	*I24*	*225*
GUSTMAN CHEVROLET & OLDSMOBILE Facility Status: CLOSED	*222 LAWE ST*	*ENE 1/4 - 1/2 (0.372 mi.)*	*I25*	*234*
Not reported Facility Status: CLOSED	*305 LAWE ST*	*ENE 1/4 - 1/2 (0.399 mi.)*	*26*	*236*
Not reported Facility Status: CLOSED	*514 DRAPER ST*	*N 1/4 - 1/2 (0.417 mi.)*	*J27*	*240*

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
Not reported Facility Status: CLOSED Facility Status: CLOSED	*502 DRAPER ST*	*N 1/4 - 1/2 (0.418 mi.)*	*J28*	*251*
FOX CITIES REALTY PROPERTY Facility Status: CLOSED Facility Status: CLOSED	*401 LAWE ST*	*ENE 1/4 - 1/2 (0.430 mi.)*	*30*	*301*
Not reported Facility Status: CLOSED	*231 TAYLOR ST*	*NE 1/4 - 1/2 (0.466 mi.)*	*31*	*306*
EXPRESS CONVIENIENCE CENTER #6 Facility Status: CLOSED	*601 N LAWE ST*	*ENE 1/4 - 1/2 (0.498 mi.)*	*32*	*322*

Lower Elevation	Address	Direction / Distance	Map ID	Page
VANHOOF OIL AND SERVICE Facility Status: CLOSED Facility Status: CLOSED	*179 MAIN AVE*	*SE 1/8 - 1/4 (0.226 mi.)*	*E11*	*41*
KAUKAUNA AREA SCHOOL DISTRICT Facility Status: CLOSED	*101 OAK ST*	*ESE 1/4 - 1/2 (0.266 mi.)*	*F17*	*95*
ATF TIRES Facility Status: CLOSED	*225 E SECOND ST*	*SE 1/4 - 1/2 (0.325 mi.)*	*G21*	*155*
KAUKAUNA UTILITIES Facility Status: CLOSED	*777 ISLAND ST*	*SE 1/4 - 1/2 (0.498 mi.)*	*K33*	*333*

LAST: A listing of leaking aboveground storage tank sites.

A review of the LAST list, as provided by EDR, and dated 10/22/2009 has revealed that there is 1 LAST site within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
Not reported	*502 DRAPER ST*	*N 1/4 - 1/2 (0.418 mi.)*	*J28*	*251*

State and tribal registered storage tank lists

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Department of Commerces' List: All Underground Storage Tanks Except for Fuel Oil.

A review of the UST list, as provided by EDR, and dated 11/06/2009 has revealed that there are 6 UST sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
Not reported	222 W 3RD ST	SSE 1/8 - 1/4 (0.148 mi.)	A3	10
Not reported	147 W 2ND ST	SE 1/8 - 1/4 (0.192 mi.)	C7	36
Not reported	116 W 3RD ST	SSE 1/8 - 1/4 (0.225 mi.)	D9	39
Not reported	112 W THIRD ST	SSE 1/8 - 1/4 (0.228 mi.)	D13	89
Not reported	100 E THIRD ST	SSE 1/8 - 1/4 (0.236 mi.)	D16	94

Lower Elevation	Address	Direction / Distance	Map ID	Page
Not reported	179 MAIN AVE	SE 1/8 - 1/4 (0.226 mi.)	E12	87

EXECUTIVE SUMMARY

AST: The Aboveground Storage Tank database contains registered ASTs. The data come from the Department of Industry, Labor & Human Resources' List: All Aboveground Storage Tanks Except for Fuel Oil.

A review of the AST list, as provided by EDR, and dated 11/06/2009 has revealed that there are 2 AST sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
Not reported	222 W 3RD ST	SSE 1/8 - 1/4 (0.148 mi.)	A2	9
Lower Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
Not reported	201 W 2ND ST	SE 1/8 - 1/4 (0.155 mi.)	B4	11

State and tribal institutional control / engineering control registries

AUL: Date a deed restriction is recorded at the Register of Deeds office for a property. Extent of soil contamination is known but impracticable to remove now or an engineering control is required to be maintained or NR720 industrial stds are applied. Restricts property use or requires future actions.

A review of the AUL list, as provided by EDR, and dated 10/22/2009 has revealed that there are 11 AUL sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
BALZA DX SVC STATION	*200 DODGE ST*	*SSE 1/4 - 1/2 (0.321 mi.)*	*H20*	*134*
KAUKAUNA CTY	*215 DODGE ST*	*SSE 1/4 - 1/2 (0.332 mi.)*	*H22*	*210*
COONENS QUIK STOP	*200 LAWE ST*	*ENE 1/4 - 1/2 (0.366 mi.)*	*I24*	*225*
Not reported	*514 DRAPER ST*	*N 1/4 - 1/2 (0.417 mi.)*	*J27*	*240*
Not reported	*502 DRAPER ST*	*N 1/4 - 1/2 (0.418 mi.)*	*J28*	*251*
Not reported	*231 TAYLOR ST*	*NE 1/4 - 1/2 (0.466 mi.)*	*31*	*306*
EXPRESS CONVIENIENCE CENTER #6	*601 N LAWE ST*	*ENE 1/4 - 1/2 (0.498 mi.)*	*32*	*322*
Lower Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
VANHOOF OIL AND SERVICE	*179 MAIN AVE*	*SE 1/8 - 1/4 (0.226 mi.)*	*E11*	*41*
KAUKAUNA PUBLIC SCHOOLS ADMIN	*112 MAIN AVE*	*E 1/4 - 1/2 (0.275 mi.)*	*F18*	*100*
ATF TIRES	*225 E SECOND ST*	*SE 1/4 - 1/2 (0.325 mi.)*	*G21*	*155*
KAUKAUNA ELECTRIC	*770 ISLAND ST*	*SE 1/4 - 1/2 (0.499 mi.)*	*K34*	*342*

State and tribal voluntary cleanup sites

VCP: The Voluntary Party Liability Exemption is an elective environmental cleanup program. Interested persons who meet the definition of "voluntary party" are eligib le to apply. A "voluntary party" is any person who submits an application and pays all the necessary fees.

A review of the VCP list, as provided by EDR, and dated 10/22/2009 has revealed that there is 1 VCP site within approximately 0.5 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
KAUKAUNA UTILITIES	*205 MAPLE ST*	*ESE 1/4 - 1/2 (0.419 mi.)*	*29*	*285*

EXECUTIVE SUMMARY

State and tribal Brownfields sites

BROWNFIELDS: A listing of brownfields sites included in the BRRTS database. Brownfields are abandoned, idle or underused commercial or industrial properties, where the expansion or redevelopment is hindered by real or perceived contamination. Brownfields vary in size, location, age, and past use -- they can be anything from a five-hundred acre automobile assembly plant to a small, abandoned corner gas station.

A review of the BROWNFIELDS list, as provided by EDR, and dated 10/22/2009 has revealed that there are 2 BROWNFIELDS sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CITY OF KAUKAUNA PROPERTY	*147 W SECOND ST*	*SE 1/8 - 1/4 (0.191 mi.)*	*C6*	*14*
Lower Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
KAUKAUNA UTILITIES	*205 MAPLE ST*	*ESE 1/4 - 1/2 (0.419 mi.)*	*29*	*285*

ADDITIONAL ENVIRONMENTAL RECORDS

Local Lists of Hazardous waste / Contaminated Sites

WI ERP: Emergency Repair Program Database. Non - LUST Sites with Contaminated Soil and/or GW. Often these are historic releases to the environment.

A review of the WI ERP list, as provided by EDR, and dated 10/22/2009 has revealed that there are 5 WI ERP sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
GHOST TOWN FITNESS CENTER	180 FOX SHORES DR	SE 0 - 1/8 (0.024 mi.)	1	7
Lower Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
KAUKAUNA PUBLIC SCHOOLS ADMIN	*112 MAIN AVE*	*E 1/4 - 1/2 (0.275 mi.)*	*F18*	*100*
KAUKAUNA CTY	200 E SECOND ST	SE 1/4 - 1/2 (0.304 mi.)	G19	130
KAUKAUNA UTILITIES	*205 MAPLE ST*	*ESE 1/4 - 1/2 (0.419 mi.)*	*29*	*285*
KAUKAUNA ELECTRIC	*770 ISLAND ST*	*SE 1/4 - 1/2 (0.499 mi.)*	*K34*	*342*

Other Ascertainable Records

RCRA-NonGen: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

A review of the RCRA-NonGen list, as provided by EDR, and dated 11/12/2008 has revealed that there are 2 RCRA-NonGen sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CITY OF KAUKAUNA PROPERTY	*147 W SECOND ST*	*SE 1/8 - 1/4 (0.191 mi.)*	*C6*	*14*

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
MECH PRINTING AND DESIGN	*131 W SECOND ST*	*SE 1/8 - 1/4 (0.203 mi.)*	*C8*	*38*

MANIFEST: Hazardous waste manifest information.

A review of the MANIFEST list, as provided by EDR, and dated 12/31/2008 has revealed that there are 2 MANIFEST sites within approximately 0.25 miles of the target property.

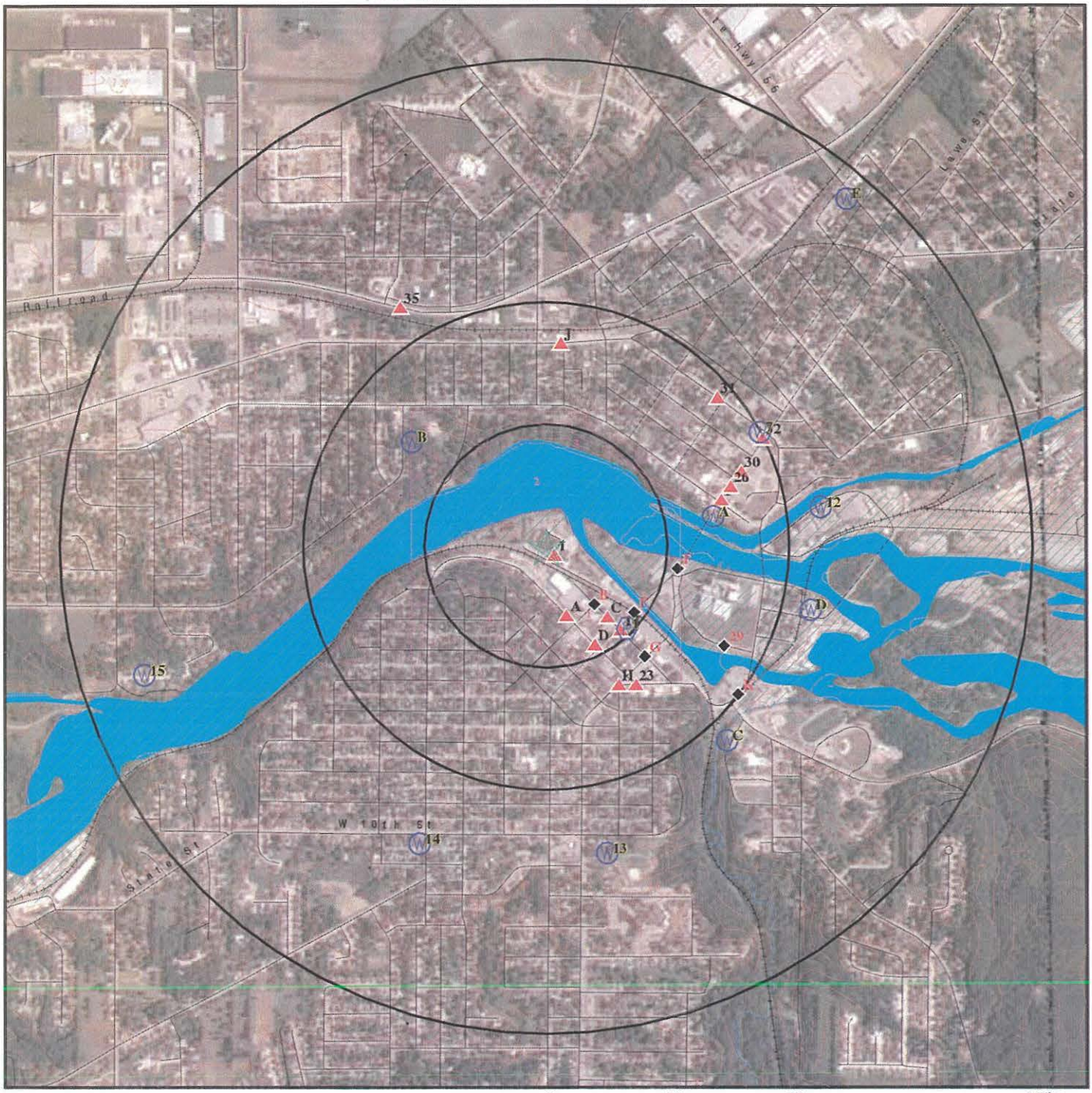
Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CITY OF KAUKAUNA PROPERTY	*147 W SECOND ST*	*SE 1/8 - 1/4 (0.191 mi.)*	*C6*	*14*
Lower Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
VANHOOF OIL AND SERVICE	*179 MAIN AVE*	*SE 1/8 - 1/4 (0.226 mi.)*	*E11*	*41*

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
FOX VALLEY WOOD PRODUCTS INC	LUST,SHWIMS
RTE 1	UST
RTE 1	UST
RTE 1	UST
RTE 2	UST
RTE 4	UST
RTE 4	UST
RTE 4	UST
HWY 55	UST
HWY 55	UST
N9378 HWY 55	UST
N260 HWY 55	UST
RTE 3	UST
N3760 HWY 55	AST
N3748 HWY 55	AST
MALONEY RD & HWY 41	AST
WASTE MANAGEMENT OF KAUKAUNA	FINDS,RCRA-NLR
WISCONSIN CHROMIUM CORP - DNR REME	FINDS,RCRA-NLR
WIDOT FREEDOM	FINDS,RCRA-NLR
WHITE CLOVER DAIRY INC	FINDS,TRIS,RCRA-CESQG

OVERVIEW MAP - 2655083.2s



0 1/4 1/2 1 Miles

- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Fox Shores Apartments ADDRESS: 400 Fox Shore Drive Kaukauna WI 54130 LAT/LONG: 44.2805 / 88.2751	CLIENT: Global Realty Services Group CONTACT: Anthony Mueller INQUIRY #: 2655083.2s DATE: December 08, 2009 4:01 pm

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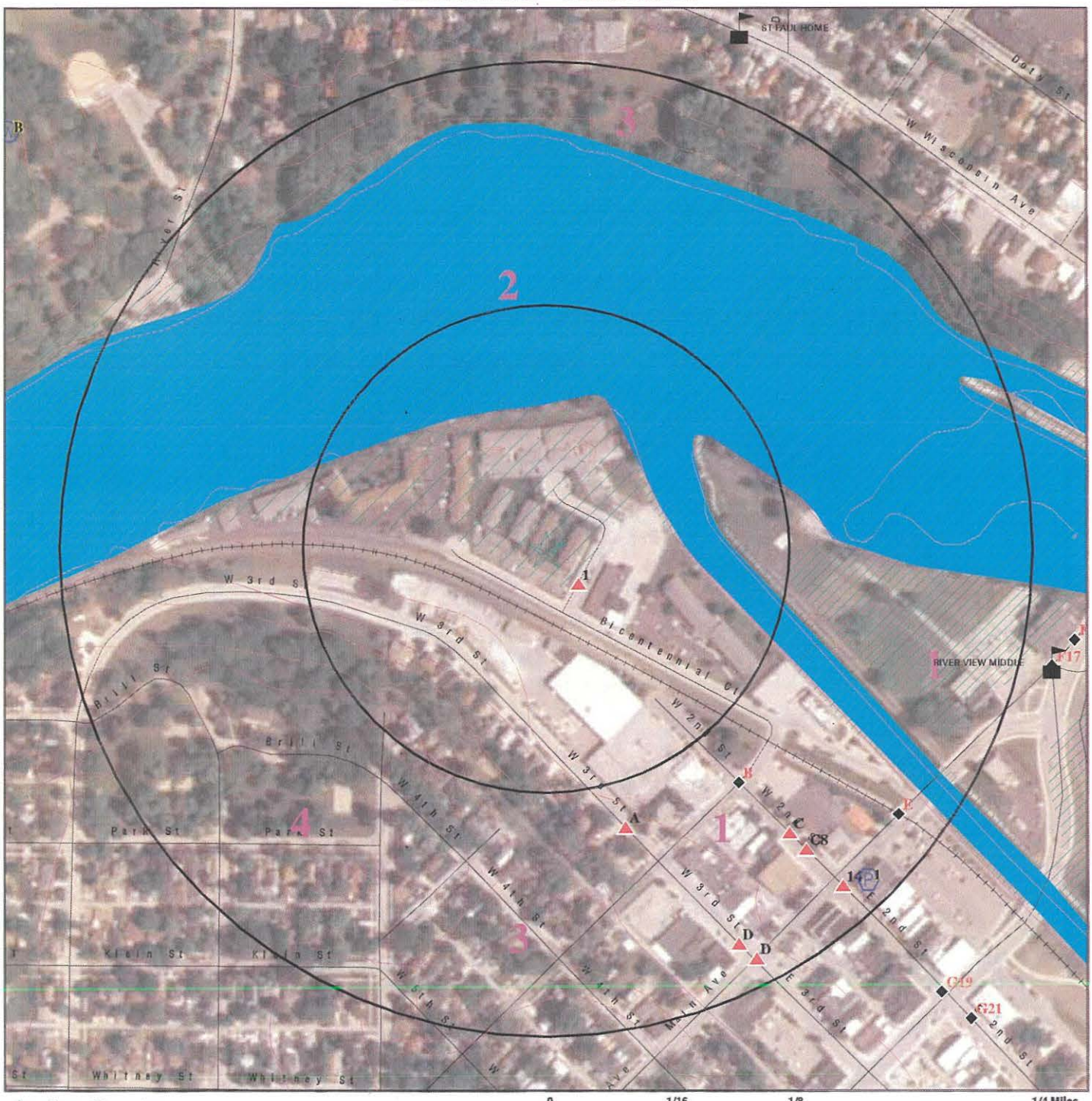
DETAIL MAP - 2655083.2s



0 1/16 1/8 1/4 Miles

- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- Sensitive Receptors
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Fox Shores Apartments	CLIENT: Global Realty Services Group
ADDRESS: 400 Fox Shore Drive Kaukauna WI 54130	CONTACT: Anthony Mueller
LAT/LONG: 44.2805 / 88.2751	INQUIRY #: 2655083.2s DATE: December 08, 2009 4:01 pm

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MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
NPL LIENS		TP	NR	NR	NR	NR	NR	0
Federal Delisted NPL site list								
Delisted NPL		1.000	0	0	0	0	NR	0
Federal CERCLIS list								
CERCLIS		0.500	0	0	0	NR	NR	0
Federal CERCLIS NFRAP site List								
CERC-NFRAP		0.500	0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS		1.000	0	0	0	1	NR	1
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF		0.500	0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG		0.250	0	0	NR	NR	NR	0
RCRA-SQG		0.250	0	0	NR	NR	NR	0
RCRA-CESQG		0.250	0	3	NR	NR	NR	3
Federal institutional controls / engineering controls registries								
US ENG CONTROLS		0.500	0	0	0	NR	NR	0
US INST CONTROL		0.500	0	0	0	NR	NR	0
Federal ERNS list								
ERNS		TP	NR	NR	NR	NR	NR	0
State- and tribal - equivalent CERCLIS								
SHWS		1.000	0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF		0.500	0	0	0	NR	NR	0
WI WDS		0.500	0	0	0	NR	NR	0
SHWIMS		TP	NR	NR	NR	NR	NR	0
State and tribal leaking storage tank lists								
LUST		0.500	0	4	14	NR	NR	18
LAST		0.500	0	0	1	NR	NR	1
INDIAN LUST		0.500	0	0	0	NR	NR	0
State and tribal registered storage tank lists								
UST		0.250	0	6	NR	NR	NR	6

FOX CITIES REALTY PROPERTY (Continued) **1001031780**

Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	02/16/1995	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	SIWP DUE 4/20/95		
Action Date:	03/16/1995	Action Code:	30
Action Name:	Site Investigation Workplan Go Ahead (notice to proceed)		
Action Desc:	Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.		
Action Cmnts:	Not reported		
Action Date:	03/29/1995	Action Code:	37
Action Name:	SI Report Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.		
Action Cmnts:	Not reported		
Action Date:	03/15/1995	Action Code:	35
Action Name:	Site Investigation Workplan Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.		
Action Cmnts:	Not reported		
Action Date:	03/17/1995	Action Code:	33
Action Name:	Tank Closure Environmental Site Assessment Rpt Received		
Action Desc:	DNR received an environmental assessment of a petroleum tank system at the time of tank closure or change in service.		
Action Cmnts:	Not reported		
Action Date:	03/29/1995	Action Code:	43
Action Name:	Status Report Received		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	REQUEST CLOSEOUT		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Not reported		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	72221		
Impact Code:	05		
Impact Comments:	Soil Contamination		

FOX CITIES REALTY PROPERTY (Continued) **1001031780**

Impact Potential:	Not reported
Org. Flag:	Y
Contact name:	FOX CITIES REALTY
Contact Address:	Not reported
Contact Addr2:	Not reported
Contact City,St,Zip:	KAUKAUNA, WI 54130
Contact Country:	UNITED STATES
Comany Address:	KAUKAUNA, WI 54130
Role Desc:	Responsible Party
Org. Flag:	N
Contact name:	TOM STURM
Contact Address:	647 LAKELAND RD
Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	TOM STURM
Contact Address:	647 LAKELAND RD
Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Project Manager

SHWIMS:

FID:	445132820
Status:	OPERATING
Region:	NORTHEAST

31
NE
1/4-1/2
0.466 mi.
2461 ft.

Relative:
Higher

Actual:
713 ft.

231 TAYLOR ST
KAUKAUNA, WI 54130

LUST **U002202827**
UST **N/A**
CRS
AUL
WI WRRSER
SHWIMS

LUST:

Region Name:	NORTHEAST
Facility ID:	445102460
Status:	**CLOSED**
Start Date:	03/30/1990
End Date:	05/19/2005
Last Action:	06/14/2005
Site Id:	1442100
Detail Seq No:	24372
Activity Type:	LUST
Act Code:	340
Activity Name:	BILLS AUTO SERVICE
Activity Number:	0345000847
Activity Display Number:	03-45-000847
Activity Detail Address:	NONE
Activity Comments:	Not reported
Jurisdiction:	COMMERCE
Owner Name:	WILLIAM MOEHRING
Owner Addr:	231 TAYLOR ST
Owner City,St,Zip:	KAUKAUNA, WI 54130

(Continued) **U002202827**

Dept Of Commerce Number: 54130202831
Comm Occurrence Id: 842
EPA Cerclis Id: NONE
Risk Code: MEDIUM
Acres: UNKNOWN
Acres 100: No
EPA NPL Site?: No
Dept Of Commerce Tracking: Yes
PECFA Funds Eligible ?: Yes
Above Ground Storage Tank?: No
Drycleaner?: No
Co-contamination?: No
Public Land Survey System Desc: NW 1/4 of the NW 1/4 of Sec 24, T21N, R18E
Geo Located: Yes
DNR GIS Registry View Map Layers: Yes

Action Date: 05/19/2005 Action Code: 232
Action Name: Residual Soil Contamination at or above RCL or SSRCL
Action Desc: Closure was approved with residual soil contamination at or abovethe Residual Contamination Level (RCL) or Site Specrifc Residual Contaminant Level (SSRCL).
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 710 ACTION ***
Action Date: 05/19/2005 Action Code: 236
Action Name: Groundwater at or above ch. NR 140 enforcement standard
Action Desc: Closure was approved with a condition to record this site in the DNR GIS Registry due to groundwater contamination in excess of ch. NR 140 groundwater enforcement standard or a groundwater use restriction was recorded
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 700 ACTION ***
Action Date: 07/11/1997 Action Code: 37
Action Name: SI Report Received (w/out Fee)/4
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: *** SITE INVESTIGATION DETERMINED BY COMMERCE TO BE COMPLETE - FROM DCOM DATA INTERCHANGE ***
Action Date: 03/30/1990 Action Code: 1
Action Name: Notification
Action Desc: Date the DNR is notified of the discovery of the contamination.
Action Cmnts: Not reported
Action Date: 04/20/1993 Action Code: 30
Action Name: Site Investigation Workplan Go Ahead (notice to proceed)
Action Desc: Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.
Action Cmnts: Not reported
Action Date: 06/16/1994 Action Code: 3
Action Name: Notice of Noncompliance (NON)
Action Desc: Date RP is sent a Notice of Noncompliance (NON) as a result of their failure or refusal to comply. Identifies the specific violation and requires a response within a given time period.
Action Cmnts: Not reported
Action Date: 07/25/1994 Action Code: 37
Action Name: SI Report Received (w/out Fee)/2
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the

(Continued) **U002202827**

appropriate remedial action.
Action Cmnts: Not reported
Action Date: 01/23/1996 Action Code: 43
Action Name: Status Report Received/3
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: CHANGE OF CONSULTANT
Action Date: 10/12/1994 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: DISCUSS/APPROVE CHANGE OF MW PLACEMENT
Action Date: 03/27/1990 Action Code: 33
Action Name: Tank Closure Environmental Site Assessment Rpt Received
Action Desc: DNR received an environmental assessment of a petroleum tank system at the time of tank closure or change in service.
Action Cmnts: Not reported
Action Date: 04/25/1995 Action Code: 43
Action Name: Status Report Received/2
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: RAP BEING DEVELOPED; WILL SEND GW MONITORING REPOR
Action Date: 06/05/1992 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 06/06/1995 Action Code: 37
Action Name: SI Report Received (w/out Fee)/3
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 10/28/1996 Action Code: 43
Action Name: Status Report Received/4
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 07/11/1997 Action Code: 41
Action Name: Remedial Action Report Received
Action Desc: Date the DNR receives the Remedial Action Report detailing remedial action efforts for an activity.
Action Cmnts: Not reported
Action Date: 05/25/1993 Action Code: 35
Action Name: Site Investigation Workplan Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.
Action Cmnts: Not reported
Action Date: 05/29/1998 Action Code: 179
Action Name: Closure Review Req Received (no fee required)
Action Desc: Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).

(Continued) **U002202827**

Action Cmnts:	Not reported		
Action Date:	10/05/1998	Action Code:	80
Action Name:	Closure Not Approved		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	Not reported		
Action Date:	04/12/1999	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	Not reported		
Action Date:	06/01/2000	Action Code:	76
Action Name:	Activity Transferred to Dept. of Commerce		
Action Desc:	Oversight of medium or low risk petroleum cleanup has been transferred to the Wisconsin Department of Commerce.		
Action Cmnts:	MASS TRANSFER		
Action Date:	05/27/1999	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	Not reported		
Action Date:	03/16/2005	Action Code:	84
Action Name:	Conditional Closure		
Action Desc:	Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.		
Action Cmnts:	*** Conditional Closure from Commerce Data Interchange ***		
Action Date:	09/24/2002	Action Code:	50
Action Name:	GIS Registry Site		
Action Desc:	Site conditions merit placement on GIS registry.		
Action Cmnts:	Autopopulated from 700/710 entry		
Action Date:	09/24/2002	Action Code:	700
Action Name:	Date Groundwater Registry Fee Received		
Action Desc:	Date Fee received for Closed Remediation Groundwater Site Registry.		
Action Cmnts:	Not reported		
Action Date:	09/24/2002	Action Code:	710
Action Name:	Date Soil Registry Fee Paid		
Action Desc:	Date Fee received for Closed Remediation Soil Site Registry.		
Action Cmnts:	Not reported		
Action Date:	05/19/2005	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	*** NR726 Closure from Commerce Data Interchange ***		
Action Date:	06/14/2005	Action Code:	100
Action Name:	GIS Registry QAQC Completed		
Action Desc:	Date and status that this site had QAQC completed for GIS registry.		
Action Cmnts:	QA/QC COMPLETE		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		

(Continued) **U002202827**

Spill Comments:	Not reported
Spill Action Code:	Not reported
Spill Action Desc:	Not reported
Spill Action Cmmnts:	Not reported
Substance Desc:	Not reported
Amount Released:	Not reported
Release Code:	Not reported
Impact Number:	67315
Impact Code:	05
Impact Comments:	Soil Contamination
Impact Potential:	Not reported
Impact Number:	559433
Impact Code:	22
Impact Comments:	Off-Site Contamination
Impact Potential:	Not reported
Impact Number:	253076
Impact Code:	04
Impact Comments:	Groundwater Contamination
Impact Potential:	Not reported
Org. Flag:	N
Contact name:	TOM STURM
Contact Address:	647 LAKELAND RD
Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	Y
Contact name:	WI DEPT OF COMMERCE (DCOM)
Contact Address:	201 WEST WASHINGTON AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	MADISON, WI 53703
Contact Country:	UNITED STATES
Comany Address:	MADISON, WI 53703
Role Desc:	Project Manager
Org. Flag:	N
Contact name:	PERSONAL INFORMATION WITHHELD
Contact Address:	319 W NORTH AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	LITTLE CHUTE, WI 54140
Contact Country:	UNITED STATES
Comany Address:	LITTLE CHUTE, WI 54140
Role Desc:	Responsible Party

UST:

Facility ID:	57291
Federally Regulated:	Not reported
Facility County Code:	44
Site Municipality:	City
Municipality Name:	KAUKAUNA
Fire Dept ID:	Kaukauna
Town Cust ID:	282556
Land Owner Type:	Private
Owner Name:	BILL MOEHRING
Owner Address:	319 W NORTH AVE
Owner PO Box:	Not reported
Owner City,St,Zip:	LITTLE CHUTE, WI 54140
Building Name:	BILLS AUTO SERVICE

(Continued) **U002202827**

Building Address: 231 TAYLOR ST
Building City,St,Zip: KAUKAUNA 54130

Object ID: 27850
Object Type: UST
Tank Wang Object ID: Not reported
Tank Status: Closed Filled With Inert Material
Tank Status Date: 1997-12-11 00:00:00.0
Tank Size (gal): 2000
Tank Contents: Leaded Gasoline
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318164
Object Type: UST
Tank Wang Object ID: 442400103
Tank Status: Closed/Removed
Tank Status Date: 1990-03-20 00:00:00.0
Tank Size (gal): 350
Tank Contents: Waste/Used Motor Oil
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318165
Object Type: UST
Tank Wang Object ID: 442400104
Tank Status: Closed/Removed
Tank Status Date: 1990-03-20 00:00:00.0
Tank Size (gal): 4000
Tank Contents: Leaded Gasoline
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318166
Object Type: UST
Tank Wang Object ID: 442400105
Tank Status: Closed/Removed
Tank Status Date: 1990-03-20 00:00:00.0
Tank Size (gal): 500
Tank Contents: Fuel Oil
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318167
Object Type: UST
Tank Wang Object ID: 442400107
Tank Status: Closed/Removed
Tank Status Date: 1990-03-20 00:00:00.0
Tank Size (gal): 9000

(Continued) **U002202827**

Tank Contents: Unleaded Gasoline
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318274
Object Type: UST
Tank Wang Object ID: 442400250
Tank Status: Closed/Removed
Tank Status Date: 1990-03-20 00:00:00.0
Tank Size (gal): 1000
Tank Contents: Leaded Gasoline
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318319
Object Type: UST
Tank Wang Object ID: 442400305
Tank Status: Closed/Removed
Tank Status Date: 1996-07-20 00:00:00.0
Tank Size (gal): 1000
Tank Contents: Waste/Used Motor Oil
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318397
Object Type: UST
Tank Wang Object ID: 442400390
Tank Status: Closed/Removed
Tank Status Date: 1996-07-20 00:00:00.0
Tank Size (gal): 300
Tank Contents: Fuel Oil
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

Object ID: 318398
Object Type: UST
Tank Wang Object ID: 442400391
Tank Status: Closed/Removed
Tank Status Date: 1996-07-20 00:00:00.0
Tank Size (gal): 1000
Tank Contents: Waste/Used Motor Oil
Tank Occupancy: Gas/Retail Sales
Tank Market: Yes
Wall Size: Single

CRS:
DNR Activity Number: 0345000847
Site ID: 1442100
Facility ID: 44510246

(Continued) **U002202827**

Detail Seq Num: 24372
Activity Open: Groundwater and Soil
Off Type: LUST closed
X Coordinate: 658072.999955257
Y Coordinate: 425025.000006461
Start Date: 3/30/1990
End Date: 5/19/2005
Date Last Updated: 20050606
Soil or Groundwater: DEEDED_AND_RIGHT_OF_WAY

AUL:
Facid: 445102460
Site Id: 1442100
Detail Seq No: 24372
Region Name: NORTHEAST
Action Code: 50
Action Comments: Autopopulated from 700/710 entry
Action Date: 09/24/2002
Activity Type: LUST
Activity Name: BILLS AUTO SERVICE
Activity Number: 0345000847
Display Number: 03-45-000847
Act Name: GIS Registry Site
ACT Description: Site conditions merit placement on GIS registry.
Activity Comments: Not reported
Detail Address: NONE
Start Date: 03/30/1990
End Date: 05/19/2005
Last Action: 06/14/2005
Status Cd: C
Status: CLOSED
Jurisdiction: COMMERCE
Risk Code: MEDIUM
EPA NPL Site?: No
Acres: UNKNOWN
Acres 100: N
Drycleaner: No
Geo Located: Y
Owner Name: WILLIAM MOEHRING
Owner Addr: 231 TAYLOR ST
Owner City,St,Zip: KAUKAUNA, WI 54130
Dept Of Commerce Number: 54130202831
Comm Occurrence Id: 842
EPA Cerclis Id: NONE
Dept Of Commerce Tracking: Yes
PECFA Funds Eligible ?: Yes
Above Ground Storage Tank?: No
Co-contamination?: No
Public Land Survey System Desc: NW 1/4 of the NW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers: Y
GIS Area Point Flag: P
Action Date: 05/19/2005 Action Code: 232
Action Name: Residual Soil Contamination at or above RCL or SSRCL
Action Desc: Closure was approved with residual soil contamination at or abovethe Residual Contamination Level (RCL) or Site Specrifc Residual Contaminant Level (SSRCL).
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 710 ACTION ***

(Continued) **U002202827**

Action Date: 05/19/2005 Action Code: 236
Action Name: Groundwater at or above ch. NR 140 enforcement standard
Action Desc: Closure was approved with a condition to record this site in the DNR GIS Registry due to groundwater contamination in excess of ch. NR 140 groundwater enforcement standard or a groundwater use restriction was recorded
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 700 ACTION ***
Action Date: 07/11/1997 Action Code: 37
Action Name: SI Report Received (w/out Fee)/4
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: *** SITE INVESTIGATION DETERMINED BY COMMERCE TO BE COMPLETE - FROM DCOM DATA INTERCHANGE ***
Action Date: 03/30/1990 Action Code: 1
Action Name: Notification
Action Desc: Date the DNR is notified of the discovery of the contamination.
Action Cmnts: Not reported
Action Date: 04/20/1993 Action Code: 30
Action Name: Site Investigation Workplan Go Ahead (notice to proceed)
Action Desc: Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.
Action Cmnts: Not reported
Action Date: 06/16/1994 Action Code: 3
Action Name: Notice of Noncompliance (NON)
Action Desc: Date RP is sent a Notice of Noncompliance (NON) as a result of their failure or refusal to comply. Identifies the specific violation and requires a response within a given time period.
Action Cmnts: Not reported
Action Date: 07/25/1994 Action Code: 37
Action Name: SI Report Received (w/out Fee)/2
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 01/23/1996 Action Code: 43
Action Name: Status Report Received/3
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: CHANGE OF CONSULTANT
Action Date: 10/12/1994 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: DISCUSS/APPROVE CHANGE OF MW PLACEMENT
Action Date: 03/27/1990 Action Code: 33
Action Name: Tank Closure Environmental Site Assessment Rpt Received
Action Desc: DNR received an environmental assessment of a petroleum tank system at the time of tank closure or change in service.
Action Cmnts: Not reported
Action Date: 04/25/1995 Action Code: 43
Action Name: Status Report Received/2
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: RAP BEING DEVELOPED; WILL SEND GW MONITORING REPOR

(Continued) **U002202827**

Action Date: 06/05/1992 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 06/06/1995 Action Code: 37
Action Name: SI Report Received (w/out Fee)/3
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 10/28/1996 Action Code: 43
Action Name: Status Report Received/4
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 07/11/1997 Action Code: 41
Action Name: Remedial Action Report Received
Action Desc: Date the DNR receives the Remedial Action Report detailing remedial action efforts for an activity.
Action Cmnts: Not reported
Action Date: 05/25/1993 Action Code: 35
Action Name: Site Investigation Workplan Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.
Action Cmnts: Not reported
Action Date: 05/29/1998 Action Code: 179
Action Name: Closure Review Req Received (no fee required)
Action Desc: Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).
Action Cmnts: Not reported
Action Date: 10/05/1998 Action Code: 80
Action Name: Closure Not Approved
Action Desc: Date closure not approved letter is sent.
Action Cmnts: Not reported
Action Date: 04/12/1999 Action Code: 43
Action Name: Status Report Received/5
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 06/01/2000 Action Code: 76
Action Name: Activity Transferred to Dept. of Commerce
Action Desc: Oversight of medium or low risk petroleum cleanup has been transferred to the Wisconsin Department of Commerce.
Action Cmnts: MASS TRANSFER
Action Date: 05/27/1999 Action Code: 43
Action Name: Status Report Received/5
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 03/16/2005 Action Code: 84
Action Name: Conditional Closure

(Continued) **U002202827**

Action Desc:	Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.		
Action Cmnts:	*** Conditional Closure from Commerce Data Interchange ***		
Action Date:	09/24/2002	Action Code:	50
Action Name:	GIS Registry Site		
Action Desc:	Site conditions merit placement on GIS registry.		
Action Cmnts:	Autopopulated from 700/710 entry		
Action Date:	09/24/2002	Action Code:	700
Action Name:	Date Groundwater Registry Fee Received		
Action Desc:	Date Fee received for Closed Remediation Groundwater Site Registry.		
Action Cmnts:	Not reported		
Action Date:	09/24/2002	Action Code:	710
Action Name:	Date Soil Registry Fee Paid		
Action Desc:	Date Fee received for Closed Remediation Soil Site Registry.		
Action Cmnts:	Not reported		
Action Date:	05/19/2005	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	*** NR726 Closure from Commerce Data Interchange ***		
Action Date:	06/14/2005	Action Code:	100
Action Name:	GIS Registry QAQC Completed		
Action Desc:	Date and status that this site had QAQC completed for GIS registry.		
Action Cmnts:	QA/QC COMPLETE		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Not reported		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	67315		
Impact Code:	05		
Impact Comments:	Soil Contamination		
Impact Potential:	Not reported		
Impact Number:	559433		
Impact Code:	22		
Impact Comments:	Off-Site Contamination		
Impact Potential:	Not reported		
Impact Number:	253076		
Impact Code:	04		
Impact Comments:	Groundwater Contamination		
Impact Potential:	Not reported		
Org. Flag:	N		
Contact name:	TOM STURM		
Contact Address:	647 LAKELAND RD		

(Continued) **U002202827**

Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	Y
Contact name:	WI DEPT OF COMMERCE (DCOM)
Contact Address:	201 WEST WASHINGTON AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	MADISON, WI 53703
Contact Country:	UNITED STATES
Comany Address:	MADISON, WI 53703
Role Desc:	Project Manager
Org. Flag:	N
Contact name:	PERSONAL INFORMATION WITHHELD
Contact Address:	319 W NORTH AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	LITTLE CHUTE, WI 54140
Contact Country:	UNITED STATES
Comany Address:	LITTLE CHUTE, WI 54140
Role Desc:	Responsible Party

AUL:

Facid:	445102460
Site Id:	1442100
Detail Seq No:	24372
Region Name:	NORTHEAST
Action Code:	50
Action Comments:	Autopopulated from 700/710 entry
Action Date:	09/24/2002
Activity Type:	LUST
Activity Name:	BILLS AUTO SERVICE
Activity Number:	0345000847
Display Number:	03-45-000847
Act Name:	GIS Registry Site
ACT Description:	Site conditions merit placement on GIS registry.
Activity Comments:	Not reported
Detail Address:	NONE
Start Date:	03/30/1990
End Date:	05/19/2005
Last Action:	06/14/2005
Status Cd:	C
Status:	CLOSED
Jurisdiction:	COMMERCE
Risk Code:	MEDIUM
EPA NPL Site?:	No
Acres:	UNKNOWN
Acres 100:	N
Drycleaner:	No
Geo Located:	Y
Owner Name:	WILLIAM MOEHRING
Owner Addr:	231 TAYLOR ST
Owner City,St,Zip:	KAUKAUNA, WI 54130
Dept Of Commerce Number:	54130202831
Comm Occurrence Id:	842
EPA Cerclis Id:	NONE
Dept Of Commerce Tracking:	Yes

(Continued) **U002202827**

PECFA Funds Eligible ?: Yes
Above Ground Storage Tank?: No
Co-contamination?: No
Public Land Survey System Desc: NW 1/4 of the NW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers: Y
GIS Area Point Flag: P

Action Date: 05/19/2005 Action Code: 232
Action Name: Residual Soil Contamination at or above RCL or SSRCL
Action Desc: Closure was approved with residual soil contamination at or abovethe Residual Contamination Level (RCL) or Site Specrifc Residual Contaminant Level (SSRCL).
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 710 ACTION ***

Action Date: 05/19/2005 Action Code: 236
Action Name: Groundwater at or above ch. NR 140 enforcement standard
Action Desc: Closure was approved with a condition to record this site in the DNR GIS Registry due to groundwater contamination in excess of ch. NR 140 groundwater enforcement standard or a groundwater use restriction was recorded
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 700 ACTION ***

Action Date: 07/11/1997 Action Code: 37
Action Name: SI Report Received (w/out Fee)/4
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: *** SITE INVESTIGATION DETERMINED BY COMMERCE TO BE COMPLETE - FROM DCOM DATA INTERCHANGE ***

Action Date: 03/30/1990 Action Code: 1
Action Name: Notification
Action Desc: Date the DNR is notified of the discovery of the contamination.
Action Cmnts: Not reported

Action Date: 04/20/1993 Action Code: 30
Action Name: Site Investigation Workplan Go Ahead (notice to proceed)
Action Desc: Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.
Action Cmnts: Not reported

Action Date: 06/16/1994 Action Code: 3
Action Name: Notice of Noncompliance (NON)
Action Desc: Date RP is sent a Notice of Noncompliance (NON) as a result of their failure or refusal to comply. Identifies the specific violation and requires a response within a given time period.
Action Cmnts: Not reported

Action Date: 07/25/1994 Action Code: 37
Action Name: SI Report Received (w/out Fee)/2
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported

Action Date: 01/23/1996 Action Code: 43
Action Name: Status Report Received/3
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: CHANGE OF CONSULTANT

Action Date: 10/12/1994 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or

(Continued) **U002202827**

other interval.
Action Cmnts: DISCUSS/APPROVE CHANGE OF MW PLACEMENT
Action Date: 03/27/1990 Action Code: 33
Action Name: Tank Closure Environmental Site Assessment Rpt Received
Action Desc: DNR received an environmental assessment of a petroleum tank system at the time of tank closure or change in service.
Action Cmnts: Not reported
Action Date: 04/25/1995 Action Code: 43
Action Name: Status Report Received/2
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: RAP BEING DEVELOPED; WILL SEND GW MONITORING REPOR
Action Date: 06/05/1992 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 06/06/1995 Action Code: 37
Action Name: SI Report Received (w/out Fee)/3
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 10/28/1996 Action Code: 43
Action Name: Status Report Received/4
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 07/11/1997 Action Code: 41
Action Name: Remedial Action Report Received
Action Desc: Date the DNR receives the Remedial Action Report detailing remedial action efforts for an activity.
Action Cmnts: Not reported
Action Date: 05/25/1993 Action Code: 35
Action Name: Site Investigation Workplan Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.
Action Cmnts: Not reported
Action Date: 05/29/1998 Action Code: 179
Action Name: Closure Review Req Received (no fee required)
Action Desc: Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).
Action Cmnts: Not reported
Action Date: 10/05/1998 Action Code: 80
Action Name: Closure Not Approved
Action Desc: Date closure not approved letter is sent.
Action Cmnts: Not reported
Action Date: 04/12/1999 Action Code: 43
Action Name: Status Report Received/5
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported

(Continued) **U002202827**

Action Date:	06/01/2000	Action Code:	76
Action Name:	Activity Transferred to Dept. of Commerce		
Action Desc:	Oversight of medium or low risk petroleum cleanup has been transferred to the Wisconsin Department of Commerce.		
Action Cmnts:	MASS TRANSFER		
Action Date:	05/27/1999	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	Not reported		
Action Date:	03/16/2005	Action Code:	84
Action Name:	Conditional Closure		
Action Desc:	Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.		
Action Cmnts:	*** Conditional Closure from Commerce Data Interchange ***		
Action Date:	09/24/2002	Action Code:	50
Action Name:	GIS Registry Site		
Action Desc:	Site conditions merit placement on GIS registry.		
Action Cmnts:	Autopopulated from 700/710 entry		
Action Date:	09/24/2002	Action Code:	700
Action Name:	Date Groundwater Registry Fee Received		
Action Desc:	Date Fee received for Closed Remediation Groundwater Site Registry.		
Action Cmnts:	Not reported		
Action Date:	09/24/2002	Action Code:	710
Action Name:	Date Soil Registry Fee Paid		
Action Desc:	Date Fee received for Closed Remediation Soil Site Registry.		
Action Cmnts:	Not reported		
Action Date:	05/19/2005	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	*** NR726 Closure from Commerce Data Interchange ***		
Action Date:	06/14/2005	Action Code:	100
Action Name:	GIS Registry QAQC Completed		
Action Desc:	Date and status that this site had QAQC completed for GIS registry.		
Action Cmnts:	QA/QC COMPLETE		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Not reported		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	67315		
Impact Code:	05		
Impact Comments:	Soil Contamination		

(Continued) **U002202827**

Impact Potential: Not reported
Impact Number: 559433
Impact Code: 22
Impact Comments: Off-Site Contamination
Impact Potential: Not reported
Impact Number: 253076
Impact Code: 04
Impact Comments: Groundwater Contamination
Impact Potential: Not reported
Org. Flag: N
Contact name: TOM STURM
Contact Address: 647 LAKELAND RD
Contact Addr2: Not reported
Contact City,St,Zip: SHAWANO, WI 54166
Contact Country: UNITED STATES
Comany Address: SHAWANO, WI 54166
Role Desc: Former Project Manager
Org. Flag: Y
Contact name: WI DEPT OF COMMERCE (DCOM)
Contact Address: 201 WEST WASHINGTON AVE
Contact Addr2: Not reported
Contact City,St,Zip: MADISON, WI 53703
Contact Country: UNITED STATES
Comany Address: MADISON, WI 53703
Role Desc: Project Manager
Org. Flag: N
Contact name: PERSONAL INFORMATION WITHHELD
Contact Address: 319 W NORTH AVE
Contact Addr2: Not reported
Contact City,St,Zip: LITTLE CHUTE, WI 54140
Contact Country: UNITED STATES
Comany Address: LITTLE CHUTE, WI 54140
Role Desc: Responsible Party

WI WRRSER:
Route of Concern: Not reported
Repair Action: Not reported
Added to Inventory: Not reported
Added to HRS List: Not reported
Scoring System: Not reported
Begin Date: 03/30/90
Site Priority: HIGH

SHWIMS:
FID: 445102460
Status: OPERATING
Region: NORTHEAST

32 ENE 1/4-1/2 0.498 mi. 2627 ft. **EXPRESS CONVIENIENCE CENTER #62**
601 N LAWE ST
KAUKAUNA, WI 54130

LUST S104240793
CRS N/A
AUL
SHWIMS

Relative: Higher

Actual: 707 ft.

LUST:

Region Name:	NORTHEAST
Facility ID:	445155150
Status:	**CLOSED**
Start Date:	09/28/1994
End Date:	05/30/2001
Last Action:	01/15/2002
Site Id:	3854400
Detail Seq No:	28543
Activity Type:	LUST
Act Code:	340
Activity Name:	KAUKAUNA MINI MART - WI DOT
Activity Number:	0345001937
Activity Display Number:	03-45-001937
Activity Detail Address:	NONE
Activity Comments:	Not reported
Jurisdiction:	DNR-RR
Owner Name:	US OIL CO INC
Owner Addr:	425 S WASHINGTON ST PO BOX 25
Owner City,St,Zip:	COMBINED LOCKS, WI 541130025
Dept Of Commerce Number:	54130202401
Comm Occurrence Id:	5707
EPA Cerclis Id:	NONE
Risk Code:	HIGH
Acres:	UNKNOWN
Acres 100:	No
EPA NPL Site?:	No
Dept Of Commerce Tracking:	Yes
PECFA Funds Eligible ?:	Yes
Above Ground Storage Tank?:	No
Drycleaner?:	No
Co-contamination?:	No
Public Land Survey System Desc:	NE 1/4 of the NW 1/4 of Sec 24, T21N, R18E
Geo Located:	Yes
DNR GIS Registry View Map Layers:	Yes

Action Date:	09/28/1994	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	Not reported		
Action Date:	09/30/1994	Action Code:	2
Action Name:	RP Letter Sent/2		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	Not reported		
Action Date:	05/16/1994	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	PRP - HIRE CONSULTANT BY 6/3/94		
Action Date:	09/30/1994	Action Code:	35
Action Name:	Site Investigation Workplan Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Workplan. States the		

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

objectives of the investigation to determine the degree and extent of contamination.
Action Cmnts: CONSULTANT HIRED & WP RECEIVED
Action Date: 01/18/1995 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SI UPDATE
Action Date: 02/29/1996 Action Code: 39
Action Name: Remedial Action Options Report received (w/out Fee)
Action Desc: Date the DNR receives the Remedial Action Options Report (workplan). Includes actions to prevent, minimize, stabilize, eliminate threat of discharged hazardous substances, restore the environment to the extent practicable. Identify and evaluate options consistent with DNR standards.
Action Cmnts: Not reported
Action Date: 01/09/1996 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported
Action Date: 09/30/1994 Action Code: 30
Action Name: Site Investigation Workplan Go Ahead (notice to proceed)
Action Desc: Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.
Action Cmnts: QUARTERLY UPDATE DUE 12/31/94
Action Date: 09/25/1995 Action Code: 43
Action Name: Status Report Received/3
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SI UPDATE
Action Date: 06/06/1996 Action Code: 43
Action Name: Status Report Received/4
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: BI-ANNUAL GW MONITORING REPORT
Action Date: 05/11/1995 Action Code: 43
Action Name: Status Report Received/2
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SI CONTINUES
Action Date: 03/09/1999 Action Code: 43
Action Name: Status Report Received/6
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 02/18/1999 Action Code: 43
Action Name: Status Report Received/5
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 10/29/1999 Action Code: 84
Action Name: Conditional Closure
Action Desc: Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

wells, disposal of soil, etc.
Action Cmnts: GW USE RESTRICTIONS
Action Date: 10/18/1999 Action Code: 43
Action Name: Status Report Received/7
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: GW UPDATE
Action Date: 10/20/1999 Action Code: 79
Action Name: Closure Review Request Received with Fee
Action Desc: Date the closure review request is received and a fee paid for DNR review.
Action Cmnts: Not reported
Action Date: 05/30/2001 Action Code: 11
Action Name: Activity Closed
Action Desc: Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.
Action Cmnts: Not reported
Action Date: 01/15/2002 Action Code: 100
Action Name: GIS Registry QAQC Completed
Action Desc: Date and status that this site had QAQC completed for GIS registry.
Action Cmnts: Not reported
Action Date: 10/29/1999 Action Code: 50
Action Name: GIS Registry Site
Action Desc: Site conditions merit placement on GIS registry.
Action Cmnts: Not reported
Incident Date: Not reported
Report Date: Not reported
Spill Source: Not reported
Notify Flag: Not reported
DNR Investigate: Not reported
Spill Cause: Not reported
Spill Color: Not reported
Spill Odor: Not reported
Physical Description: Not reported
Spill Comments: Not reported
Spill Comments: Not reported
Spill Action Code: Not reported
Spill Action Desc: Not reported
Spill Action Cmmnts: Not reported
Substance Desc: Not reported
Amount Released: Not reported
Release Code: Not reported
Impact Number: 71963
Impact Code: 05
Impact Comments: Soil Contamination
Impact Potential: Not reported
Impact Number: 71962
Impact Code: 04
Impact Comments: Groundwater Contamination
Impact Potential: Not reported
Org. Flag: N
Contact name: TOM STURM
Contact Address: 647 LAKELAND RD
Contact Addr2: Not reported
Contact City,St,Zip: SHAWANO, WI 54166
Contact Country: UNITED STATES
Comany Address: SHAWANO, WI 54166

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Role Desc: Former Project Manager
Org. Flag: Y
Contact name: BROEREN OIL CO
Contact Address: 8067 HWY D
Contact Addr2: ATTN: BOB BROEREN/OWNER
Contact City,St,Zip: KAUKAUNA, WI 54130
Contact Country: UNITED STATES
Comany Address: KAUKAUNA, WI 54130
Role Desc: Responsible Party
Org. Flag: N
Contact name: VICKIE TADDY
Contact Address: 2984 SHAWANO AVE
Contact Addr2: Not reported
Contact City,St,Zip: GREEN BAY, WI 54313-6727
Contact Country: UNITED STATES
Comany Address: GREEN BAY, WI 54313
Role Desc: Project Manager
Org. Flag: N
Contact name: KATE KRAMER
Contact Address: 625 E COUNTY RD Y STE 700
Contact Addr2: Not reported
Contact City,St,Zip: OSHKOSH, WI 54901-9731
Contact Country: UNITED STATES
Comany Address: OSHKOSH, WI 54901
Role Desc: Former Project Manager
Org. Flag: N
Contact name: CASEY JONES
Contact Address: NORTHEAST REGION
Contact Addr2: Not reported
Contact City,St,Zip: OSHKOSH, WI 54901-9731
Contact Country: UNITED STATES
Comany Address: OSHKOSH, WI 54901
Role Desc: Former Project Manager

CRS:
DNR Activity Number: 0345001937
Site ID: 3854400
Facility ID: 44515515
Detail Seq Num: 28543
Activity Open: Groundwater
Off Type: LUST closed
X Coordinate: 658413.99987938
Y Coordinate: 424962.000048201
Start Date: 9/28/1994
End Date: 5/30/2001
Date Last Updated: 20020110
Soil or Groundwater: RIGHT_OF_WAY

AUL:
Facid: 445155150
Site Id: 3854400
Detail Seq No: 28543
Region Name: NORTHEAST
Action Code: 50
Action Comments: Not reported
Action Date: 10/29/1999
Activity Type: LUST

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Activity Name:	KAUKAUNA MINI MART - WI DOT
Activity Number:	0345001937
Display Number:	03-45-001937
Act Name:	GIS Registry Site
ACT Description:	Site conditions merit placement on GIS registry.
Activity Comments:	Not reported
Detail Address:	NONE
Start Date:	09/28/1994
End Date:	05/30/2001
Last Action:	01/15/2002
Status Cd:	C
Status:	CLOSED
Jurisdiction:	DNR-RR
Risk Code:	HIGH
EPA NPL Site?:	No
Acres:	UNKNOWN
Acres 100:	N
Drycleaner:	No
Geo Located:	Y
Owner Name:	US OIL CO INC
Owner Addr:	425 S WASHINGTON ST PO BOX 25
Owner City,St,Zip:	COMBINED LOCKS, WI 541130025
Dept Of Commerce Number:	54130202401
Comm Occurrence Id:	5707
EPA Cerclis Id:	NONE
Dept Of Commerce Tracking:	Yes
PECFA Funds Eligible ?:	Yes
Above Ground Storage Tank?:	No
Co-contamination?:	No
Public Land Survey System Desc:	NE 1/4 of the NW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers:	Y
GIS Area Point Flag:	P

Action Date:	09/28/1994	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	Not reported		
Action Date:	09/30/1994	Action Code:	2
Action Name:	RP Letter Sent/2		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	Not reported		
Action Date:	05/16/1994	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	PRP - HIRE CONSULTANT BY 6/3/94		
Action Date:	09/30/1994	Action Code:	35
Action Name:	Site Investigation Workplan Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.		
Action Cmnts:	CONSULTANT HIRED & WP RECEIVED		
Action Date:	01/18/1995	Action Code:	43
Action Name:	Status Report Received		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SI UPDATE		

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Action Date:	02/29/1996	Action Code:	39
Action Name:	Remedial Action Options Report received (w/out Fee)		
Action Desc:	Date the DNR receives the Remedial Action Options Report (workplan). Includes actions to prevent, minimize, stabilize, eliminate threat of discharged hazardous substances, restore the environment to the extent practicable. Identify and evaluate options consistent with DNR standards.		
Action Cmnts:	Not reported		
Action Date:	01/09/1996	Action Code:	37
Action Name:	SI Report Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.		
Action Cmnts:	Not reported		
Action Date:	09/30/1994	Action Code:	30
Action Name:	Site Investigation Workplan Go Ahead (notice to proceed)		
Action Desc:	Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.		
Action Cmnts:	QUARTERLY UPDATE DUE 12/31/94		
Action Date:	09/25/1995	Action Code:	43
Action Name:	Status Report Received/3		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SI UPDATE		
Action Date:	06/06/1996	Action Code:	43
Action Name:	Status Report Received/4		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	BI-ANNUAL GW MONITORING REPORT		
Action Date:	05/11/1995	Action Code:	43
Action Name:	Status Report Received/2		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SI CONTINUES		
Action Date:	03/09/1999	Action Code:	43
Action Name:	Status Report Received/6		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	Not reported		
Action Date:	02/18/1999	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	Not reported		
Action Date:	10/29/1999	Action Code:	84
Action Name:	Conditional Closure		
Action Desc:	Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.		
Action Cmnts:	GW USE RESTRICTIONS		
Action Date:	10/18/1999	Action Code:	43
Action Name:	Status Report Received/7		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	GW UPDATE		
Action Date:	10/20/1999	Action Code:	79

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Action Name:	Closure Review Request Received with Fee		
Action Desc:	Date the closure review request is received and a fee paid for DNR review.		
Action Cmnts:	Not reported		
Action Date:	05/30/2001	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	01/15/2002	Action Code:	100
Action Name:	GIS Registry QAQC Completed		
Action Desc:	Date and status that this site had QAQC completed for GIS registry.		
Action Cmnts:	Not reported		
Action Date:	10/29/1999	Action Code:	50
Action Name:	GIS Registry Site		
Action Desc:	Site conditions merit placement on GIS registry.		
Action Cmnts:	Not reported		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Not reported		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	71963		
Impact Code:	05		
Impact Comments:	Soil Contamination		
Impact Potential:	Not reported		
Impact Number:	71962		
Impact Code:	04		
Impact Comments:	Groundwater Contamination		
Impact Potential:	Not reported		
Org. Flag:	N		
Contact name:	TOM STURM		
Contact Address:	647 LAKELAND RD		
Contact Addr2:	Not reported		
Contact City,St,Zip:	SHAWANO, WI 54166		
Contact Country:	UNITED STATES		
Comany Address:	SHAWANO, WI 54166		
Role Desc:	Former Project Manager		
Org. Flag:	Y		
Contact name:	BROEREN OIL CO		
Contact Address:	8067 HWY D		
Contact Addr2:	ATTN: BOB BROEREN/OWNER		
Contact City,St,Zip:	KAUKAUNA, WI 54130		
Contact Country:	UNITED STATES		
Comany Address:	KAUKAUNA, WI 54130		

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Role Desc: Responsible Party
Org. Flag: N
Contact name: VICKIE TADDY
Contact Address: 2984 SHAWANO AVE
Contact Addr2: Not reported
Contact City,St,Zip: GREEN BAY, WI 54313-6727
Contact Country: UNITED STATES
Comany Address: GREEN BAY, WI 54313
Role Desc: Project Manager
Org. Flag: N
Contact name: KATE KRAMER
Contact Address: 625 E COUNTY RD Y STE 700
Contact Addr2: Not reported
Contact City,St,Zip: OSHKOSH, WI 54901-9731
Contact Country: UNITED STATES
Comany Address: OSHKOSH, WI 54901
Role Desc: Former Project Manager
Org. Flag: N
Contact name: CASEY JONES
Contact Address: NORTHEAST REGION
Contact Addr2: Not reported
Contact City,St,Zip: OSHKOSH, WI 54901-9731
Contact Country: UNITED STATES
Comany Address: OSHKOSH, WI 54901
Role Desc: Former Project Manager

AUL:
Facid: 445155150
Site Id: 3854400
Detail Seq No: 28543
Region Name: NORTHEAST
Action Code: 50
Action Comments: Not reported
Action Date: 10/29/1999
Activity Type: LUST
Activity Name: KAUKAUNA MINI MART - WI DOT
Activity Number: 0345001937
Display Number: 03-45-001937
Act Name: GIS Registry Site
ACT Description: Site conditions merit placement on GIS registry.
Activity Comments: Not reported
Detail Address: NONE
Start Date: 09/28/1994
End Date: 05/30/2001
Last Action: 01/15/2002
Status Cd: C
Status: CLOSED
Jurisdiction: DNR-RR
Risk Code: HIGH
EPA NPL Site?: No
Acres: UNKNOWN
Acres 100: N
Drycleaner: No
Geo Located: Y
Owner Name: US OIL CO INC
Owner Addr: 425 S WASHINGTON ST PO BOX 25
Owner City,St,Zip: COMBINED LOCKS, WI 541130025

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Dept Of Commerce Number: 54130202401
Comm Occurrence Id: 5707
EPA Cerclis Id: NONE
Dept Of Commerce Tracking: Yes
PECFA Funds Eligible ?: Yes
Above Ground Storage Tank?: No
Co-contamination?: No
Public Land Survey System Desc: NE 1/4 of the NW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers: Y
GIS Area Point Flag: P

Action Date: 09/28/1994 Action Code: 1
Action Name: Notification
Action Desc: Date the DNR is notified of the discovery of the contamination.
Action Cmnts: Not reported

Action Date: 09/30/1994 Action Code: 2
Action Name: RP Letter Sent/2
Action Desc: Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.
Action Cmnts: Not reported

Action Date: 05/16/1994 Action Code: 2
Action Name: RP Letter Sent
Action Desc: Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.
Action Cmnts: PRP - HIRE CONSULTANT BY 6/3/94

Action Date: 09/30/1994 Action Code: 35
Action Name: Site Investigation Workplan Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.
Action Cmnts: CONSULTANT HIRED & WP RECEIVED

Action Date: 01/18/1995 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SI UPDATE

Action Date: 02/29/1996 Action Code: 39
Action Name: Remedial Action Options Report received (w/out Fee)
Action Desc: Date the DNR receives the Remedial Action Options Report (workplan). Includes actions to prevent, minimize, stabilize, eliminate threat of discharged hazardous substances, restore the environment to the extent practicable. Identify and evaluate options consistent with DNR standards.
Action Cmnts: Not reported

Action Date: 01/09/1996 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: Not reported

Action Date: 09/30/1994 Action Code: 30
Action Name: Site Investigation Workplan Go Ahead (notice to proceed)
Action Desc: Date the DNR allows the RP to proceed without approval of the SIWP. Either written or by phone call.
Action Cmnts: QUARTERLY UPDATE DUE 12/31/94

Action Date: 09/25/1995 Action Code: 43
Action Name: Status Report Received/3

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SI UPDATE
Action Date: 06/06/1996 Action Code: 43
Action Name: Status Report Received/4
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: BI-ANNUAL GW MONITORING REPORT
Action Date: 05/11/1995 Action Code: 43
Action Name: Status Report Received/2
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SI CONTINUES
Action Date: 03/09/1999 Action Code: 43
Action Name: Status Report Received/6
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 02/18/1999 Action Code: 43
Action Name: Status Report Received/5
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: Not reported
Action Date: 10/29/1999 Action Code: 84
Action Name: Conditional Closure
Action Desc: Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.
Action Cmnts: GW USE RESTRICTIONS
Action Date: 10/18/1999 Action Code: 43
Action Name: Status Report Received/7
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: GW UPDATE
Action Date: 10/20/1999 Action Code: 79
Action Name: Closure Review Request Received with Fee
Action Desc: Date the closure review request is received and a fee paid for DNR review.
Action Cmnts: Not reported
Action Date: 05/30/2001 Action Code: 11
Action Name: Activity Closed
Action Desc: Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.
Action Cmnts: Not reported
Action Date: 01/15/2002 Action Code: 100
Action Name: GIS Registry QAQC Completed
Action Desc: Date and status that this site had QAQC completed for GIS registry.
Action Cmnts: Not reported
Action Date: 10/29/1999 Action Code: 50
Action Name: GIS Registry Site
Action Desc: Site conditions merit placement on GIS registry.
Action Cmnts: Not reported
Incident Date: Not reported
Report Date: Not reported
Spill Source: Not reported
Notify Flag: Not reported
DNR Investigate: Not reported

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Spill Cause:	Not reported
Spill Color:	Not reported
Spill Odor:	Not reported
Physical Description:	Not reported
Spill Comments:	Not reported
Spill Comments:	Not reported
Spill Action Code:	Not reported
Spill Action Desc:	Not reported
Spill Action Cmmnts:	Not reported
Substance Desc:	Not reported
Amount Released:	Not reported
Release Code:	Not reported
Impact Number:	71963
Impact Code:	05
Impact Comments:	Soil Contamination
Impact Potential:	Not reported
Impact Number:	71962
Impact Code:	04
Impact Comments:	Groundwater Contamination
Impact Potential:	Not reported
Org. Flag:	N
Contact name:	TOM STURM
Contact Address:	647 LAKELAND RD
Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	Y
Contact name:	BROEREN OIL CO
Contact Address:	8067 HWY D
Contact Addr2:	ATTN: BOB BROEREN/OWNER
Contact City,St,Zip:	KAUKAUNA, WI 54130
Contact Country:	UNITED STATES
Comany Address:	KAUKAUNA, WI 54130
Role Desc:	Responsible Party
Org. Flag:	N
Contact name:	VICKIE TADDY
Contact Address:	2984 SHAWANO AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	GREEN BAY, WI 54313-6727
Contact Country:	UNITED STATES
Comany Address:	GREEN BAY, WI 54313
Role Desc:	Project Manager
Org. Flag:	N
Contact name:	KATE KRAMER
Contact Address:	625 E COUNTY RD Y STE 700
Contact Addr2:	Not reported
Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	CASEY JONES
Contact Address:	NORTHEAST REGION
Contact Addr2:	Not reported
Contact City,St,Zip:	OSHKOSH, WI 54901-9731

EXPRESS CONVIENIENCE CENTER #62 (Continued) **S104240793**

Contact Country: UNITED STATES
Comany Address: OSHKOSH, WI 54901
Role Desc: Former Project Manager

SHWIMS:
FID: 445155150
Status: OPERATING
Region: NORTHEAST

K33 **KAUKAUNA UTILITIES** **RCRA-CESQG** **1007991000**
SE **777 ISLAND ST** **LUST** **WIR000120881**
1/4-1/2 **KAUKAUNA, WI 54130** **MANIFEST**
0.498 mi. **SPILLS**
2629 ft. **Site 1 of 2 in cluster K** **SHWIMS**

Relative:
Lower

Actual:
645 ft.

RCRA-CESQG:
Date form received by agency: 02/02/2005
Facility name: KAUKAUNA UTILITIES
Facility address: 777 ISLAND ST
KAUKAUNA, WI 54130
EPA ID: WIR000120881
Contact: MICHAEL D PEDERSEN
Contact address: 777 ISLAND ST
KAUKAUNA, WI 54130
Contact country: US
Contact telephone: (920) 766-5721
Telephone ext.: 220
Contact email: MPEDERSEN@WPPISYS.ORG
EPA Region: 05
Classification: Conditionally Exempt Small Quantity Generator
Description: Handler: generates 100 kg or less of hazardous waste per calendar month, and accumulates 1000 kg or less of hazardous waste at any time; or generates 1 kg or less of acutely hazardous waste per calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste; or generates 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste during any calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste

Owner/Operator Summary:
Owner/operator name: KAUKAUNA UTILITIES
Owner/operator address: 777 ISLAND ST
KAUKAUNA, WI 54130
Owner/operator country: US
Owner/operator telephone: (920) 766-5721
Legal status: Municipal
Owner/Operator Type: Owner
Owner/Op start date: 02/01/2005
Owner/Op end date: Not reported

Owner/operator name: KAUKAUNA UTILITIES

KAUKAUNA UTILITIES (Continued) **1007991000**

Owner/operator address: 777 ISLAND ST
KAUKAUNA, WI 54130
Owner/operator country: US
Owner/operator telephone: (920) 766-5721
Legal status: Municipal
Owner/Operator Type: Operator
Owner/Op start date: 02/01/2005
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: No
Mixed waste (haz. and radioactive): No
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: No
Furnace exemption: No
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No
Off-site waste receiver: Commercial status unknown

Hazardous Waste Summary:
Waste code: D001
Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: D018
Waste name: BENZENE

Violation Status: No violations found

LUST:
Region Name: NORTHEAST
Facility ID: 445033600
Status: **CLOSED**
Start Date: 05/06/1994
End Date: 08/05/1994
Last Action: 08/05/1994
Site Id: 3828300
Detail Seq No: 28175
Activity Type: LUST
Act Code: 340
Activity Name: KAUKAUNA ELECTRIC & WATER DEPT
Activity Number: 0345001803
Activity Display Number: 03-45-001803
Activity Detail Address: NONE

KAUKAUNA UTILITIES (Continued) **1007991000**

Activity Comments:	Not reported
Jurisdiction:	DNR-RR
Owner Name:	KAUKAUNA UTILITIES
Owner Addr:	777 ISLAND ST
Owner City,St,Zip:	KAUKAUNA, WI 54130
Dept Of Commerce Number:	NONE
Comm Occurrence Id:	NONE
EPA Cerclis Id:	NONE
Risk Code:	LOW
Acres:	UNKNOWN
Acres 100:	No
EPA NPL Site?:	No
Dept Of Commerce Tracking:	No
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No
Drycleaner?:	No
Co-contamination?:	No
Public Land Survey System Desc:	NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E
Geo Located:	Yes
DNR GIS Registry View Map Layers:	No

Action Date:	05/06/1994	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	Not reported		
Action Date:	08/05/1994	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	05/16/1994	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	SIWP DUE 7/30/94		
Action Date:	06/16/1994	Action Code:	33
Action Name:	Tank Closure Environmental Site Assessment Rpt Received		
Action Desc:	DNR received an environmental assessment of a petroleum tank system at the time of tank closure or change in service.		
Action Cmnts:	Not reported		

Incident Date:	Not reported
Report Date:	Not reported
Spill Source:	Not reported
Notify Flag:	Not reported
DNR Investigate:	Not reported
Spill Cause:	Not reported
Spill Color:	Not reported
Spill Odor:	Not reported
Physical Description:	Not reported
Spill Comments:	Not reported
Spill Comments:	Not reported
Spill Action Code:	Not reported
Spill Action Desc:	Not reported
Spill Action Cmmnts:	Not reported
Substance Desc:	Not reported
Amount Released:	Not reported
Release Code:	Not reported

KAUKAUNA UTILITIES (Continued) **1007991000**

Impact Number: 71581
Impact Code: 05
Impact Comments: Soil Contamination
Impact Potential: Not reported
Org. Flag: N
Contact name: TOM STURM
Contact Address: 647 LAKELAND RD
Contact Addr2: Not reported
Contact City,St,Zip: SHAWANO, WI 54166
Contact Country: UNITED STATES
Comany Address: SHAWANO, WI 54166
Role Desc: Project Manager
Org. Flag: N
Contact name: TOM STURM
Contact Address: 647 LAKELAND RD
Contact Addr2: Not reported
Contact City,St,Zip: SHAWANO, WI 54166
Contact Country: UNITED STATES
Comany Address: SHAWANO, WI 54166
Role Desc: Former Project Manager
Org. Flag: Y
Contact name: KAUKAUNA CTY
Contact Address: Not reported
Contact Addr2: Not reported
Contact City,St,Zip: KAUKAUNA, WI 54130
Contact Country: UNITED STATES
Comany Address: KAUKAUNA, WI 54130
Role Desc: Responsible Party

WI MANIFEST:
Year: 05
EPA ID: WIR000120881
FID: 445033600
ACT Code: 203
ACT Status: A
ACT Code 1: 203
ACT Name: HW Generator - Very Small
Contact First Name: MICHAEL
Contact Last Name: PEDERSEN
Contact Title: Not reported
Contact Address: 777 ISLAND ST
Contact State: WI
Contact City: KAUKAUNA
Contact Zip: 54130
Contact Telephone: 9207665721
Contact Extention: 220
Contact Email Address: mpedersen@wppisys.org
WI MANIFEST SHIP: -
Manifest DOC ID: Not reported
Copy Type: Not reported
Gen EPA ID: Not reported
Gen Date: Not reported
TSD Date: Not reported
TSD EPA ID: Not reported
GEN Copy Revd Date: Not reported
TSG Copy Revd Date: Not reported
Manifest DOC ID: Not reported
Waste Page No: Not reported

KAUKAUNA UTILITIES (Continued) **1007991000**

Waste Line No: Not reported
Waste Code: Not reported
Waste Amount: Not reported
Unit of Measure: Not reported
Waste LBS: Not reported

WI MANIFEST TRANS: -
Mifest DOC ID: Not reported
TRAN EPA ID: Not reported
TRAN ORDER NO: Not reported
TRAN Date: Not reported

Manifest DOC ID: Not reported
Waste Page No: Not reported
Waste Line No: Not reported
Waste Code: Not reported
Waste Amount: Not reported
Unit of Measure: Not reported
Waste LBS: Not reported

Year: 06
EPA ID: WIR000120881
FID: 445033600
ACT Code: 203
ACT Status: A
ACT Code 1: 203
ACT Name: HW Generator - Very Small
Contact First Name: MICHAEL
Contact Last Name: PEDERSEN
Contact Title: Not reported
Contact Address: 777 ISLAND ST
Contact State: WI
Contact City: KAUKAUNA
Contact Zip: 54130
Contact Telephone: 9207665721
Contact Extention: 220
Contact Email Address: mpedersen@wppisys.org
WI MANIFEST SHIP: -
Manifest DOC ID: Not reported
Copy Type: Not reported
Gen EPA ID: Not reported
Gen Date: Not reported
TSD Date: Not reported
TSD EPA ID: Not reported
GEN Copy Revd Date: Not reported
TSG Copy Revd Date: Not reported
Manifest DOC ID: Not reported
Waste Page No: Not reported
Waste Line No: Not reported
Waste Code: Not reported
Waste Amount: Not reported
Unit of Measure: Not reported
Waste LBS: Not reported

WI MANIFEST TRANS: -
Mifest DOC ID: Not reported

KAUKAUNA UTILITIES (Continued) **1007991000**

TRAN EPA ID: Not reported
TRAN ORDER NO: Not reported
TRAN Date: Not reported

Manifest DOC ID: Not reported
Waste Page No: Not reported
Waste Line No: Not reported
Waste Code: Not reported
Waste Amount: Not reported
Unit of Measure: Not reported
Waste LBS: Not reported

WI Spills:

Site Id:	3828300
Detail Seq No:	226962
Activity Type:	SPILL
Activity Name:	KAUKAUNA ELECTRIC & WATER DEPT SUBSTATIO
Activity Number:	0445226962
Activity Display Number:	04-45-226962
Activity Detail Address:	NONE
Activity Comments:	Not reported
Region Name:	NORTHEAST
Faclity ID:	445033600
Start Date:	03/04/1998
End Date:	10/07/1998
Last Action:	10/07/1998
Status Cd:	C
Status:	CLOSED
Jurisdiction:	DNR-RR
Act Code:	350
Owner Name:	KAUKAUNA UTILITIES
Owner Addr:	777 ISLAND ST
Owner City,St,Zip:	KAUKAUNA, WI 54130
Dept Of Commerce Number:	NONE
Comm Occurrence Id:	NONE
EPA Cerclis Id:	NONE
Risk Code:	UNKNOWN
Acres:	UNKNOWN
Acres 100:	N
EPA NPL Site?:	No
Dept Of Commerce Tracking:	No
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No
Drycleaner?:	No
Co-contamination?:	No
Public Land Survey System Desc:	? 1/4 of the ? 1/4 of Sec ?, T?N, R??
Geo Located:	?
DNR GIS Registry View Map Layers:	N
GIS Area Point Flag:	Not reported

Action Date: 03/04/1998 Action Code: 5
Action Name: Spill Reported to DNR
Action Desc: Date the DNR was notified of the Spill incident.
Action Cmnts: Not reported
Action Date: 10/07/1998 Action Code: 11
Action Name: Spill Closed
Action Desc: No further action; RP is not required to conduct NR716 investigation.

KAUKAUNA UTILITIES (Continued) **1007991000**

NOTE: This is the ONLY action code that will close an activity.

Action Cmnts:	Not reported
Action Date:	03/04/1998 Action Code: 1
Action Name:	Spill Incident Occurred
Action Desc:	Date the Spill occurred or the date reported to DNR if actual date unknown.
Action Cmnts:	Not reported
Incident Date:	03/04/1998 11:00:00 AM
Report Date:	03/04/1998 2:10:00 PM
Spill Source:	Not reported
Notify Flag:	Not reported
DNR Investigate:	Not reported
Spill Cause:	split seam in transformer
Spill Color:	Not reported
Spill Odor:	Not reported
Physical Description:	Not reported
Spill Comments:	Not reported
Spill Comments:	Not reported
Spill Action Code:	05
Spill Action Desc:	Waste Destination
Spill Action Cmmnts:	outagamie
Spill Action Code:	04
Spill Action Desc:	Cleanup Method - Absorbent
Spill Action Cmmnts:	excavation
Spill Action Code:	06
Spill Action Desc:	Containment
Spill Action Cmmnts:	Not reported
Substance Desc:	Petroleum - Unknown Type
Amount Released:	1000
Release Code:	Gram
Impact Number:	226965
Impact Code:	05
Impact Comments:	Soil Contamination
Impact Potential:	Not reported
Org. Flag:	Y
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address:	777 ISLAND ST
Contact Addr2:	ATTN: JOHN RABIDEAU
Contact City,St,Zip:	KAUKANA, WI 54130-7077
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	Responsible Party
Org. Flag:	N
Contact name:	ROXANNE CHRONERT
Contact Address:	2984 SHAWANO AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	GREEN BAY, WI 54313-6727
Contact Country:	UNITED STATES
Comany Address:	GREEN BAY, WI 54313
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JASON MOELLER
Contact Address:	2984 SHAWANO AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	GREEN BAY, WI 54313-6727
Contact Country:	UNITED STATES
Comany Address:	GREEN BAY, WI 54313

KAUKAUNA UTILITIES (Continued) **1007991000**

Role Desc:	Project Manager
Site Id:	3828300
Detail Seq No:	226781
Activity Type:	SPILL
Activity Name:	KAUKAUNA ELECTRIC & WATER DEPT
Activity Number:	0445226781
Activity Display Number:	04-45-226781
Activity Detail Address:	NONE
Activity Comments:	Not reported
Region Name:	NORTHEAST
Facility ID:	445033600
Start Date:	10/23/1998
End Date:	11/04/1998
Last Action:	11/04/1998
Status Cd:	C
Status:	CLOSED
Jurisdiction:	DNR-RR
Act Code:	350
Owner Name:	KAUKAUNA UTILITIES
Owner Addr:	777 ISLAND ST
Owner City,St,Zip:	KAUKAUNA, WI 54130
Dept Of Commerce Number:	NONE
Comm Occurrence Id:	NONE
EPA Cerclis Id:	NONE
Risk Code:	UNKNOWN
Acres:	UNKNOWN
Acres 100:	N
EPA NPL Site?:	No
Dept Of Commerce Tracking:	No
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No
Drycleaner?:	No
Co-contamination?:	No
Public Land Survey System Desc:	? 1/4 of the ? 1/4 of Sec ?, T?N, R??
Geo Located:	?
DNR GIS Registry View Map Layers:	N
GIS Area Point Flag:	Not reported
Action Date:	10/23/1998 Action Code: 1
Action Name:	Spill Incident Occurred
Action Desc:	Date the Spill occurred or the date reported to DNR if actual date unknown.
Action Cmnts:	Not reported
Action Date:	11/04/1998 Action Code: 11
Action Name:	Spill Closed
Action Desc:	No further action; RP is not required to conduct NR716 investigation. NOTE: This is the ONLY action code that will close an activity.
Action Cmnts:	Not reported
Action Date:	10/23/1998 Action Code: 5
Action Name:	Spill Reported to DNR
Action Desc:	Date the DNR was notified of the Spill incident.
Action Cmnts:	Not reported
Incident Date:	10/23/1998 3:16:00 PM
Report Date:	10/23/1998 3:16:00 PM
Spill Source:	10
Notify Flag:	Not reported
DNR Investigate:	Not reported
Spill Cause:	valve left open--produt being poured into diesel generator, valve

KAUKAUNA UTILITIES (Continued) **1007991000**

	open, ran out
Spill Color:	Not reported
Spill Odor:	Not reported
Physical Description:	Not reported
Spill Comments:	Not reported
Spill Comments:	see spill sheet
Spill Action Code:	04
Spill Action Desc:	Cleanup Method - Absorbent
Spill Action Cmmnts:	Not reported
Substance Desc:	Petroleum - Unknown Type
Amount Released:	55
Release Code:	Gram
Impact Number:	226784
Impact Code:	05
Impact Comments:	Soil Contamination
Impact Potential:	Not reported
Org. Flag:	N
Contact name:	ROXANNE CHRONERT
Contact Address:	2984 SHAWANO AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	GREEN BAY, WI 54313-6727
Contact Country:	UNITED STATES
Comany Address:	GREEN BAY, WI 54313
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JASON MOELLER
Contact Address:	2984 SHAWANO AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	GREEN BAY, WI 54313-6727
Contact Country:	UNITED STATES
Comany Address:	GREEN BAY, WI 54313
Role Desc:	Project Manager
Org. Flag:	Y
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address:	777 ISLAND ST
Contact Addr2:	ATTN: JOHN RABIDEAU
Contact City,St,Zip:	KAUKANA, WI 54130-7077
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	Responsible Party
Org. Flag:	N
Contact name:	JIM JELLISH
Contact Address:	777 ISLAND ST
Contact Addr2:	Not reported
Contact City,St,Zip:	KAUKANA, WI 54130
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	RP Contact/Agent

SHWIMS:

FID:	445033600
Status:	OPERATING
Region:	NORTHEAST

K34 **KAUKAUNA ELECTRIC** **WI ERP** **S105164697**
SE **770 ISLAND ST** **SPILLS** **N/A**
1/4-1/2 **KAUKAUNA, WI 54130** **CRS**
0.499 mi. **AUL**
2634 ft. **Site 2 of 2 in cluster K**

Relative:
Lower

Actual:
644 ft.

WI ERP:

Site Id:	7416600
Detail Seq No:	242489
Activity Type:	ERP
Activity Name:	KAUKAUNA ELECTRIC - SITE 1
Activity Number:	0245242489
Activity Display Number:	02-45-242489
Activity Detail Address:	NONE
Activity Comments:	Not reported
Region Name:	NORTHEAST
Facility ID:	NONE
Start Date:	10/23/1998
End Date:	01/28/2003
Last Action:	11/25/2003
Status Cd:	C
Status:	CLOSED
Jurisdiction:	DNR-RR
Act Code:	330
Owner Name:	Not reported
Owner Addr:	Not reported
Owner City,St,Zip:	Not reported
Dept Of Commerce Number:	NONE
Comm Occurrence Id:	NONE
EPA Cerclis Id:	NONE
Risk Code:	N/A
Acres:	UNKNOWN
Acres 100:	N
EPA NPL Site?:	No
Dept Of Commerce Tracking:	No
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No
Drycleaner?:	No
Co-contamination?:	No
Public Land Survey System Desc:	NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E
Geo Located:	Y
DNR GIS Registry View Map Layers:	N
GIS Area Point Flag:	P

Action Date:	01/28/2003	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	02/14/2002	Action Code:	80
Action Name:	Closure Not Approved/2		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	ADDITIONAL SI NEEDED		
Action Date:	02/26/2002	Action Code:	43
Action Name:	Status Report Received/6		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	PROPOSED MW LOCATIONS		
Action Date:	10/31/2001	Action Code:	80
Action Name:	Closure Not Approved/2		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	ADDITIONAL SOIL & GW SI NEEDED		
Action Date:	10/04/2001	Action Code:	43
Action Name:	Status Report Received/4		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	ADDITIONAL INFO FOR CLOSURE		
Action Date:	07/20/2001	Action Code:	99
Action Name:	Miscellaneous		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	REQUEST FOR WRITTEN UPDATE		
Action Date:	09/05/2001	Action Code:	179
Action Name:	Closure Review Req Received (no fee required)		
Action Desc:	Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).		
Action Cmnts:	SECOND CLOSURE REQUEST		
Action Date:	11/21/2001	Action Code:	179
Action Name:	Closure Review Req Received (no fee required)		
Action Desc:	Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).		
Action Cmnts:	ADDITIONAL INFORMATION FOR RECONSIDERATION OF CLOSURE		
Action Date:	11/29/2000	Action Code:	79
Action Name:	Closure Review Request Received with Fee		
Action Desc:	Date the closure review request is received and a fee paid for DNR review.		
Action Cmnts:	Not reported		
Action Date:	12/04/2000	Action Code:	80
Action Name:	Closure Not Approved		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	NEED MORE SITE INVESTIGATION		
Action Date:	02/23/2000	Action Code:	43
Action Name:	Status Report Received/2		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SOIL RA REPORT		
Action Date:	02/23/2000	Action Code:	35
Action Name:	Site Investigation Workplan Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.		
Action Cmnts:	Not reported		
Action Date:	12/20/2000	Action Code:	43
Action Name:	Status Report Received/3		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	RESPONSE TO DENIAL AND WORKPLAN		
Action Date:	10/23/1998	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	Not reported		
Action Date:	02/07/2000	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	Was spill - is now ERP		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Date:	05/17/1999	Action Code:	43
Action Name:	Status Report Received		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	LIMITED SUBSURFACE INVESTIGATION		
Action Date:	01/18/2002	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	DRO RESULTS FROM GW & RQT FOR RECONSIDERATION OF CLOSURE		
Action Date:	11/25/2003	Action Code:	99
Action Name:	Miscellaneous/3		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	SOIL SAMPLING TEST RESULTS		
Action Date:	08/08/2003	Action Code:	99
Action Name:	Miscellaneous/2		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	1406 TONS OF IMPACTED SOILS REMOVED		
Action Date:	01/27/2003	Action Code:	43
Action Name:	Status Report Received/7		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	MW-4 & MW-5 DATA		
Action Date:	01/28/2003	Action Code:	86
Action Name:	Activity Closed with site specific conditions.		
Action Desc:	Date the DNR sends a letter notifying RP that the site has been closed with site specific conditions described. For example, soil contamination may exist but if dug up, it would not pose a direct contact threat.		
Action Cmnts:	DRO > 250 PPM REMAINS AT GW-02, GS-2A, SS-01		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Diesel Fuel		
Amount Released:	Not reported		
Release Code:	Not reported		
Substance Desc:	Petroleum - Unknown Type		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	242492		
Impact Code:	05		
Impact Comments:	Soil Contamination		
Impact Potential:	Not reported		
Org. Flag:	N		
Contact name:	TOM STURM		
Contact Address:	647 LAKELAND RD		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JENNIFER BORSKI
Contact Address:	625 E CNTY RD Y
Contact Addr2:	SUITE 700
Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JENNIFER BORSKI
Contact Address:	625 E CNTY RD Y
Contact Addr2:	SUITE 700
Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Project Manager
Org. Flag:	Y
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address:	777 ISLAND ST
Contact Addr2:	ATTN: JOHN RABIDEAU
Contact City,St,Zip:	KAUKANA, WI 54130-7077
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	Responsible Party
Site Id:	7416600
Detail Seq No:	282322
Activity Type:	ERP
Activity Name:	KAUKAUNA ELECTRIC & WATER - SITE 2
Activity Number:	0245282322
Activity Display Number:	02-45-282322
Activity Detail Address:	NONE
Activity Comments:	Not reported
Region Name:	NORTHEAST
Faclity ID:	NONE
Start Date:	10/29/2001
End Date:	01/23/2003
Last Action:	07/24/2003
Status Cd:	C
Status:	CLOSED
Jurisdiction:	COMMERCE
Act Code:	330
Owner Name:	Not reported
Owner Addr:	Not reported
Owner City,St,Zip:	Not reported
Dept Of Commerce Number:	54130256070
Comm Occurrence Id:	17826
EPA Cerclis Id:	NONE
Risk Code:	LOW
Acres:	UNKNOWN
Acres 100:	N
EPA NPL Site?:	No
Dept Of Commerce Tracking:	Yes

KAUKAUNA ELECTRIC (Continued) **S105164697**

PECFA Funds Eligible ?: No
Above Ground Storage Tank?: No
Drycleaner?: No
Co-contamination?: No
Public Land Survey System Desc: NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E
Geo Located: Y
DNR GIS Registry View Map Layers: Y
GIS Area Point Flag: P

Action Date: 11/21/2001 Action Code: 43
Action Name: Status Report Received/3
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: PROPOSED WELL LOCATIONS

Action Date: 01/23/2003 Action Code: 232
Action Name: Residual Soil Contamination at or above RCL or SSRCL
Action Desc: Closure was approved with residual soil contamination at or abovethe Residual Contamination Level (RCL) or Site Specrifc Residual Contaminant Level (SSRCL).
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 710 ACTION ***

Action Date: 01/23/2003 Action Code: 11
Action Name: Activity Closed
Action Desc: Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.
Action Cmnts: *** NR726 Closure from Commerce Data Interchange ***

Action Date: 07/22/2002 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: *** SITE INVESTIGATION DETERMINED BY COMMERCE TO BE COMPLETE - FROM DCOM DATA INTERCHANGE ***

Action Date: 07/24/2003 Action Code: 100
Action Name: GIS Registry QAQC Completed
Action Desc: Date and status that this site had QAQC completed for GIS registry.
Action Cmnts: Not reported

Action Date: 01/21/2003 Action Code: 50
Action Name: GIS Registry Site
Action Desc: Site conditions merit placement on GIS registry.
Action Cmnts: Autopopulated from 700/710 entry

Action Date: 01/21/2003 Action Code: 710
Action Name: Date Soil Registry Fee Paid
Action Desc: Date Fee received for Closed Remediation Soil Site Registry.
Action Cmnts: Not reported

Action Date: 06/21/2002 Action Code: 76
Action Name: Activity Transferred to DCOM
Action Desc: Oversight of medium or low risk petroleum cleanup has been transferred to the Wisconsin Department of Commerce.
Action Cmnts: CONSULTANT REQUESTS TRANSFER TO DCOM

Action Date: 10/31/2001 Action Code: 2
Action Name: RP Letter Sent
Action Desc: Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.
Action Cmnts: Not reported

Action Date: 09/05/2001 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or

KAUKAUNA ELECTRIC (Continued) **S105164697**

other interval.
Action Cmnts: SOIL DATA
Action Date: 10/04/2001 Action Code: 43
Action Name: Status Report Received/2
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: UPDATED DATA TABLES AND MAPS
Action Date: 10/29/2001 Action Code: 1
Action Name: Notification
Action Desc: Date the DNR is notified of the discovery of the contamination.
Action Cmnts: TANK CLOSURE ASSESSMENT 03/23/2001
Action Date: 07/25/2002 Action Code: 84
Action Name: Conditional Closure
Action Desc: Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.
Action Cmnts: *** Conditional Closure from Commerce Data Interchange ***
Incident Date: Not reported
Report Date: Not reported
Spill Source: Not reported
Notify Flag: Not reported
DNR Investigate: Not reported
Spill Cause: Not reported
Spill Color: Not reported
Spill Odor: Not reported
Physical Description: Not reported
Spill Comments: Not reported
Spill Comments: Not reported
Spill Action Code: Not reported
Spill Action Desc: Not reported
Spill Action Cmmnts: Not reported
Substance Desc: Petroleum - Unknown Type
Amount Released: Not reported
Release Code: Not reported
Impact Number: 282325
Impact Code: 05
Impact Comments: Soil Contamination
Impact Potential: Not reported
Org. Flag: Y
Contact name: KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address: 777 ISLAND ST
Contact Addr2: ATTN: JOHN RABIDEAU
Contact City,St,Zip: KAUKANA, WI 54130-7077
Contact Country: UNITED STATES
Comany Address: KAUKANA, WI 54130
Role Desc: Responsible Party
Org. Flag: Y
Contact name: WI DEPT OF COMMERCE (DCOM)
Contact Address: 201 WEST WASHINGTON AVE
Contact Addr2: Not reported
Contact City,St,Zip: MADISON, WI 53703
Contact Country: UNITED STATES
Comany Address: MADISON, WI 53703
Role Desc: Project Manager
Org. Flag: N
Contact name: TOM STURM
Contact Address: 647 LAKELAND RD

KAUKAUNA ELECTRIC (Continued) **S105164697**

Contact Addr2: Not reported
Contact City,St,Zip: SHAWANO, WI 54166
Contact Country: UNITED STATES
Comany Address: SHAWANO, WI 54166
Role Desc: Former Project Manager
Org. Flag: Y
Contact name: MCMAHON ASSOCIATES INC
Contact Address: 1445 MCMAHON DRIVE
Contact Addr2: Not reported
Contact City,St,Zip: NEENAH, WI 54957-
Contact Country: UNITED STATES
Comany Address: NEENAH, WI 54957
Role Desc: Consultant

WI Spills:
Site Id: 7416600
Detail Seq No: 243078
Activity Type: SPILL
Activity Name: KAUKAUNA ELECTRIC/UTILITY TRANSFER FACILITY
Activity Number: 0445243078
Activity Display Number: 04-45-243078
Activity Detail Address: NONE
Activity Comments: Not reported
Region Name: NORTHEAST
Faclity ID: NONE
Start Date: 10/23/1998
End Date: 02/04/2000
Last Action: 02/04/2000
Status Cd: C
Status: CLOSED
Jurisdiction: DNR-RR
Act Code: 350
Owner Name: Not reported
Owner Addr: Not reported
Owner City,St,Zip: Not reported
Dept Of Commerce Number: NONE
Comm Occurrence Id: NONE
EPA Cerclis Id: NONE
Risk Code: UNKNOWN
Acres: UNKNOWN
Acres 100: N
EPA NPL Site?: No
Dept Of Commerce Tracking: No
PECFA Funds Eligible ?: No
Above Ground Storage Tank?: No
Drycleaner?: No
Co-contamination?: No
Public Land Survey System Desc: ? 1/4 of the ? 1/4 of Sec ?, T?N, R??
Geo Located: ?
DNR GIS Registry View Map Layers: N
GIS Area Point Flag: Not reported
Action Date: 10/23/1998 Action Code: 1
Action Name: Spill Incident Occurred
Action Desc: Date the Spill occurred or the date reported to DNR if actual date unknown.
Action Cmnts: Not reported
Action Date: 10/23/1998 Action Code: 5
Action Name: Spill Reported to DNR

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Desc:	Date the DNR was notified of the Spill incident.		
Action Cmnts:	Not reported		
Action Date:	02/04/2000	Action Code:	11
Action Name:	Spill Closed		
Action Desc:	No further action; RP is not required to conduct NR716 investigation. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	10/23/1998	Action Code:	6
Action Name:	Activity Transferred to ERP		
Action Desc:	Spill is now tracked as an ERP activity type because it needs additional investigation.		
Action Cmnts:	Not reported		
Incident Date:	10/23/1998 3:16:00 PM		
Report Date:	10/23/1998 3:16:00 PM		
Spill Source:	10		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	valve left open		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	see spill sheet		
Spill Action Code:	04		
Spill Action Desc:	Cleanup Method - Absorbent		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Petroleum - Unknown Type		
Amount Released:	55		
Release Code:	Gram		
Impact Number:	243081		
Impact Code:	05		
Impact Comments:	Soil Contamination		
Impact Potential:	Not reported		
Org. Flag:	N		
Contact name:	ROXANNE CHRONERT		
Contact Address:	2984 SHAWANO AVE		
Contact Addr2:	Not reported		
Contact City,St,Zip:	GREEN BAY, WI 54313-6727		
Contact Country:	UNITED STATES		
Comany Address:	GREEN BAY, WI 54313		
Role Desc:	Former Project Manager		
Org. Flag:	Y		
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY		
Contact Address:	777 ISLAND ST		
Contact Addr2:	ATTN: JOHN RABIDEAU		
Contact City,St,Zip:	KAUKANA, WI 54130-7077		
Contact Country:	UNITED STATES		
Comany Address:	KAUKANA, WI 54130		
Role Desc:	Responsible Party		
Org. Flag:	N		
Contact name:	JASON MOELLER		
Contact Address:	2984 SHAWANO AVE		
Contact Addr2:	Not reported		
Contact City,St,Zip:	GREEN BAY, WI 54313-6727		
Contact Country:	UNITED STATES		
Comany Address:	GREEN BAY, WI 54313		
Role Desc:	Project Manager		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Org. Flag: N
Contact name: JIM JELLISH
Contact Address: 777 ISLAND ST
Contact Addr2: Not reported
Contact City,St,Zip: KAUKANA, WI 54130
Contact Country: UNITED STATES
Comany Address: KAUKANA, WI 54130
Role Desc: RP Contact/Agent

CRS:
DNR Activity Number: 0245282322
Site ID: 7416600
Facility ID: Not reported
Detail Seq Num: 282322
Activity Open: Soil
Off Type: ERP closed
X Coordinate: 658450.999974903
Y Coordinate: 424003.999932675
Start Date: 10/29/2001
End Date: 1/23/2003
Date Last Updated: 20030604
Soil or Groundwater: Not reported

AUL:
Facid: NONE
Site Id: 7416600
Detail Seq No: 242489
Region Name: NORTHEAST
Action Code: 86
Action Comments: DRO > 250 PPM REMAINS AT GW-02, GS-2A, SS-01
Action Date: 01/28/2003
Activity Type: ERP
Activity Name: KAUKAUNA ELECTRIC - SITE 1
Activity Number: 0245242489
Display Number: 02-45-242489
Act Name: Activity Closed with site specific conditions.
ACT Description: Date the DNR sends a letter notifying RP that the site has been closed with site specific conditions described. For example, soil contamination may exist but if dug up, it would not pose a direct contact threat.
Activity Comments: Not reported
Detail Address: NONE
Start Date: 10/23/1998
End Date: 01/28/2003
Last Action: 11/25/2003
Status Cd: C
Status: CLOSED
Jurisdiction: DNR-RR
Risk Code: N/A
EPA NPL Site?: No
Acres: UNKNOWN
Acres 100: N
Drycleaner: No
Geo Located: Y
Owner Name: Not reported
Owner Addr: Not reported
Owner City,St,Zip: Not reported

KAUKAUNA ELECTRIC (Continued) **S105164697**

Dept Of Commerce Number:	NONE		
Comm Occurrence Id:	NONE		
EPA Cerclis Id:	NONE		
Dept Of Commerce Tracking:	No		
PECFA Funds Eligible ?:	No		
Above Ground Storage Tank?:	No		
Co-contamination?:	No		
Public Land Survey System Desc:	NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E		
DNR GIS Registry View Map Layers:	N		
GIS Area Point Flag:	P		
Action Date:	01/28/2003	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	02/14/2002	Action Code:	80
Action Name:	Closure Not Approved/2		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	ADDITIONAL SI NEEDED		
Action Date:	02/26/2002	Action Code:	43
Action Name:	Status Report Received/6		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	PROPOSED MW LOCATIONS		
Action Date:	10/31/2001	Action Code:	80
Action Name:	Closure Not Approved/2		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	ADDITIONAL SOIL & GW SI NEEDED		
Action Date:	10/04/2001	Action Code:	43
Action Name:	Status Report Received/4		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	ADDITIONAL INFO FOR CLOSURE		
Action Date:	07/20/2001	Action Code:	99
Action Name:	Miscellaneous		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	REQUEST FOR WRITTEN UPDATE		
Action Date:	09/05/2001	Action Code:	179
Action Name:	Closure Review Req Received (no fee required)		
Action Desc:	Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).		
Action Cmnts:	SECOND CLOSURE REQUEST		
Action Date:	11/21/2001	Action Code:	179
Action Name:	Closure Review Req Received (no fee required)		
Action Desc:	Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).		
Action Cmnts:	ADDITIONAL INFORMATION FOR RECONSIDERATION OF CLOSURE		
Action Date:	11/29/2000	Action Code:	79
Action Name:	Closure Review Request Received with Fee		
Action Desc:	Date the closure review request is received and a fee paid for DNR review.		
Action Cmnts:	Not reported		
Action Date:	12/04/2000	Action Code:	80
Action Name:	Closure Not Approved		
Action Desc:	Date closure not approved letter is sent.		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Cmnts:	NEED MORE SITE INVESTIGATION		
Action Date:	02/23/2000	Action Code:	43
Action Name:	Status Report Received/2		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SOIL RA REPORT		
Action Date:	02/23/2000	Action Code:	35
Action Name:	Site Investigation Workplan Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.		
Action Cmnts:	Not reported		
Action Date:	12/20/2000	Action Code:	43
Action Name:	Status Report Received/3		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	RESPONSE TO DENIAL AND WORKPLAN		
Action Date:	10/23/1998	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	Not reported		
Action Date:	02/07/2000	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	Was spill - is now ERP		
Action Date:	05/17/1999	Action Code:	43
Action Name:	Status Report Received		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	LIMITED SUBSURFACE INVESTIGATION		
Action Date:	01/18/2002	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	DRO RESULTS FROM GW & RQT FOR RECONSIDERATION OF CLOSURE		
Action Date:	11/25/2003	Action Code:	99
Action Name:	Miscellaneous/3		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	SOIL SAMPLING TEST RESULTS		
Action Date:	08/08/2003	Action Code:	99
Action Name:	Miscellaneous/2		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	1406 TONS OF IMPACTED SOILS REMOVED		
Action Date:	01/27/2003	Action Code:	43
Action Name:	Status Report Received/7		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	MW-4 & MW-5 DATA		
Action Date:	01/28/2003	Action Code:	86
Action Name:	Activity Closed with site specific conditions.		
Action Desc:	Date the DNR sends a letter notifying RP that the site has been closed with site specific conditions described. For example, soil contamination may exist but if dug up, it would not pose a direct contact threat.		
Action Cmnts:	DRO > 250 PPM REMAINS AT GW-02, GS-2A, SS-01		
Incident Date:	Not reported		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Report Date:	Not reported
Spill Source:	Not reported
Notify Flag:	Not reported
DNR Investigate:	Not reported
Spill Cause:	Not reported
Spill Color:	Not reported
Spill Odor:	Not reported
Physical Description:	Not reported
Spill Comments:	Not reported
Spill Comments:	Not reported
Spill Action Code:	Not reported
Spill Action Desc:	Not reported
Spill Action Cmmnts:	Not reported
Substance Desc:	Diesel Fuel
Amount Released:	Not reported
Release Code:	Not reported
Substance Desc:	Petroleum - Unknown Type
Amount Released:	Not reported
Release Code:	Not reported
Impact Number:	242492
Impact Code:	05
Impact Comments:	Soil Contamination
Impact Potential:	Not reported
Org. Flag:	N
Contact name:	TOM STURM
Contact Address:	647 LAKELAND RD
Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JENNIFER BORSKI
Contact Address:	625 E CNTY RD Y
Contact Addr2:	SUITE 700
Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JENNIFER BORSKI
Contact Address:	625 E CNTY RD Y
Contact Addr2:	SUITE 700
Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Project Manager
Org. Flag:	Y
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address:	777 ISLAND ST
Contact Addr2:	ATTN: JOHN RABIDEAU
Contact City,St,Zip:	KAUKANA, WI 54130-7077
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	Responsible Party

Facid: NONE

KAUKAUNA ELECTRIC (Continued) **S105164697**

Site Id:	7416600
Detail Seq No:	282322
Region Name:	NORTHEAST
Action Code:	50
Action Comments:	Autopopulated from 700/710 entry
Action Date:	01/21/2003
Activity Type:	ERP
Activity Name:	KAUKAUNA ELECTRIC & WATER - SITE 2
Activity Number:	0245282322
Display Number:	02-45-282322
Act Name:	GIS Registry Site
ACT Description:	Site conditions merit placement on GIS registry.
Activity Comments:	Not reported
Detail Address:	NONE
Start Date:	10/29/2001
End Date:	01/23/2003
Last Action:	07/24/2003
Status Cd:	C
Status:	CLOSED
Jurisdiction:	COMMERCE
Risk Code:	LOW
EPA NPL Site?:	No
Acres:	UNKNOWN
Acres 100:	N
Drycleaner:	No.
Geo Located:	Y
Owner Name:	Not reported
Owner Addr:	Not reported
Owner City,St,Zip:	Not reported
Dept Of Commerce Number:	54130256070
Comm Occurrence Id:	17826
EPA Cerclis Id:	NONE
Dept Of Commerce Tracking:	Yes
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No
Co-contamination?:	No
Public Land Survey System Desc:	NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers:	Y
GIS Area Point Flag:	P

Action Date:	11/21/2001	Action Code:	43
Action Name:	Status Report Received/3		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	PROPOSED WELL LOCATIONS		
Action Date:	01/23/2003	Action Code:	232
Action Name:	Residual Soil Contamination at or above RCL or SSRCL		
Action Desc:	Closure was approved with residual soil contamination at or abovethe Residual Contamination Level (RCL) or Site Specrifc Residual Contaminant Level (SSRCL).		
Action Cmnts:	*** AUTO POPULATED AT FINAL CLOSURE DUE TO 710 ACTION ***		
Action Date:	01/23/2003	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	*** NR726 Closure from Commerce Data Interchange ***		
Action Date:	07/22/2002	Action Code:	37
Action Name:	SI Report Received (w/out Fee)		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Desc:	Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.		
Action Cmnts:	*** SITE INVESTIGATION DETERMINED BY COMMERCE TO BE COMPLETE - FROM DCOM DATA INTERCHANGE ***		
Action Date:	07/24/2003	Action Code:	100
Action Name:	GIS Registry QAQC Completed		
Action Desc:	Date and status that this site had QAQC completed for GIS registry.		
Action Cmnts:	Not reported		
Action Date:	01/21/2003	Action Code:	50
Action Name:	GIS Registry Site		
Action Desc:	Site conditions merit placement on GIS registry.		
Action Cmnts:	Autopopulated from 700/710 entry		
Action Date:	01/21/2003	Action Code:	710
Action Name:	Date Soil Registry Fee Paid		
Action Desc:	Date Fee received for Closed Remediation Soil Site Registry.		
Action Cmnts:	Not reported		
Action Date:	06/21/2002	Action Code:	76
Action Name:	Activity Transferred to DCOM		
Action Desc:	Oversight of medium or low risk petroleum cleanup has been transferred to the Wisconsin Department of Commerce.		
Action Cmnts:	CONSULTANT REQUESTS TRANSFER TO DCOM		
Action Date:	10/31/2001	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	Not reported		
Action Date:	09/05/2001	Action Code:	43
Action Name:	Status Report Received		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SOIL DATA		
Action Date:	10/04/2001	Action Code:	43
Action Name:	Status Report Received/2		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	UPDATED DATA TABLES AND MAPS		
Action Date:	10/29/2001	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	TANK CLOSURE ASSESSMENT 03/23/2001		
Action Date:	07/25/2002	Action Code:	84
Action Name:	Conditional Closure		
Action Desc:	Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.		
Action Cmnts:	*** Conditional Closure from Commerce Data Interchange ***		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Spill Comments:	Not reported
Spill Comments:	Not reported
Spill Action Code:	Not reported
Spill Action Desc:	Not reported
Spill Action Cmmnts:	Not reported
Substance Desc:	Petroleum - Unknown Type
Amount Released:	Not reported
Release Code:	Not reported
Impact Number:	282325
Impact Code:	05
Impact Comments:	Soil Contamination
Impact Potential:	Not reported
Org. Flag:	Y
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address:	777 ISLAND ST
Contact Addr2:	ATTN: JOHN RABIDEAU
Contact City,St,Zip:	KAUKANA, WI 54130-7077
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	Responsible Party
Org. Flag:	Y
Contact name:	WI DEPT OF COMMERCE (DCOM)
Contact Address:	201 WEST WASHINGTON AVE
Contact Addr2:	Not reported
Contact City,St,Zip:	MADISON, WI 53703
Contact Country:	UNITED STATES
Comany Address:	MADISON, WI 53703
Role Desc:	Project Manager
Org. Flag:	N
Contact name:	TOM STURM
Contact Address:	647 LAKELAND RD
Contact Addr2:	Not reported
Contact City,St,Zip:	SHAWANO, WI 54166
Contact Country:	UNITED STATES
Comany Address:	SHAWANO, WI 54166
Role Desc:	Former Project Manager
Org. Flag:	Y
Contact name:	MCMAHON ASSOCIATES INC
Contact Address:	1445 MCMAHON DRIVE
Contact Addr2:	Not reported
Contact City,St,Zip:	NEENAH, WI 54957-
Contact Country:	UNITED STATES
Comany Address:	NEENAH, WI 54957
Role Desc:	Consultant

AUL:

Facid:	NONE
Site Id:	7416600
Detail Seq No:	242489
Region Name:	NORTHEAST
Action Code:	86
Action Comments:	DRO > 250 PPM REMAINS AT GW-02, GS-2A, SS-01
Action Date:	01/28/2003
Activity Type:	ERP
Activity Name:	KAUKAUNA ELECTRIC - SITE 1
Activity Number:	0245242489
Display Number:	02-45-242489

KAUKAUNA ELECTRIC (Continued) **S105164697**

Act Name:	Activity Closed with site specific conditions.
ACT Description:	Date the DNR sends a letter notifying RP that the site has been closed with site specific conditions described. For example, soil contamination may exist but if dug up, it would not pose a direct contact threat.
Activity Comments:	Not reported
Detail Address:	NONE
Start Date:	10/23/1998
End Date:	01/28/2003
Last Action:	11/25/2003
Status Cd:	C
Status:	CLOSED
Jurisdiction:	DNR-RR
Risk Code:	N/A
EPA NPL Site?:	No
Acres:	UNKNOWN
Acres 100:	N
Drycleaner:	No
Geo Located:	Y
Owner Name:	Not reported
Owner Addr:	Not reported
Owner City,St,Zip:	Not reported
Dept Of Commerce Number:	NONE
Comm Occurrence Id:	NONE
EPA Cerclis Id:	NONE
Dept Of Commerce Tracking:	No
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No
Co-contamination?:	No
Public Land Survey System Desc:	NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers:	N
GIS Area Point Flag:	P

Action Date:	01/28/2003	Action Code:	11
Action Name:	Activity Closed		
Action Desc:	Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.		
Action Cmnts:	Not reported		
Action Date:	02/14/2002	Action Code:	80
Action Name:	Closure Not Approved/2		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	ADDITIONAL SI NEEDED		
Action Date:	02/26/2002	Action Code:	43
Action Name:	Status Report Received/6		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	PROPOSED MW LOCATIONS		
Action Date:	10/31/2001	Action Code:	80
Action Name:	Closure Not Approved/2		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	ADDITIONAL SOIL & GW SI NEEDED		
Action Date:	10/04/2001	Action Code:	43
Action Name:	Status Report Received/4		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	ADDITIONAL INFO FOR CLOSURE		
Action Date:	07/20/2001	Action Code:	99
Action Name:	Miscellaneous		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	REQUEST FOR WRITTEN UPDATE		
Action Date:	09/05/2001	Action Code:	179
Action Name:	Closure Review Req Received (no fee required)		
Action Desc:	Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).		
Action Cmnts:	SECOND CLOSURE REQUEST		
Action Date:	11/21/2001	Action Code:	179
Action Name:	Closure Review Req Received (no fee required)		
Action Desc:	Date the closure review request is received for DNR review on a site where a fee has previously been paid or no fee is required (i.e. VPLE).		
Action Cmnts:	ADDITIONAL INFORMATION FOR RECONSIDERATION OF CLOSURE		
Action Date:	11/29/2000	Action Code:	79
Action Name:	Closure Review Request Received with Fee		
Action Desc:	Date the closure review request is received and a fee paid for DNR review.		
Action Cmnts:	Not reported		
Action Date:	12/04/2000	Action Code:	80
Action Name:	Closure Not Approved		
Action Desc:	Date closure not approved letter is sent.		
Action Cmnts:	NEED MORE SITE INVESTIGATION		
Action Date:	02/23/2000	Action Code:	43
Action Name:	Status Report Received/2		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	SOIL RA REPORT		
Action Date:	02/23/2000	Action Code:	35
Action Name:	Site Investigation Workplan Received (w/out Fee)		
Action Desc:	Date the DNR receives the Site Investigation Workplan. States the objectives of the investigation to determine the degree and extent of contamination.		
Action Cmnts:	Not reported		
Action Date:	12/20/2000	Action Code:	43
Action Name:	Status Report Received/3		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	RESPONSE TO DENIAL AND WORKPLAN		
Action Date:	10/23/1998	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	Not reported		
Action Date:	02/07/2000	Action Code:	2
Action Name:	RP Letter Sent		
Action Desc:	Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.		
Action Cmnts:	Was spill - is now ERP		
Action Date:	05/17/1999	Action Code:	43
Action Name:	Status Report Received		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	LIMITED SUBSURFACE INVESTIGATION		
Action Date:	01/18/2002	Action Code:	43
Action Name:	Status Report Received/5		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Cmnts:	DRO RESULTS FROM GW & RQT FOR RECONSIDERATION OF CLOSURE		
Action Date:	11/25/2003	Action Code:	99
Action Name:	Miscellaneous/3		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	SOIL SAMPLING TEST RESULTS		
Action Date:	08/08/2003	Action Code:	99
Action Name:	Miscellaneous/2		
Action Desc:	Miscellaneous action. Please see action comments.		
Action Cmnts:	1406 TONS OF IMPACTED SOILS REMOVED		
Action Date:	01/27/2003	Action Code:	43
Action Name:	Status Report Received/7		
Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	MW-4 & MW-5 DATA		
Action Date:	01/28/2003	Action Code:	86
Action Name:	Activity Closed with site specific conditions.		
Action Desc:	Date the DNR sends a letter notifying RP that the site has been closed with site specific conditions described. For example, soil contamination may exist but if dug up, it would not pose a direct contact threat.		
Action Cmnts:	DRO > 250 PPM REMAINS AT GW-02, GS-2A, SS-01		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Diesel Fuel		
Amount Released:	Not reported		
Release Code:	Not reported		
Substance Desc:	Petroleum - Unknown Type		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	242492		
Impact Code:	05		
Impact Comments:	Soil Contamination		
Impact Potential:	Not reported		
Org. Flag:	N		
Contact name:	TOM STURM		
Contact Address:	647 LAKELAND RD		
Contact Addr2:	Not reported		
Contact City,St,Zip:	SHAWANO, WI 54166		
Contact Country:	UNITED STATES		
Comany Address:	SHAWANO, WI 54166		
Role Desc:	Former Project Manager		
Org. Flag:	N		
Contact name:	JENNIFER BORSKI		
Contact Address:	625 E CNTY RD Y		
Contact Addr2:	SUITE 700		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Former Project Manager
Org. Flag:	N
Contact name:	JENNIFER BORSKI
Contact Address:	625 E CNTY RD Y
Contact Addr2:	SUITE 700
Contact City,St,Zip:	OSHKOSH, WI 54901-9731
Contact Country:	UNITED STATES
Comany Address:	OSHKOSH, WI 54901
Role Desc:	Project Manager
Org. Flag:	Y
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY
Contact Address:	777 ISLAND ST
Contact Addr2:	ATTN: JOHN RABIDEAU
Contact City,St,Zip:	KAUKANA, WI 54130-7077
Contact Country:	UNITED STATES
Comany Address:	KAUKANA, WI 54130
Role Desc:	Responsible Party

Facid:	NONE
Site Id:	7416600
Detail Seq No:	282322
Region Name:	NORTHEAST
Action Code:	50
Action Comments:	Autopopulated from 700/710 entry
Action Date:	01/21/2003
Activity Type:	ERP
Activity Name:	KAUKAUNA ELECTRIC & WATER - SITE 2
Activity Number:	0245282322
Display Number:	02-45-282322
Act Name:	GIS Registry Site
ACT Description:	Site conditions merit placement on GIS registry.
Activity Comments:	Not reported
Detail Address:	NONE
Start Date:	10/29/2001
End Date:	01/23/2003
Last Action:	07/24/2003
Status Cd:	C
Status:	CLOSED
Jurisdiction:	COMMERCE
Risk Code:	LOW
EPA NPL Site?:	No
Acres:	UNKNOWN
Acres 100:	N
Drycleaner:	No
Geo Located:	Y
Owner Name:	Not reported
Owner Addr:	Not reported
Owner City,St,Zip:	Not reported
Dept Of Commerce Number:	54130256070
Comm Occurrence Id:	17826
EPA Cerclis Id:	NONE
Dept Of Commerce Tracking:	Yes
PECFA Funds Eligible ?:	No
Above Ground Storage Tank?:	No

KAUKAUNA ELECTRIC (Continued) **S105164697**

Co-contamination?: No
Public Land Survey System Desc: NE 1/4 of the SW 1/4 of Sec 24, T21N, R18E
DNR GIS Registry View Map Layers: Y
GIS Area Point Flag: P

Action Date: 11/21/2001 Action Code: 43
Action Name: Status Report Received/3
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: PROPOSED WELL LOCATIONS

Action Date: 01/23/2003 Action Code: 232
Action Name: Residual Soil Contamination at or above RCL or SSRCL
Action Desc: Closure was approved with residual soil contamination at or abovethe Residual Contamination Level (RCL) or Site Specrifc Residual Contaminant Level (SSRCL).
Action Cmnts: *** AUTO POPULATED AT FINAL CLOSURE DUE TO 710 ACTION ***

Action Date: 01/23/2003 Action Code: 11
Action Name: Activity Closed
Action Desc: Date the Closure Letter or No Further Action letter is sent. NOTE: This is the ONLY action code that will close an activity.
Action Cmnts: *** NR726 Closure from Commerce Data Interchange ***

Action Date: 07/22/2002 Action Code: 37
Action Name: SI Report Received (w/out Fee)
Action Desc: Date the DNR receives the Site Investigation Report. Provides information regarding activities performed to determine degree & extent of contamination and forming a basis for choosing the appropriate remedial action.
Action Cmnts: *** SITE INVESTIGATION DETERMINED BY COMMERCE TO BE COMPLETE - FROM DCOM DATA INTERCHANGE ***

Action Date: 07/24/2003 Action Code: 100
Action Name: GIS Registry QAQC Completed
Action Desc: Date and status that this site had QAQC completed for GIS registry.
Action Cmnts: Not reported

Action Date: 01/21/2003 Action Code: 50
Action Name: GIS Registry Site
Action Desc: Site conditions merit placement on GIS registry.
Action Cmnts: Autopopulated from 700/710 entry

Action Date: 01/21/2003 Action Code: 710
Action Name: Date Soil Registry Fee Paid
Action Desc: Date Fee received for Closed Remediation Soil Site Registry.
Action Cmnts: Not reported

Action Date: 06/21/2002 Action Code: 76
Action Name: Activity Transferred to DCOM
Action Desc: Oversight of medium or low risk petroleum cleanup has been transferred to the Wisconsin Department of Commerce.
Action Cmnts: CONSULTANT REQUESTS TRANSFER TO DCOM

Action Date: 10/31/2001 Action Code: 2
Action Name: RP Letter Sent
Action Desc: Date of letter to RP notifying of legal responsibilities associated with the discovery of contamination.
Action Cmnts: Not reported

Action Date: 09/05/2001 Action Code: 43
Action Name: Status Report Received
Action Desc: Date updates on progress are received. Can be 30, 60, 90 days or other interval.
Action Cmnts: SOIL DATA

Action Date: 10/04/2001 Action Code: 43
Action Name: Status Report Received/2

KAUKAUNA ELECTRIC (Continued) **S105164697**

Action Desc:	Date updates on progress are received. Can be 30, 60, 90 days or other interval.		
Action Cmnts:	UPDATED DATA TABLES AND MAPS		
Action Date:	10/29/2001	Action Code:	1
Action Name:	Notification		
Action Desc:	Date the DNR is notified of the discovery of the contamination.		
Action Cmnts:	TANK CLOSURE ASSESSMENT 03/23/2001		
Action Date:	07/25/2002	Action Code:	84
Action Name:	Conditional Closure		
Action Desc:	Date conditional closure approval letter is sent - the site will not be formally closed until receipt of documentation of abandonment of wells, disposal of soil, etc.		
Action Cmnts:	*** Conditional Closure from Commerce Data Interchange ***		
Incident Date:	Not reported		
Report Date:	Not reported		
Spill Source:	Not reported		
Notify Flag:	Not reported		
DNR Investigate:	Not reported		
Spill Cause:	Not reported		
Spill Color:	Not reported		
Spill Odor:	Not reported		
Physical Description:	Not reported		
Spill Comments:	Not reported		
Spill Comments:	Not reported		
Spill Action Code:	Not reported		
Spill Action Desc:	Not reported		
Spill Action Cmmnts:	Not reported		
Substance Desc:	Petroleum - Unknown Type		
Amount Released:	Not reported		
Release Code:	Not reported		
Impact Number:	282325		
Impact Code:	05		
Impact Comments:	Soil Contamination		
Impact Potential:	Not reported		
Org. Flag:	Y		
Contact name:	KAUKAUNA ELECTRIC & WATER UTILITY		
Contact Address:	777 ISLAND ST		
Contact Addr2:	ATTN: JOHN RABIDEAU		
Contact City,St,Zip:	KAUKANA, WI 54130-7077		
Contact Country:	UNITED STATES		
Comany Address:	KAUKANA, WI 54130		
Role Desc:	Responsible Party		
Org. Flag:	Y		
Contact name:	WI DEPT OF COMMERCE (DCOM)		
Contact Address:	201 WEST WASHINGTON AVE		
Contact Addr2:	Not reported		
Contact City,St,Zip:	MADISON, WI 53703		
Contact Country:	UNITED STATES		
Comany Address:	MADISON, WI 53703		
Role Desc:	Project Manager		
Org. Flag:	N		
Contact name:	TOM STURM		
Contact Address:	647 LAKELAND RD		
Contact Addr2:	Not reported		
Contact City,St,Zip:	SHAWANO, WI 54166		
Contact Country:	UNITED STATES		
Comany Address:	SHAWANO, WI 54166		

KAUKAUNA ELECTRIC (Continued) **S105164697**

Role Desc: Former Project Manager
Org. Flag: Y
Contact name: MCMAHON ASSOCIATES INC
Contact Address: 1445 MCMAHON DRIVE
Contact Addr2: Not reported
Contact City,St,Zip: NEENAH, WI 54957-
Contact Country: UNITED STATES
Comany Address: NEENAH, WI 54957
Role Desc: Consultant

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35 NNW 1/2-1 0.574 mi. 3032 ft. **K R WEST COMPANY INCORPORATED** **CERC-NFRAP 1000106723**
909 HYLAND AVENUE **CORRACTS WID080498769**
KAUKAUNA, WI 54130 **RCRA-NonGen**
FINDS

Relative: Higher

Actual: 713 ft.

CERC-NFRAP:
Site ID: 0506888
Federal Facility: Not a Federal Facility
NPL Status: Not on the NPL
Non NPL Status: Deferred to RCRA

CERCLIS-NFRAP Site Contact Name(s):
Contact Title: RESPONSIBLE PARTY INVESTIGATOR
Contact Name: JANET PFUNDHELLER
Contact Tel: (312) 353-5821

CERCLIS-NFRAP Site Alias Name(s):
Alias Name: FORMERLY SUN CHEMICAL CORPORATION
Alias Address: Not reported
WI

Alias Name: SUN CHEMICAL CORP GPT
Alias Address: Not reported
Not reported

Program Priority:
Description: Great Lakes

Description: RCRA Deferral Audit

Description: RCRA Deferral - Lead Confirmed

CERCLIS-NFRAP Assessment History:
Action: DISCOVERY
Date Started: Not reported
Date Completed: 03/30/1992
Priority Level: Not reported

Action: PRELIMINARY ASSESSMENT
Date Started: Not reported
Date Completed: 09/16/1992
Priority Level: Deferred to RCRA (Subtitle C)

Action: ARCHIVE SITE
Date Started: Not reported

K R WEST COMPANY INCORPORATED (Continued) **1000106723**

Date Completed: 12/28/1995
Priority Level: Not reported

CORRACTS:

EPA ID: WID080498769
EPA Region: 05
Area Name: ENTIRE FACILITY
Actual Date: 9/14/1992
Action: CA075LO - CA Prioritization, Facility or area was assigned a low corrective action priority
NAICS Code(s): Not reported
Original schedule date: Not reported
Schedule end date: Not reported

EPA ID: WID080498769
EPA Region: 05
Area Name: ENTIRE FACILITY
Actual Date: 9/22/1992
Action: CA225NR - Stabilization Measures Evaluation, This facility is, not amenable to stabilization activity at the, present time for reasons other than (1) it appears to be technically, infeasible or inappropriate (NF) or (2) there is a lack of technical, information (IN). Reasons for this conclusion may be the status of, closure at the facility, the degree of risk, timing considerations, the status of corrective action work at the facility, or other, administrative considerations
NAICS Code(s): Not reported
Original schedule date: Not reported
Schedule end date: Not reported

RCRA-NonGen:
Date form received by agency: 11/10/1980
Facility name: SUN CHEMICAL CORP GPT DIVISION
Facility address: 909 HYLAND AVE
KAUKAUNA, WI 54130
EPA ID: WID080498769
Contact: GARY ANDRZEJEWSKI
Contact address: 909 HYLAND AVE
KAUKAUNA, WI 54130
Contact country: US
Contact telephone: (201) 933-4500
Contact email: Not reported
EPA Region: 05
Classification: Non-Generator
Description: Handler: Non-Generators do not presently generate hazardous waste

Owner/Operator Summary:
Owner/operator name: SUN CHEMICAL CORP
Owner/operator address: 200 PARK AVE PAN AM BLDG
NEW YORK, NY 10166
Owner/operator country: Not reported
Owner/operator telephone: (212) 986-5500
Legal status: Private
Owner/Operator Type: Owner

K R WEST COMPANY INCORPORATED (Continued) **1000106723**

Owner/Op start date: Not reported
Owner/Op end date: Not reported

Owner/operator name: SUN CHEMICAL CORP
Owner/operator address: 200 PARK AVE PAN AM BLDG
CITY NOT REPORTED, NY 99998
Owner/operator country: Not reported
Owner/operator telephone: (212) 986-5500
Legal status: Private
Owner/Operator Type: Operator
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: Unknown
Mixed waste (haz. and radioactive): Unknown
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: Unknown
Furnace exemption: Unknown
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No
Off-site waste receiver: Commercial status unknown

Historical Generators:
Date form received by agency: 08/12/1980
Facility name: SUN CHEMICAL CORP GPT DIVISION
Classification: Not a generator, verified

Hazardous Waste Summary:
Waste code: D001
Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: D005
Waste name: BARIUM

Waste code: K086
Waste name: SOLVENT WASHES AND SLUDGES, CAUSTIC WASHES AND SLUDGES, OR WATER WASHES AND SLUDGES FROM CLEANING TUBS AND EQUIPMENT USED IN THE FORMULATION OF INK FROM PIGMENTS, DRIERS, SOAPS, AND STABILIZERS CONTAINING CHROMIUM AND LEAD.

Waste code: D000

K R WEST COMPANY INCORPORATED (Continued) **1000106723**

Waste name: Not Defined

Waste code: D001
Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: D002
Waste name: A WASTE WHICH HAS A PH OF LESS THAN 2 OR GREATER THAN 12.5 IS CONSIDERED TO BE A CORROSIVE HAZARDOUS WASTE. SODIUM HYDROXIDE, A CAUSTIC SOLUTION WITH A HIGH PH, IS OFTEN USED BY INDUSTRIES TO CLEAN OR DEGREASE PARTS. HYDROCHLORIC ACID, A SOLUTION WITH A LOW PH, IS USED BY MANY INDUSTRIES TO CLEAN METAL PARTS PRIOR TO PAINTING. WHEN THESE CAUSTIC OR ACID SOLUTIONS BECOME CONTAMINATED AND MUST BE DISPOSED, THE WASTE WOULD BE A CORROSIVE HAZARDOUS WASTE.

Waste code: D005
Waste name: BARIUM

Waste code: F002
Waste name: THE FOLLOWING SPENT HALOGENATED SOLVENTS: TETRACHLOROETHYLENE, METHYLENE CHLORIDE, TRICHLOROETHYLENE, 1,1,1-TRICHLOROETHANE, CHLOROBENZENE, 1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE, ORTHO-DICHLOROBENZENE, TRICHLOROFLUOROMETHANE, AND 1,1,2-TRICHLOROETHANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE HALOGENATED SOLVENTS OR THOSE LISTED IN F001, F004, OR F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Waste code: F003
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: XYLENE, ACETONE, ETHYL ACETATE, ETHYL BENZENE, ETHYL ETHER, METHYL ISOBUTYL KETONE, N-BUTYL ALCOHOL, CYCLOHEXANONE, AND METHANOL; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONLY THE ABOVE SPENT NON-HALOGENATED SOLVENTS; AND ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS, AND, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THOSE SOLVENTS LISTED IN F001, F002, F004, AND F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Waste code: F005
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: TOLUENE, METHYL ETHYL KETONE, CARBON DISULFIDE, ISOBUTANOL, PYRIDINE, BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS OR THOSE SOLVENTS LISTED IN F001, F002, OR F004; AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Waste code: K086
Waste name: SOLVENT WASHES AND SLUDGES, CAUSTIC WASHES AND SLUDGES, OR WATER

K R WEST COMPANY INCORPORATED (Continued) **1000106723**

WASHES AND SLUDGES FROM CLEANING TUBS AND EQUIPMENT USED IN THE FORMULATION OF INK FROM PIGMENTS, DRIERS, SOAPS, AND STABILIZERS CONTAINING CHROMIUM AND LEAD.

Waste code: P030
Waste name: CYANIDES (SOLUBLE CYANIDE SALTS), NOT OTHERWISE SPECIFIED

Waste code: U002
Waste name: ACETONE (I)

Waste code: U112
Waste name: ACETIC ACID ETHYL ESTER (I)

Waste code: U154
Waste name: METHANOL (I)

Waste code: U159
Waste name: 2-BUTANONE (I,T)

Waste code: U220
Waste name: BENZENE, METHYL-

Corrective Action Summary:

Event date: 09/14/1992
Event: CA Prioritization, Facility or area was assigned a low corrective action priority.

Event date: 09/22/1992
Event: Stabilization Measures Evaluation,This facility is not amenable to stabilization activity at the present time for reasons other than 1- it appears to be technically infeasible or inappropriate (NF) or 2- there is a lack of technical information (IN). Reasons for this conclusion may be the status of closure at the facility, the degree of risk, timing considerations, the status of corrective action work at the facility, or other administrative considerations.

Violation Status: No violations found

FINDS:

Registry ID: 110005442734

Environmental Interest/Information System

RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
KAUKAUNA	1000180020	WISCONSIN CHROMIUM CORP - DNR REME	KAUKAUNA INDUSTRIAL PARK	54130	FINDS,RCRA-NLR
FREEDOM	1000342581	WIDOT FREEDOM	10798 CO TRUNK HWY E	54130	FINDS,RCRA-NLR
KAUKAUNA	1000396993	WHITE CLOVER DAIRY INC	JCT OF HWY D AND CE	54130	FINDS,TRIS,RCRA-CESQG
KAUKAUNA	1000397352	WASTE MANAGEMENT OF KAUKAUNA	RT 4 HIGHWAY 55	54130	FINDS,RCRA-NLR
KAUKAUNA	A100211689		N3760 HWY 55	54130	AST
KAUKAUNA	A100263296		N3748 HWY 55	54130	AST
KAUKAUNA	S102849699	FOX VALLEY WOOD PRODUCTS INC	RT 3 HWY 96	54130	LUST,SHWIMS
KAUKAUNA	U003440205		RTE 4	54130	UST
KAUKAUNA	U003450388		RTE 1	54130	UST
GREENLEAF	U003454177		RTE 1	54130	UST
KAUKAUNA	U003468000		HWY 55	54130	UST
VANDENBROCK	U003472030		MALONEY RD & HWY 41	54130	AST
KAUKAUNA	U003481040		HWY 55	54130	UST
HOLLAND	U003486029		RTE 4	54130	UST
KAUKAUNA	U003489810		RTE 4	54130	UST
WRIGHTSTOWN	U003493390		RTE 3	54130	UST
KAUKAUNA	U003503293		RTE 2	54130	UST
KAUKAUNA	U003889078		RTE 1	54130	UST
KAUKAUNA	U004021482		N9378 HWY 55	54130	UST
KAUKAUNA	U004121134		N260 HWY 55	54130	UST

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Number of Days to Update: Provides confirmation that EDR is reporting records that have been updated within 90 days from the date the government agency made the information available to the public.

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL: National Priority List

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 10/01/2009
Date Data Arrived at EDR: 10/14/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 26

Source: EPA
Telephone: N/A
Last EDR Contact: 11/13/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 6
Telephone: 214-655-6659

EPA Region 3
Telephone 215-814-5418

EPA Region 7
Telephone: 913-551-7247

EPA Region 4
Telephone 404-562-8033

EPA Region 8
Telephone: 303-312-6774

EPA Region 5
Telephone 312-886-6686

EPA Region 9
Telephone: 415-947-4246

EPA Region 10
Telephone 206-553-8665

Proposed NPL: Proposed National Priority List Sites

A site that has been proposed for listing on the National Priorities List through the issuance of a proposed rule in the Federal Register. EPA then accepts public comments on the site, responds to the comments, and places on the NPL those sites that continue to meet the requirements for listing.

Date of Government Version: 10/01/2009
Date Data Arrived at EDR: 10/14/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 26

Source: EPA
Telephone: N/A
Last EDR Contact: 11/13/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

NPL LIENS: Federal Superfund Liens

Federal Superfund Liens. Under the authority granted the USEPA by CERCLA of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner received notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/1991
Date Data Arrived at EDR: 02/02/1994
Date Made Active in Reports: 03/30/1994
Number of Days to Update: 56

Source: EPA
Telephone: 202-564-4267
Last EDR Contact: 08/17/2009
Next Scheduled EDR Contact: 11/16/2009
Data Release Frequency: No Update Planned

Date of Government Version: 11/12/2008
Date Data Arrived at EDR: 11/18/2008
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 118

Source: Environmental Protection Agency
Telephone: 312-886-6186
Last EDR Contact: 11/18/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Quarterly

Federal RCRA generators list

RCRA-LQG: RCRA - Large Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

Date of Government Version: 11/12/2008
Date Data Arrived at EDR: 11/18/2008
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 118

Source: Environmental Protection Agency
Telephone: 312-886-6186
Last EDR Contact: 11/18/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Quarterly

RCRA-SQG: RCRA - Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

Date of Government Version: 11/12/2008
Date Data Arrived at EDR: 11/18/2008
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 118

Source: Environmental Protection Agency
Telephone: 312-886-6186
Last EDR Contact: 11/18/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Quarterly

RCRA-CESQG: RCRA - Conditionally Exempt Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

Date of Government Version: 11/12/2008
Date Data Arrived at EDR: 11/18/2008
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 118

Source: Environmental Protection Agency
Telephone: 312-886-6186
Last EDR Contact: 11/18/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Varies

Federal institutional controls / engineering controls registries

US ENG CONTROLS: Engineering Controls Sites List

A listing of sites with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Date of Government Version: 10/01/2009
Date Data Arrived at EDR: 10/09/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 31

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 09/18/2009
Next Scheduled EDR Contact: 12/28/2009
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

US INST CONTROL: Sites with Institutional Controls

A listing of sites with institutional controls in place. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Date of Government Version: 10/01/2009
Date Data Arrived at EDR: 10/09/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 31

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 09/18/2009
Next Scheduled EDR Contact: 12/28/2009
Data Release Frequency: Varies

Federal ERNS list

ERNS: Emergency Response Notification System

Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 08/31/2009
Date Data Arrived at EDR: 09/17/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 53

Source: National Response Center, United States Coast Guard
Telephone: 202-267-2180
Last EDR Contact: 10/06/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Annually

State- and tribal - equivalent CERCLIS

SHWS: Hazard Ranking List

State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 11/30/1994
Date Data Arrived at EDR: 02/10/1995
Date Made Active in Reports: 03/01/1995
Number of Days to Update: 19

Source: Department of Natural Resources
Telephone: 608-266-2632
Last EDR Contact: 10/05/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: No Update Planned

State and tribal landfill and/or solid waste disposal site lists

SWF/LF: List of Licensed Landfills

Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 10/07/2009
Date Data Arrived at EDR: 10/09/2009
Date Made Active in Reports: 10/23/2009
Number of Days to Update: 14

Source: Department of Natural Resources
Telephone: 608-267-7557
Last EDR Contact: 10/05/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Semi-Annually

WDS: Registry of Waste Disposal Sites

The registry was created by the DNR to serve as a comprehensive listing of all sites where solid or hazardous wastes have been or may have been deposited.

Date of Government Version: 02/03/2009
Date Data Arrived at EDR: 04/23/2009
Date Made Active in Reports: 06/02/2009
Number of Days to Update: 40

Source: Department of Natural Resources
Telephone: 608-266-2632
Last EDR Contact: 10/15/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: No Update Planned

SHWIMS: Solid & Hazardous Waste Information Management System
Information on sites, and facilities operating at sites, that are regulated by the Waste Management program

Date of Government Version: 10/06/2009
Date Data Arrived at EDR: 10/08/2009
Date Made Active in Reports: 10/23/2009
Number of Days to Update: 15

Source: Department of Natural Resources
Telephone: 608-266-2414
Last EDR Contact: 10/08/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Quarterly

State and tribal leaking storage tank lists

LUST: Leaking Underground Storage Tank Database
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-266-2111
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

LAST: Leaking Aboveground Storage Tank Listing
A listing of leaking aboveground storage tank sites.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-267-7563
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Varies

INDIAN LUST R8: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Date of Government Version: 08/24/2009
Date Data Arrived at EDR: 09/10/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 42

Source: EPA Region 8
Telephone: 303-312-6271
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Quarterly

INDIAN LUST R7: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Iowa, Kansas, and Nebraska

Date of Government Version: 03/24/2009
Date Data Arrived at EDR: 05/20/2009
Date Made Active in Reports: 06/17/2009
Number of Days to Update: 28

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 11/04/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

INDIAN LUST R1: Leaking Underground Storage Tanks on Indian Land
A listing of leaking underground storage tank locations on Indian Land.

Date of Government Version: 02/19/2009
Date Data Arrived at EDR: 02/19/2009
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 25

Source: EPA Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

INDIAN LUST R10: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Alaska, Idaho, Oregon and Washington.

Date of Government Version: 08/20/2009
Date Data Arrived at EDR: 08/21/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 31

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Quarterly

INDIAN LUST R9: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Arizona, California, New Mexico and Nevada

Date of Government Version: 08/21/2009
Date Data Arrived at EDR: 10/06/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 16

Source: Environmental Protection Agency
Telephone: 415-972-3372
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Quarterly

INDIAN LUST R4: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Florida, Mississippi and North Carolina.

Date of Government Version: 08/20/2009
Date Data Arrived at EDR: 08/26/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 57

Source: EPA Region 4
Telephone: 404-562-8677
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Semi-Annually

INDIAN LUST R6: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in New Mexico and Oklahoma.

Date of Government Version: 08/24/2009
Date Data Arrived at EDR: 08/26/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 26

Source: EPA Region 6
Telephone: 214-665-6597
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

State and tribal registered storage tank lists

UST: Registered Underground Storage Tanks
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 11/06/2009
Date Data Arrived at EDR: 11/13/2009
Date Made Active in Reports: 12/08/2009
Number of Days to Update: 25

Source; Department of Commerce
Telephone: 608-266-7874
Last EDR Contact: 11/13/2009
Next Scheduled EDR Contact: 01/04/2010
Data Release Frequency: Quarterly

AST: Tanks Database
Aboveground storage tank site locations.

Date of Government Version: 11/06/2009
Date Data Arrived at EDR: 11/13/2009
Date Made Active in Reports: 12/08/2009
Number of Days to Update: 25

Source: Department of Commerce
Telephone: 608-266-7874
Last EDR Contact: 11/13/2009
Next Scheduled EDR Contact: 01/04/2010
Data Release Frequency: Quarterly

INDIAN UST R5: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 5 (Michigan, Minnesota and Wisconsin and Tribal Nations).

Date of Government Version: 09/08/2008
Date Data Arrived at EDR: 09/19/2008
Date Made Active in Reports: 10/16/2008
Number of Days to Update: 27

Source: EPA Region 5
Telephone: 312-886-6136
Last EDR Contact: 10/22/2009
Next Scheduled EDR Contact: 11/16/2009
Data Release Frequency: Varies

INDIAN UST R6: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 6 (Louisiana, Arkansas, Oklahoma, New Mexico, Texas and 65 Tribes).

Date of Government Version: 08/24/2009
Date Data Arrived at EDR: 08/26/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 26

Source: EPA Region 6
Telephone: 214-665-7591
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Semi-Annually

INDIAN UST R4: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Tribal Nations)

Date of Government Version: 08/20/2009
Date Data Arrived at EDR: 08/26/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 57

Source: EPA Region 4
Telephone: 404-562-9424
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Semi-Annually

INDIAN UST R9: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 9 (Arizona, California, Hawaii, Nevada, the Pacific Islands, and Tribal Nations).

Date of Government Version: 08/21/2009
Date Data Arrived at EDR: 08/26/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 57

Source: EPA Region 9
Telephone: 415-972-3368
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Quarterly

INDIAN UST R8: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming and 27 Tribal Nations).

Date of Government Version: 08/24/2009
Date Data Arrived at EDR: 09/10/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 42

Source: EPA Region 8
Telephone: 303-312-6137
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Quarterly

INDIAN UST R7: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 7 (Iowa, Kansas, Missouri, Nebraska, and 9 Tribal Nations).

Date of Government Version: 04/01/2008
Date Data Arrived at EDR: 12/30/2008
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 76

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 11/04/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

INDIAN UST R1: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont and ten Tribal Nations).

Date of Government Version: 02/19/2009
Date Data Arrived at EDR: 02/19/2009
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 25

Source: EPA, Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

INDIAN UST R10: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 10 (Alaska, Idaho, Oregon, Washington, and Tribal Nations).

Date of Government Version: 08/20/2009
Date Data Arrived at EDR: 08/21/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 31

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/30/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Quarterly

State and tribal institutional control / engineering control registries

CRS: Closed Remediation Sites

A Closed Remediation Site is parcel of land at which the groundwater has become contaminated and which is affected by a particular type of legal restriction. Specifically, certain steps have been taken to stabilize/remediate the contamination, and the state is satisfied that no further efforts are necessary provided that the property is not used for certain purposes.

Date of Government Version: 11/23/2009
Date Data Arrived at EDR: 11/23/2009
Date Made Active in Reports: 12/02/2009
Number of Days to Update: 9

Source: Department of Natural Resources
Telephone: 608-267-0554
Last EDR Contact: 11/23/2009
Next Scheduled EDR Contact: 03/08/2010
Data Release Frequency: Semi-Annually

AUL: Deed Restriction at Closeout Sites

Date a deed restriction is recorded at the Register of Deeds office for a property. Extent of soil contamination is known but impracticable to remove now or an engineering control is required to be maintained or NR720 industrial stds are applied. Restricts property use or requires future actions.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-266-2111
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

State and tribal voluntary cleanup sites

VCP: Voluntary Party Liability Exemption Sites

The Voluntary Party Liability Exemption is an elective environmental cleanup program. Interested persons who meet the definition of "voluntary party" are eligible to apply. A "voluntary party" is any person who submits an application and pays all the necessary fees.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-266-2111
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Varies

INDIAN VCP R7: Voluntary Cleanup Priority Lisitng

A listing of voluntary cleanup priority sites located on Indian Land located in Region 7.

Date of Government Version: 03/20/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 7
Telephone: 913-551-7365
Last EDR Contact: 04/20/2009
Next Scheduled EDR Contact: 07/20/2009
Data Release Frequency: Varies

INDIAN VCP R1: Voluntary Cleanup Priority Listing
A listing of voluntary cleanup priority sites located on Indian Land located in Region 1.

Date of Government Version: 04/02/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 1
Telephone: 617-918-1102
Last EDR Contact: 10/05/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Varies

State and tribal Brownfields sites

BEAP: Brownfields Environmental Assessment Program
The Brownfields Environmental Assessment Program (BEAP) was a federal program that assisted municipalities with Environmental Site Assessments (ESA's) for tax delinquent or bankrupt properties, or properties a local government acquired for redevelopment. Using federal dollars, site assessments were conducted by Department of Natural Resources (DNR) staff to determine if the properties were contaminated.

Date of Government Version: 12/31/2000
Date Data Arrived at EDR: 05/29/2001
Date Made Active in Reports: 06/29/2001
Number of Days to Update: 31

Source: Department of Natural Resources
Telephone: 608-266-1618
Last EDR Contact: 08/17/2009
Next Scheduled EDR Contact: 11/16/2009
Data Release Frequency: No Update Planned

BROWNFIELDS: Brownfields Site Locations Listing
A listing of brownfields sites included in the BRRTS database. Brownfields are abandoned, idle or underused commercial or industrial properties, where the expansion or redevelopment is hindered by real or perceived contamination. Brownfields vary in size, location, age, and past use -- they can be anything from a five-hundred acre automobile assembly plant to a small, abandoned corner gas station.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-266-3084
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS: A Listing of Brownfields Sites
Included in the listing are brownfields properties addresses by Cooperative Agreement Recipients and brownfields properties addressed by Targeted Brownfields Assessments. Targeted Brownfields Assessments-EPA's Targeted Brownfields Assessments (TBA) program is designed to help states, tribes, and municipalities--especially those without EPA Brownfields Assessment Demonstration Pilots--minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields. Cooperative Agreement Recipients-States, political subdivisions, territories, and Indian tribes become Brownfields Cleanup Revolving Loan Fund (BCRLF) cooperative agreement recipients when they enter into BCRLF cooperative agreements with the U.S. EPA. EPA selects BCRLF cooperative agreement recipients based on a proposal and application process. BCRLF cooperative agreement recipients must use EPA funds provided through BCRLF cooperative agreement for specified brownfields-related cleanup activities.

Date of Government Version: 07/01/2009
Date Data Arrived at EDR: 09/11/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 59

Source: Environmental Protection Agency
Telephone: 202-566-2777
Last EDR Contact: 11/04/2009
Next Scheduled EDR Contact: 01/11/2010
Data Release Frequency: Semi-Annually

Local Lists of Landfill / Solid Waste Disposal Sites

ODI: Open Dump Inventory
An open dump is defined as a disposal facility that does not comply with one or more of the Part 257 or Part 258 Subtitle D Criteria.

Date of Government Version: 06/30/1985
Date Data Arrived at EDR: 08/09/2004
Date Made Active in Reports: 09/17/2004
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 800-424-9346
Last EDR Contact: 06/09/2004
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

DEBRIS REGION 9: Torres Martinez Reservation Illegal Dump Site Locations
A listing of illegal dump sites location on the Torres Martinez Indian Reservation located in eastern Riverside County and northern Imperial County, California.

Date of Government Version: 01/12/2009
Date Data Arrived at EDR: 05/07/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 137

Source: EPA, Region 9
Telephone: 415-972-3336
Last EDR Contact: 12/08/2009
Next Scheduled EDR Contact: 03/22/2010
Data Release Frequency: Varies

INDIAN ODI: Report on the Status of Open Dumps on Indian Lands
Location of open dumps on Indian land.

Date of Government Version: 12/31/1998
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 703-308-8245
Last EDR Contact: 11/09/2009
Next Scheduled EDR Contact: 02/22/2010
Data Release Frequency: Varies

Local Lists of Hazardous waste / Contaminated Sites

US CDL: Clandestine Drug Labs
A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 03/01/2009
Date Data Arrived at EDR: 06/22/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 91

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 03/26/2009
Next Scheduled EDR Contact: 06/22/2009
Data Release Frequency: Quarterly

ERP: Environmental Repair Program Database
Environmental Repair Program sites are sites other than LUST's that have contaminated soil and/or groundwater. Often, these are old historic releases to the environment.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-267-3543
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

CDL: Clandestine Drug Lab Listing
A listing of clandestine drug lab locations in the state.

Date of Government Version: 03/02/2009
Date Data Arrived at EDR: 03/05/2009
Date Made Active in Reports: 03/25/2009
Number of Days to Update: 20

Source: Department of Justice
Telephone: 920-832-2751
Last EDR Contact: 11/30/2009
Next Scheduled EDR Contact: 03/01/2010
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

US HIST CDL: National Clandestine Laboratory Register

A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 09/01/2007
Date Data Arrived at EDR: 11/19/2008
Date Made Active in Reports: 03/30/2009
Number of Days to Update: 131

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 03/23/2009
Next Scheduled EDR Contact: 06/22/2009
Data Release Frequency: No Update Planned

Local Land Records

LIENS 2: CERCLA Lien Information

A Federal CERCLA ('Superfund') lien can exist by operation of law at any site or property at which EPA has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties.

Date of Government Version: 08/18/2009
Date Data Arrived at EDR: 08/21/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 31

Source: Environmental Protection Agency
Telephone: 202-564-6023
Last EDR Contact: 11/02/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

LUCIS: Land Use Control Information System

LUCIS contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.

Date of Government Version: 12/09/2005
Date Data Arrived at EDR: 12/11/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 31

Source: Department of the Navy
Telephone: 843-820-7326
Last EDR Contact: 11/20/2009
Next Scheduled EDR Contact: 03/08/2010
Data Release Frequency: Varies

Records of Emergency Release Reports

HMIRS: Hazardous Materials Information Reporting System

Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 10/05/2009
Date Data Arrived at EDR: 10/05/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 35

Source: U.S. Department of Transportation
Telephone: 202-366-4555
Last EDR Contact: 10/05/2009
Next Scheduled EDR Contact: 01/11/2010
Data Release Frequency: Annually

SPILLS: Spills Database

A discharge of a hazardous substance that may adversely impact, or threaten to adversely impact public health, welfare or the environment. Spills are usually cleaned up quickly.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-264-6009
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

AG SPILLS: Agricultural Spill Cases

Spills reported to the Department of Agriculture, Trade & Consumer Protection. There are two types of spills. Long-term: These are mainly pesticide and fertilizer cases. Some might include other contaminants at the same site. Some might involve wood-treaters - which use pesticides. All of them involve spills of products, but these spills generally result from day to day use (chronic spills) rather than accidental spills (acute). Accidental: These are the acute spills of pesticides and fertilizers and only involve pesticides and fertilizers. Most of these are cleaned up and closed within 3 to 6 months.

Date of Government Version: 11/17/2009
Date Data Arrived at EDR: 11/18/2009
Date Made Active in Reports: 12/02/2009
Number of Days to Update: 14

Source: Department of Agriculture, Trade & Consumer Protection
Telephone: 608-224-5058
Last EDR Contact: 11/16/2009
Next Scheduled EDR Contact: 03/01/2010
Data Release Frequency: Varies

Other Ascertainable Records

RCRA-NonGen: RCRA - Non Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

Date of Government Version: 11/12/2008
Date Data Arrived at EDR: 11/18/2008
Date Made Active in Reports: 03/16/2009
Number of Days to Update: 118

Source: Environmental Protection Agency
Telephone: 312-886-6186
Last EDR Contact: 11/18/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Varies

DOT OPS: Incident and Accident Data

Department of Transporation, Office of Pipeline Safety Incident and Accident data.

Date of Government Version: 08/12/2009
Date Data Arrived at EDR: 08/27/2009
Date Made Active in Reports: 12/01/2009
Number of Days to Update: 96

Source: Department of Transporation, Office of Pipeline Safety
Telephone: 202-366-4595
Last EDR Contact: 11/10/2009
Next Scheduled EDR Contact: 02/22/2010
Data Release Frequency: Varies

DOD: Department of Defense Sites

This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 11/10/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 62

Source: USGS
Telephone: 703-692-8801
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 02/01/2010
Data Release Frequency: Semi-Annually

FUDS: Formerly Used Defense Sites

The listing includes locations of Formerly Used Defense Sites properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions.

Date of Government Version: 12/31/2008
Date Data Arrived at EDR: 09/30/2009
Date Made Active in Reports: 12/01/2009
Number of Days to Update: 62

Source: U.S. Army Corps of Engineers
Telephone: 202-528-4285
Last EDR Contact: 09/30/2009
Next Scheduled EDR Contact: 12/28/2009
Data Release Frequency: Varies

CONSENT: Superfund (CERCLA) Consent Decrees

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: 08/03/2009
Date Data Arrived at EDR: 10/27/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 13

Source: Department of Justice, Consent Decree Library
Telephone: Varies
Last EDR Contact: 10/06/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

ROD: Records Of Decision
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 09/01/2009
Date Data Arrived at EDR: 09/22/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 30

Source: EPA
Telephone: 703-416-0223
Last EDR Contact: 09/22/2009
Next Scheduled EDR Contact: 12/28/2009
Data Release Frequency: Annually

UMTRA: Uranium Mill Tailings Sites
Uranium ore was mined by private companies for federal government use in national defense programs. When the mills shut down, large piles of the sand-like material (mill tailings) remain after uranium has been extracted from the ore. Levels of human exposure to radioactive materials from the piles are low; however, in some cases tailings were used as construction materials before the potential health hazards of the tailings were recognized.

Date of Government Version: 01/05/2009
Date Data Arrived at EDR: 05/07/2009
Date Made Active in Reports: 05/08/2009
Number of Days to Update: 1

Source: Department of Energy
Telephone: 505-845-0011
Last EDR Contact: 11/30/2009
Next Scheduled EDR Contact: 03/15/2010
Data Release Frequency: Varies

MINES: Mines Master Index File
Contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information.

Date of Government Version: 08/07/2009
Date Data Arrived at EDR: 09/18/2009
Date Made Active in Reports: 11/09/2009
Number of Days to Update: 52

Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959
Last EDR Contact: 12/08/2009
Next Scheduled EDR Contact: 03/22/2010
Data Release Frequency: Semi-Annually

TRIS: Toxic Chemical Release Inventory System
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 04/09/2009
Date Made Active in Reports: 06/17/2009
Number of Days to Update: 69

Source: EPA
Telephone: 202-566-0250
Last EDR Contact: 12/01/2009
Next Scheduled EDR Contact: 03/15/2010
Data Release Frequency: Annually

TSCA: Toxic Substances Control Act
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/2002
Date Data Arrived at EDR: 04/14/2006
Date Made Active in Reports: 05/30/2006
Number of Days to Update: 46

Source: EPA
Telephone: 202-260-5521
Last EDR Contact: 10/07/2009
Next Scheduled EDR Contact: 01/11/2010
Data Release Frequency: Every 4 Years

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-566-1667
Last EDR Contact: 11/30/2009
Next Scheduled EDR Contact: 03/15/2010
Data Release Frequency: Quarterly

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
A listing of FIFRA/TSCA Tracking System (FTTS) inspections and enforcements.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA
Telephone: 202-566-1667
Last EDR Contact: 11/30/2009
Next Scheduled EDR Contact: 03/15/2010
Data Release Frequency: Quarterly

HIST FTTS: FIFRA/TSCA Tracking System Administrative Case Listing
A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2007
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

HIST FTTS INSP: FIFRA/TSCA Tracking System Inspection & Enforcement Case Listing
A complete inspection and enforcement case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2008
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

SSTS: Section 7 Tracking Systems
Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 05/19/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 125

Source: EPA
Telephone: 202-564-4203
Last EDR Contact: 11/02/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Annually

ICIS: Integrated Compliance Information System
The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.

Date of Government Version: 08/21/2009
Date Data Arrived at EDR: 08/27/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 56

Source: Environmental Protection Agency
Telephone: 202-564-5088
Last EDR Contact: 09/28/2009
Next Scheduled EDR Contact: 01/11/2010
Data Release Frequency: Quarterly

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

PADS: PCB Activity Database System

PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 09/01/2009
Date Data Arrived at EDR: 10/21/2009
Date Made Active in Reports: 12/01/2009
Number of Days to Update: 41

Source: EPA
Telephone: 202-566-0500
Last EDR Contact: 10/21/2009
Next Scheduled EDR Contact: 02/01/2010
Data Release Frequency: Annually

MLTS: Material Licensing Tracking System

MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 07/06/2009
Date Data Arrived at EDR: 07/13/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 70

Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
Last EDR Contact: 09/21/2009
Next Scheduled EDR Contact: 12/28/2009
Data Release Frequency: Quarterly

RADINFO: Radiation Information Database

The Radiation Information Database (RADINFO) contains information about facilities that are regulated by U.S. Environmental Protection Agency (EPA) regulations for radiation and radioactivity.

Date of Government Version: 10/15/2009
Date Data Arrived at EDR: 10/16/2009
Date Made Active in Reports: 12/01/2009
Number of Days to Update: 46

Source: Environmental Protection Agency
Telephone: 202-343-9775
Last EDR Contact: 10/16/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

FINDS: Facility Index System/Facility Registry System

Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 10/19/2009
Date Data Arrived at EDR: 10/22/2009
Date Made Active in Reports: 12/01/2009
Number of Days to Update: 40

Source: EPA
Telephone: (312) 353-2000
Last EDR Contact: 09/18/2009
Next Scheduled EDR Contact: 12/28/2009
Data Release Frequency: Quarterly

RAATS: RCRA Administrative Action Tracking System

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/1995
Date Data Arrived at EDR: 07/03/1995
Date Made Active in Reports: 08/07/1995
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4104
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: No Update Planned

BRS: Biennial Reporting System

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 02/19/2009
Date Made Active in Reports: 05/22/2009
Number of Days to Update: 92

Source: EPA/NTIS
Telephone: 800-424-9346
Last EDR Contact: 11/20/2009
Next Scheduled EDR Contact: 03/05/2010
Data Release Frequency: Biennially

BRRTS: Bureau of Remediation & Redevelopment Tracking System

BRRTS is a tracking system of contaminated sites. It holds key information for finding out more about a site or an activity. Activity types included are: Abandoned Container - An abandoned container with potentially hazardous contents recovered from a site. No discharge to the environment occurs. If the container did release a hazardous substance, a spill would be associated with the site. Superfund - is a federal program created by Congress in 1980 to finance cleanup of the nation's worst hazardous waste sites. VPLE - Voluntary Property Liability Exemptions apply to sites in which a property owner conducts an environmental investigation and cleanup of an entire property and then receives limits on their future liability. General Property - Environmental actions which apply to the property as a whole, rather than a specific source of contamination, such as the LUST or environmental repair site. Examples would be off-site letters, municipal liability clarification letters, lease letters, voluntary party liability exemption actions, and general liability clarification letters.

Date of Government Version: 10/22/2009
Date Data Arrived at EDR: 10/23/2009
Date Made Active in Reports: 11/19/2009
Number of Days to Update: 27

Source: Department of Natural Resources
Telephone: 608-267-7563
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 01/25/2010
Data Release Frequency: Quarterly

WI MANIFEST: Manifest Information

Hazardous waste manifest information.

Date of Government Version: 12/31/2008
Date Data Arrived at EDR: 07/17/2009
Date Made Active in Reports: 08/10/2009
Number of Days to Update: 24

Source: Department of Natural Resources
Telephone: N/A
Last EDR Contact: 09/24/2009
Next Scheduled EDR Contact: 01/04/2010
Data Release Frequency: Annually

DRYCLEANERS: Five Star Recognition Program Sites

Drycleaning facilities enrolled in the Five Star Recognition Program. The primary focus of the Five Star program is to encourage reductions in the use and emissions of perchloroethylene (perc), a common but potentially hazardous drycleaning solvent. Participating cleaners pursue recycling opportunities, spill prevention strategies, more efficient solvent use, and more wet cleaning to reduce their perc consumption.

Date of Government Version: 01/16/2009
Date Data Arrived at EDR: 07/10/2009
Date Made Active in Reports: 08/10/2009
Number of Days to Update: 31

Source: Department of Natural Resources
Telephone: 608-267-3125
Last EDR Contact: 10/01/2009
Next Scheduled EDR Contact: 01/04/2010
Data Release Frequency: Varies

WRRSER: Wisconsin Remedial Response Site Evaluation Report

The WRRSER provides information about location, status, and priority of sites or facilities in the state which are known to cause or have a high potential to cause environmental pollution.

Date of Government Version: 10/01/1995
Date Data Arrived at EDR: 01/02/1996
Date Made Active in Reports: 02/01/1996
Number of Days to Update: 30

Source: Department of Natural Resources
Telephone: 608-266-2632
Last EDR Contact: 10/05/2009
Next Scheduled EDR Contact: 01/18/2010
Data Release Frequency: No Update Planned

AIRS: Air Permit Program Listing

A listing of permits issued by the Air Permit Program.

Date of Government Version: 12/31/2008
Date Data Arrived at EDR: 08/18/2009
Date Made Active in Reports: 08/31/2009
Number of Days to Update: 13

Source: Department of Natural Resources
Telephone: 608-266-2621
Last EDR Contact: 10/26/2009
Next Scheduled EDR Contact: 02/08/2010
Data Release Frequency: Annually

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

TIER 2: Tier 2 Facility Listing
A listing of facilities which store or manufacture hazardous materials that submit a chemical inventory report.

Date of Government Version: 12/26/2008
Date Data Arrived at EDR: 01/07/2009
Date Made Active in Reports: 03/25/2009
Number of Days to Update: 77

Source: Department of Natural Resources
Telephone: 608-242-3225
Last EDR Contact: 10/26/2009
Next Scheduled EDR Contact: 02/08/2010
Data Release Frequency: Varies

LEAD: Lead Inspection Data
Lead inspection information.

Date of Government Version: 10/01/2009
Date Data Arrived at EDR: 10/01/2009
Date Made Active in Reports: 10/23/2009
Number of Days to Update: 22

Source: Department of Health & Family Services
Telephone: 608-267-0473
Last EDR Contact: 09/29/2009
Next Scheduled EDR Contact: 01/11/2010
Data Release Frequency: Annually

INDIAN RESERV: Indian Reservations
This map layer portrays Indian administered lands of the United States that have any area equal to or greater than 640 acres.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 12/08/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 34

Source: USGS
Telephone: 202-208-3710
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 02/01/2010
Data Release Frequency: Semi-Annually

SCRD DRYCLEANERS: State Coalition for Remediation of Drycleaners Listing
The State Coalition for Remediation of Drycleaners was established in 1998, with support from the U.S. EPA Office of Superfund Remediation and Technology Innovation. It is comprised of representatives of states with established drycleaner remediation programs. Currently the member states are Alabama, Connecticut, Florida, Illinois, Kansas, Minnesota, Missouri, North Carolina, Oregon, South Carolina, Tennessee, Texas, and Wisconsin.

Date of Government Version: 09/09/2009
Date Data Arrived at EDR: 09/09/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 43

Source: Environmental Protection Agency
Telephone: 615-532-8599
Last EDR Contact: 11/09/2009
Next Scheduled EDR Contact: 02/08/2010
Data Release Frequency: Varies

PCB TRANSFORMER: PCB Transformer Registration Database
The database of PCB transformer registrations that includes all PCB registration submittals.

Date of Government Version: 01/01/2008
Date Data Arrived at EDR: 02/18/2009
Date Made Active in Reports: 05/29/2009
Number of Days to Update: 100

Source: Environmental Protection Agency
Telephone: 202-566-0517
Last EDR Contact: 11/13/2009
Next Scheduled EDR Contact: 02/15/2010
Data Release Frequency: Varies

FEDLAND: Federal and Indian Lands
Federally and Indian administrated lands of the United States. Lands included are administrated by: Army Corps of Engineers, Bureau of Reclamation, National Wild and Scenic River, National Wildlife Refuge, Public Domain Land, Wilderness, Wilderness Study Area, Wildlife Management Area, Bureau of Indian Affairs, Bureau of Land Management, Department of Justice, Forest Service, Fish and Wildlife Service, National Park Service.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 02/06/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 339

Source: U.S. Geological Survey
Telephone: 888-275-8747
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 02/01/2010
Data Release Frequency: N/A

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

EDR PROPRIETARY RECORDS

EDR Proprietary Records

Manufactured Gas Plants: EDR Proprietary Manufactured Gas Plants

The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR's researchers. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

CT MANIFEST: Hazardous Waste Manifest Data

Facility and manifest data. Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a tsd facility.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 08/26/2009
Date Made Active in Reports: 09/11/2009
Number of Days to Update: 16

Source: Department of Environmental Protection
Telephone: 860-424-3375
Last EDR Contact: 11/24/2009
Next Scheduled EDR Contact: 03/08/2010
Data Release Frequency: Annually

NJ MANIFEST: Manifest Information

Hazardous waste manifest information.

Date of Government Version: 12/31/2008
Date Data Arrived at EDR: 05/05/2009
Date Made Active in Reports: 05/22/2009
Number of Days to Update: 17

Source: Department of Environmental Protection
Telephone: N/A
Last EDR Contact: 10/20/2009
Next Scheduled EDR Contact: 02/01/2010
Data Release Frequency: Annually

NY MANIFEST: Facility and Manifest Data

Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a TSD facility.

Date of Government Version: 07/28/2009
Date Data Arrived at EDR: 08/27/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 25

Source: Department of Environmental Conservation
Telephone: 518-402-8651
Last EDR Contact: 11/10/2009
Next Scheduled EDR Contact: 02/22/2010
Data Release Frequency: Annually

PA MANIFEST: Manifest Information

Hazardous waste manifest information.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 09/11/2008
Date Made Active in Reports: 10/02/2008
Number of Days to Update: 21

Source: Department of Environmental Protection
Telephone: N/A
Last EDR Contact: 11/23/2009
Next Scheduled EDR Contact: 03/08/2010
Data Release Frequency: Annually

RI MANIFEST: Manifest information
Hazardous waste manifest information

Date of Government Version: 06/01/2009
Date Data Arrived at EDR: 06/12/2009
Date Made Active in Reports: 06/29/2009
Number of Days to Update: 17

Source: Department of Environmental Management
Telephone: 401-222-2797
Last EDR Contact: 11/30/2009
Next Scheduled EDR Contact: 03/15/2010
Data Release Frequency: Annually

VT MANIFEST: Hazardous Waste Manifest Data
Hazardous waste manifest information.

Date of Government Version: 03/31/2009
Date Data Arrived at EDR: 04/09/2009
Date Made Active in Reports: 05/20/2009
Number of Days to Update: 41

Source: Department of Environmental Conservation
Telephone: 802-241-3443
Last EDR Contact: 10/23/2009
Next Scheduled EDR Contact: 02/08/2010
Data Release Frequency: Annually

Oil/Gas Pipelines: This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines.

Electric Power Transmission Line Data
Source: PennWell Corporation
Telephone: (800) 823-6277
This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Daycare Centers: Day Care Directory
Source: Department of Health & Family Services
Telephone: 608-266-9314

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 and 2005 from the U.S. Fish and Wildlife Service.

Scanned Digital USGS 7.5' Topographic Map (DRG)
Source: United States Geologic Survey
A digital raster graphic (DRG) is a scanned image of a U.S. Geological Survey topographic map. The map images are made by scanning published paper maps on high-resolution scanners. The raster image is georeferenced and fit to the Universal Transverse Mercator (UTM) projection.

STREET AND ADDRESS INFORMATION

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GEOCHECK®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

FOX SHORES APARTMENTS
400 FOX SHORE DRIVE
KAUKAUNA, WI 54130

TARGET PROPERTY COORDINATES

Latitude (North):	44.28050 - 44° 16' 49.8"
Longitude (West):	88.2751 - 88° 16' 30.4"
Universal Tranverse Mercator:	Zone 16
UTM X (Meters):	398249.7
UTM Y (Meters):	4903602.0
Elevation:	657 ft. above sea level

USGS TOPOGRAPHIC MAP

Target Property Map:	44088-C3 KAUKAUNA, WI
Most Recent Revision:	1995

EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

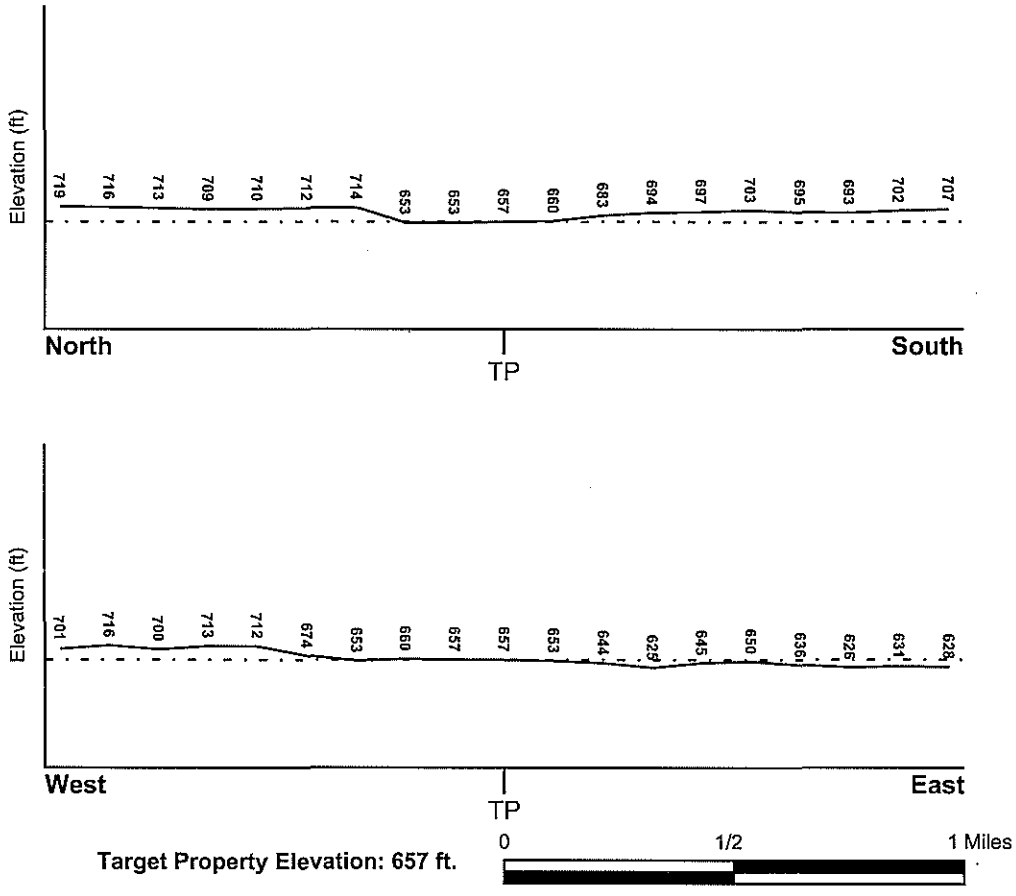
TOPOGRAPHIC INFORMATION

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

General Topographic Gradient: General ENE

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES



Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
OUTAGAMIE, WI	YES - refer to the Overview Map and Detail Map

Flood Plain Panel at Target Property:	5503050002C
Additional Panels in search area:	5503020050B 5503050001C 5503070002B 5503040001B

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
NOT AVAILABLE	Not Available

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Site-Specific Hydrogeological Data*:

Search Radius:	1.25 miles
Status:	Not found

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

* ©1996 Site-specific hydrogeological data gathered by CERCLIS Alerts, Inc., Bainbridge Island, WA. All rights reserved. All of the information and opinions presented are those of the cited EPA report(s), which were completed under a Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) investigation.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

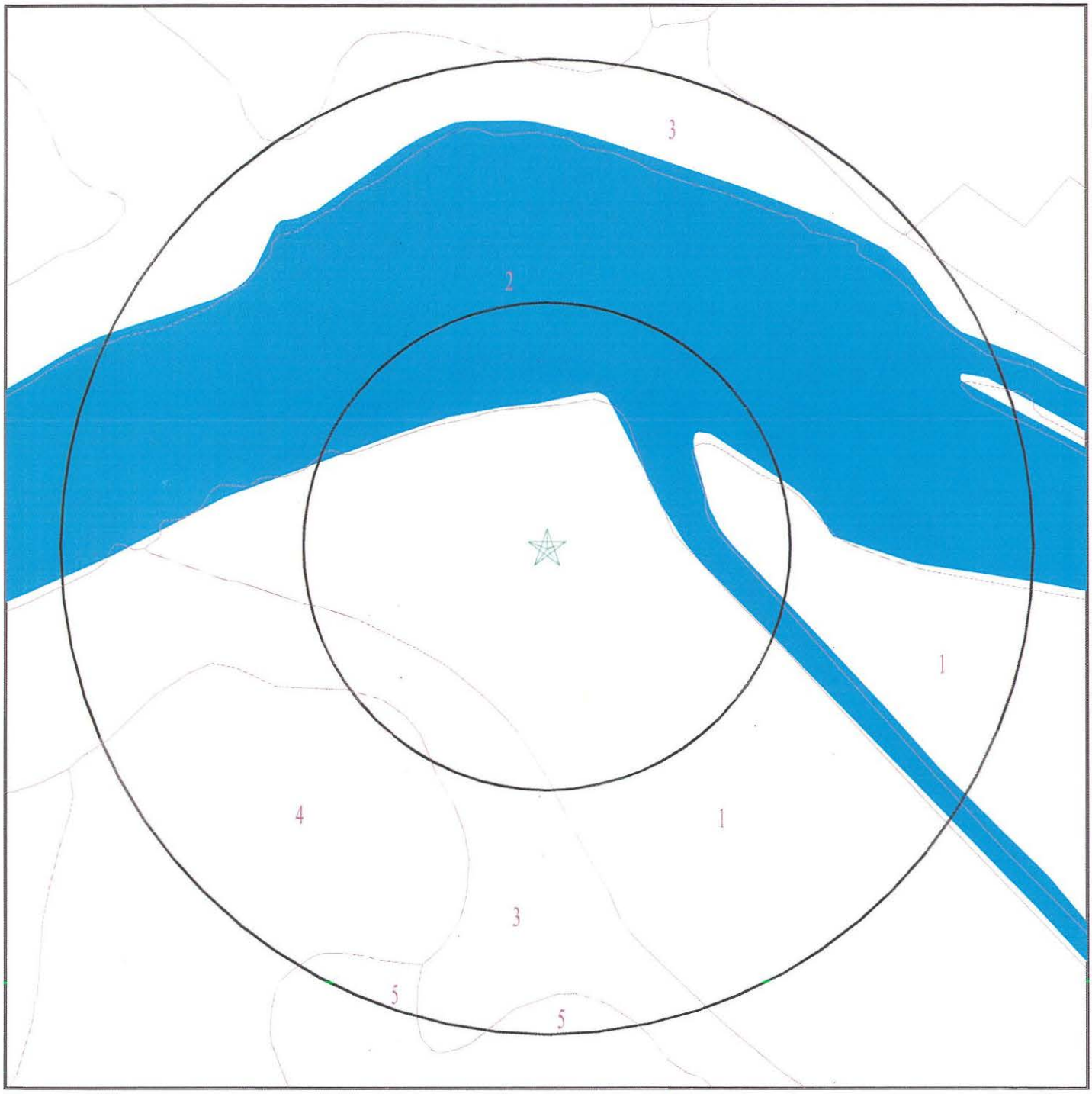
Era:	Paleozoic
System:	Ordovician
Series:	Middle Ordovician (Mohawkian)
Code:	O2 *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Stratified Sequence

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

SSURGO SOIL MAP - 2655083.2s



☆ Target Property
SSURGO Soil
Water

SITE NAME: Fox Shores Apartments ADDRESS: 400 Fox Shore Drive Kaukauna WI 54130 LAT/LONG: 44.2805 / 88.2751	CLIENT: Global Realty Services Group CONTACT: Anthony Mueller INQUIRY #: 2655083.2s DATE: December 08, 2009 4:01 pm

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GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. The following information is based on Soil Conservation Service SSURGO data.

Soil Map ID: 1

Soil Component Name: Udorthents

Soil Surface Texture: variable

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Somewhat excessively drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	59 inches	variable	Not reported	Not reported	Max: 42 Min: 0	Max: Min:

Soil Map ID: 2

Soil Component Name: Water

Soil Surface Texture: variable

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class:
Hydric Status: Unknown

Corrosion Potential - Uncoated Steel: Not Reported

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

No Layer Information available.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Map ID: 3

Soil Component Name: Kewaunee

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	5 inches	silty clay loam	Not reported	Not reported	Max: 4 Min: 0	Max: 8.4 Min: 7.4
2	5 inches	27 inches	clay	Not reported	Not reported	Max: 4 Min: 0	Max: 8.4 Min: 7.4
3	27 inches	59 inches	silty clay	Not reported	Not reported	Max: 4 Min: 0	Max: 8.4 Min: 7.4

Soil Map ID: 4

Soil Component Name: Briggsville

Soil Surface Texture: silt loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	11 inches	silt loam	Not reported	Not reported	Max: 4 Min: 1	Max: 8.4 Min: 7.4
2	11 inches	27 inches	silty clay	Not reported	Not reported	Max: 4 Min: 1	Max: 8.4 Min: 7.4
3	27 inches	59 inches	silty clay loam	Not reported	Not reported	Max: 4 Min: 1	Max: 8.4 Min: 7.4

Soil Map ID: 5

Soil Component Name: Winneconne

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	9 inches	silty clay loam	Not reported	Not reported	Max: 0 Min: 0	Max: 8.4 Min: 7.4
2	9 inches	31 inches	clay	Not reported	Not reported	Max: 0 Min: 0	Max: 8.4 Min: 7.4
3	31 inches	59 inches	clay	Not reported	Not reported	Max: 0 Min: 0	Max: 8.4 Min: 7.4

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Map ID: 6

Soil Component Name: Nichols

Soil Surface Texture: very fine sandy loam

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Moderately well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Low

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 137 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	9 inches	very fine sandy loam	Not reported	Not reported	Max: 14 Min: 4	Max: 8.4 Min: 7.4
2	9 inches	25 inches	loamy sand	Not reported	Not reported	Max: 14 Min: 4	Max: 8.4 Min: 7.4
3	25 inches	59 inches	stratified fine sand to silt	Not reported	Not reported	Max: 14 Min: 4	Max: 8.4 Min: 7.4

Soil Map ID: 7

Soil Component Name: Kaukauna

Soil Surface Texture: silty clay loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Moderately well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 137 inches

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	9 inches	silty clay loam	Not reported	Not reported	Max: 14 Min: 1	Max: 8.4 Min: 7.4
2	9 inches	27 inches	clay	Not reported	Not reported	Max: 14 Min: 1	Max: 8.4 Min: 7.4
3	27 inches	33 inches	silt loam	Not reported	Not reported	Max: 14 Min: 1	Max: 8.4 Min: 7.4
4	33 inches	59 inches	stratified very fine sand to silt	Not reported	Not reported	Max: 14 Min: 1	Max: 8.4 Min: 7.4

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A2	USGS2391153	1/4 - 1/2 Mile East
B3	USGS2391162	1/4 - 1/2 Mile NW
B4	USGS2391161	1/4 - 1/2 Mile NW
A5	USGS2391154	1/4 - 1/2 Mile East
A6	USGS2391156	1/4 - 1/2 Mile ENE
7	USGS2391164	1/4 - 1/2 Mile ENE
C8	USGS2391134	1/2 - 1 Mile SE
C9	USGS2391135	1/2 - 1 Mile SE
D10	USGS2391147	1/2 - 1 Mile ESE
D11	USGS2391148	1/2 - 1 Mile ESE
12	USGS2391155	1/2 - 1 Mile East
13	USGS2391121	1/2 - 1 Mile South
14	USGS2391122	1/2 - 1 Mile SSW
15	USGS2391145	1/2 - 1 Mile WSW

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
E16	USGS2391183	1/2 - 1 Mile NE
E17	USGS2391182	1/2 - 1 Mile NE

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
1	WI4450106	1/8 - 1/4 Mile SE

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No Wells Found		

PHYSICAL SETTING SOURCE MAP - 2655083.2s



- County Boundary
- Major Roads
- Contour Lines
- Airports
- Earthquake epicenter, Richter 5 or greater
- Water Wells
- Public Water Supply Wells
- Cluster of Multiple Icons

- Groundwater Flow Direction
- (GI) Indeterminate Groundwater Flow at Location
- (GV) Groundwater Flow Varies at Location
- (HD) Closest Hydrogeological Data

SITE NAME: Fox Shores Apartments	CLIENT: Global Realty Services Group
ADDRESS: 400 Fox Shore Drive Kaukauna WI 54130	CONTACT: Anthony Mueller
LAT/LONG: 44.2805 / 88.2751	INQUIRY #: 2655083.2s DATE: December 08, 2009 4:01 pm

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GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID
Direction
Distance
Elevation | Database | EDR ID Number

1
SE
1/8 - 1/4 Mile
Higher | **FRDS PWS** | **WI4450106**

PWS ID:	WI4450106		
Date Initiated:	Not Reported	Date Deactivated:	Not Reported
PWS Name:	BEAVER HUT TAVERN FREEDOM, WI 54130		
Addressee / Facility:	Not Reported		
Facility Latitude:	44 16 41	Facility Longitude:	088 16 18
City Served:	Not Reported		
Treatment Class:	Untreated	Population:	00000025

Violations information not reported.

ENFORCEMENT INFORMATION:

System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/10/2003 0:00:00	Enf. Action:	State Boil Water Order
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/10/2003 0:00:00	Enf. Action:	State Violation/Reminder Notice
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	11/5/2003 0:00:00	Enf. Action:	State Compliance Achieved
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/20/2003 0:00:00	Enf. Action:	State Public Notif Received
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/15/2003 0:00:00	Enf. Action:	State Public Notif Issued
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/10/2003 0:00:00	Enf. Action:	State Public Notif Requested

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

ENFORCEMENT INFORMATION:

System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/10/2003 0:00:00	Enf. Action:	State Public Notif Requested
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/15/2003 0:00:00	Enf. Action:	State Public Notif Issued
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/20/2003 0:00:00	Enf. Action:	State Public Notif Received
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	11/5/2003 0:00:00	Enf. Action:	State Compliance Achieved
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/10/2003 0:00:00	Enf. Action:	State Boil Water Order
System Name:	BEAVER HUT TAVERN		
Violation Type:	MCL, Monthly (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	9/1/2003 0:00:00 - 9/30/2003 0:00:00		
Violation ID:	0400002		
Enforcement Date:	10/10/2003 0:00:00	Enf. Action:	State Violation/Reminder Notice
System Name:	BEAVER HUT TAVERN		
Violation Type:	Monitoring, Routine Major (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	1/1/2005 0:00:00 - 9/30/2005 0:00:00		
Violation ID:	0600003		
Enforcement Date:	11/9/2005 0:00:00	Enf. Action:	State Compliance Achieved
System Name:	BEAVER HUT TAVERN		
Violation Type:	Monitoring, Routine Major (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	1/1/2005 0:00:00 - 9/30/2005 0:00:00		
Violation ID:	0600003		
Enforcement Date:	10/24/2005 0:00:00	Enf. Action:	State Public Notif Requested
System Name:	BEAVER HUT TAVERN		
Violation Type:	Monitoring, Routine Major (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	1/1/2005 0:00:00 - 9/30/2005 0:00:00		
Violation ID:	0600003		
Enforcement Date:	10/24/2005 0:00:00	Enf. Action:	State Violation/Reminder Notice

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

ENFORCEMENT INFORMATION:

System Name:	BEAVER HUT TAVERN		
Violation Type:	PN Violation for NPDWR Violation		
Contaminant:	7500		
Compliance Period:	10/1/2005 0:00:00 - 12/31/2025 0:00:00		
Violation ID:	0700004		
Enforcement Date:	4/12/2007 0:00:00	Enf. Action:	Not Reported
System Name:	BEAVER HUT TAVERN		
Violation Type:	Monitoring, Regular		
Contaminant:	NITRATE		
Compliance Period:	1994-01-13 - 1994-12-31		
Violation ID:	9500001		
Enforcement Date:	1995-06-23	Enf. Action:	State Violation/Reminder Notice

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A2
East
1/4 - 1/2 Mile
Lower

FED USGS **USGS2391153**

Agency cd:	USGS	Site no:	441652088160501
Site name:	OU-21/18E/24-0381		
Latitude:	441652	EDR Site id:	USGS2391153
Longitude:	0881605	Dec lat:	44.28109872
Dec lon:	-88.2681614	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NESWNWS24 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	670.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	10		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Not Reported		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	51.2	Hole depth:	51.5
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID
Direction
Distance
Elevation

	Database	EDR ID Number
B3 **NW** **1/4 - 1/2 Mile** **Higher**	**FED USGS**	**USGS2391162**

Agency cd:	WI001	Site no:	441701088165002
Site name:	USER 1493 7		
Latitude:	441701	EDR Site id:	USGS2391162
Longitude:	0881650	Dec lat:	44.28359863
Dec lon:	-88.28066141	Coor meth:	M
Coor accr:	M	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	Not Reported		
Altitude method:	Not Reported		
Altitude accuracy:	Not Reported		
Altitude datum:	Not Reported		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	Not Reported	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

B4 **NW** **1/4 - 1/2 Mile** **Higher**	**FED USGS**	**USGS2391161**

Agency cd:	USGS	Site no:	441701088165001
Site name:	OU-21/18E/23-0334		
Latitude:	441701	EDR Site id:	USGS2391161
Longitude:	0881650	Dec lat:	44.28359863
Dec lon:	-88.28066141	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NWNES23 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000

Altitude:	685.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	10		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	806	Hole depth:	806
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	1974-05-07	Ground water data end date:	1974-05-07
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1974-05-07	72.00	

A5
East
1/4 - 1/2 Mile
Higher

FED USGS USGS2391154

Agency cd:	USGS	Site no:	441653088160501
Site name:	OU-21/18E/24-0288		
Latitude:	441653	EDR Site id:	USGS2391154
Longitude:	0881605	Dec lat:	44.2813765
Dec lon:	-88.26816139	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NESWNWS24 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	680.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	10		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	52.5	Hole depth:	52.5
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported

Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

A6
ENE
1/4 - 1/2 Mile
Higher

FED USGS **USGS2391156**

Agency cd:	USGS	Site no:	441654088160501
Site name:	OU-21/24E/24-0289		
Latitude:	441654	EDR Site id:	USGS2391156
Longitude:	0881605	Dec lat:	44.28165428
Dec lon:	-88.26816139	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NESWNWS24 T021N R024E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	690.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	10		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	59.5	Hole depth:	59.5
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

7
ENE
1/4 - 1/2 Mile
Higher

FED USGS **USGS2391164**

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Agency cd:	USGS	Site no:	441702088155801
Site name:	OU-21/18E/24-0293		
Latitude:	441702	EDR Site id:	USGS2391164
Longitude:	0881558	Dec lat:	44.28387652
Dec lon:	-88.26621691	Coor meth:	M
Coor accr:	T	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NWNES24 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	700.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	775	Hole depth:	775
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	1956-01-01	Ground water data end date:	1956-01-01
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1956-01-01	36.00	

C8
SE
1/2 - 1 Mile
Lower

FED USGS **USGS2391134**

Agency cd:	USGS	Site no:	441629088160301
Site name:	OU-21/18E/24-0045		
Latitude:	441629	EDR Site id:	USGS2391134
Longitude:	0881603	Dec lat:	44.27470981
Dec lon:	-88.26760593	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NWSWSWS24 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	642.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	5		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Flat surface		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST

Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	734	Hole depth:	734
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	1994-09-06
Water quality data end date:	1994 09-06	Water quality data count:	1
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

C9
SE
1/2 - 1 Mile
Lower

FED USGS **USGS2391135**

Agency cd:	WI001	Site no:	441629088160303
Site name:	USER 1493 5		
Latitude:	441629	EDR Site id:	USGS2391135
Longitude:	0881603	Dec lat:	44.27470981
Dec lon:	-88.26760593	Coor meth:	M
Coor accr:	M	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	Not Reported		
Altitude method:	Not Reported		
Altitude accuracy:	Not Reported		
Altitude datum:	Not Reported		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	Not Reported	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID
Direction
Distance
Elevation

	Database	EDR ID Number
D10 **ESE** **1/2 - 1 Mile** **Lower**	**FED USGS**	**USGS2391147**

Agency cd:	USGS	Site no:	441642088155101
Site name:	OU-21/18E/24-0309		
Latitude:	441642	EDR Site id:	USGS2391147
Longitude:	0881551	Dec lat:	44.27832096
Dec lon:	-88.26427253	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NENESWS24 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	740.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	5		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Flat surface		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	726	Hole depth:	726
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

D11 **ESE** **1/2 - 1 Mile** **Lower**	**FED USGS**	**USGS2391148**

Agency cd:	USGS	Site no:	441644088155001
Site name:	OU-21/18E/24-0002		
Latitude:	441644	EDR Site id:	USGS2391148
Longitude:	0881550	Dec lat:	44.27887652
Dec lon:	-88.26399474	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NENESWS24 T021N R018E 4
Location map:	APPLETON	Map scale:	62500

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Altitude:	645.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	5		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19090101
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	PALEOZOIC SANDSTONE		
Well depth:	700	Hole depth:	799
Source of depth data:	driller		
Project number:	445509300		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	1911-04-26
Water quality data end date:	1935-01-01	Water quality data count:	2
Ground water data begin date:	1946-12-04	Ground water data end date:	1970-05-26
Ground water data count:	6425		

Ground-water levels, Number of Measurements: 6425

Date	Feet below Surface	Feet to Sealevel	Date	Feet below Surface	Feet to Sealevel
1970-05-26	41.84		1970-03-25	34.39	
1969-07-10	42.42		1969-07-09	41.41	
1969-07-08	41.64		1969-07-07	38.86	
1969-07-06	38.07		1969-07-05	38.88	
1969-07-02	41.97		1969-07-01	41.69	
1969-06-30	40.84		1969-06-29	40.63	
1969-06-28	42.42		1969-06-27	41.63	
1969-06-26	41.20		1969-06-25	41.18	
1969-06-24	37.71		1969-06-23	36.80	
1969-06-22	38.19		1969-06-21	38.45	
1969-06-20	38.48		1969-06-19	36.89	
1969-06-18	36.89		1969-06-17	36.46	
1969-06-16	36.56		1969-06-15	35.48	
1969-06-14	36.86		1969-06-13	37.52	
1969-06-12	38.43		1969-06-11	37.28	
1969-06-10	37.97		1969-06-09	38.40	
1969-06-08	37.43		1969-06-07	37.90	
1969-06-06	37.96		1969-06-05	36.76	
1969-06-04	36.28		1969-06-03	37.16	
1969-06-02	36.17		1969-06-01	34.62	
1969-05-31	35.16		1969-05-28	34.87	
1969-05-27	34.52		1969-05-26	35.16	
1969-05-25	33.87		1969-05-24	35.21	
1969-05-23	36.27		1969-05-22	36.53	
1969-05-21	36.09		1969-05-20	34.50	
1969-05-18	35.50		1969-05-17	36.15	
1969-05-16	36.38		1969-05-15	35.94	
1969-05-14	36.60		1969-05-13	36.46	
1969-05-11	34.61		1969-05-10	34.86	
1969-05-09	34.91		1969-05-08	35.45	
1969-05-07	36.30		1969-05-06	35.07	
1969-05-05	35.39		1969-05-04	34.35	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1969-05-03	35.24	
1969-04-30	36.66	
1969-04-28	34.51	
1969-04-26	36.37	
1969-04-24	35.92	
1969-04-22	36.64	
1969-04-20	34.76	
1969-04-18	35.95	
1969-04-16	35.27	
1969-04-14	35.13	
1969-04-12	37.90	
1969-04-10	38.68	
1969-04-08	37.28	
1969-04-06	35.15	
1969-04-04	36.27	
1969-04-02	36.01	
1969-03-31	36.32	
1969-03-29	36.53	
1969-03-27	35.41	
1969-03-25	34.94	
1969-02-25	86.44	
Note: A nearby site that taps the same aquifer was being pumped.		
1969-01-21	70.61	
Note: A nearby site that taps the same aquifer was being pumped.		
1968-12-17	36.17	
1968-10-01	48.33	
1968-09-29	45.59	
1968-09-25	49.20	
1968-09-23	48.00	
1968-09-21	48.57	
1968-09-17	46.60	
1968-08-21	47.96	
1968-07-27	39.38	
1968-07-20	40.55	
1968-07-13	42.44	
1968-07-11	43.69	
1968-07-08	33.86	
1968-07-06	35.04	
1968-07-04	40.24	
1968-07-02	39.64	
1968-06-30	37.33	
1968-06-28	40.22	
1968-06-25	38.87	
1968-06-02	29.72	
1968-05-31	30.82	
1968-05-29	29.51	
1968-05-27	29.47	
1968-05-25	29.63	
1968-05-23	28.61	
1968-05-20	27.13	
1968-05-16	28.62	
1968-05-14	28.63	
1968-05-12	29.01	
1968-05-10	30.95	
1968-05-04	28.80	

Date	Feet below Surface	Feet to Sealevel
1969-05-01	36.12	
1969-04-29	35.73	
1969-04-27	34.87	
1969-04-25	36.83	
1969-04-23	36.77	
1969-04-21	34.86	
1969-04-19	35.11	
1969-04-17	36.11	
1969-04-15	35.48	
1969-04-13	37.19	
1969-04-11	38.74	
1969-04-09	37.37	
1969-04-07	36.28	
1969-04-05	35.77	
1969-04-03	35.93	
1969-04-01	35.23	
1969-03-30	36.12	
1969-03-28	35.88	
1969-03-26	34.60	
1968-10-19	36.10	
1968-09-30	43.19	
1968-09-28	49.21	
1968-09-24	48.31	
1968-09-22	47.46	
1968-09-18	46.09	
1968-09-16	45.65	
1968-07-28	40.12	
1968-07-21	41.78	
1968-07-14	42.46	
1968-07-12	43.35	
1968-07-10	42.59	
1968-07-07	35.23	
1968-07-05	36.01	
1968-07-03	40.75	
1968-07-01	36.07	
1968-06-29	39.49	
1968-06-26	38.90	
1968-06-24	38.61	
1968-06-01	30.82	
1968-05-30	29.34	
1968-05-28	30.54	
1968-05-26	28.87	
1968-05-24	28.64	
1968-05-22	28.85	
1968-05-19	28.78	
1968-05-15	29.41	
1968-05-13	28.80	
1968-05-11	30.30	
1968-05-05	28.44	
1968-05-03	28.99	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1968-05-02	29.30	
1968-04-30	28.14	
1968-04-28	27.33	
1968-04-26	28.17	
1968-04-24	27.19	
1968-04-22	28.33	
1968-04-20	29.08	
1968-04-18	28.12	
1968-04-16	28.30	
1968-04-14	28.34	
1968-04-12	30.10	
1968-04-10	29.08	
1968-04-08	28.87	
1968-04-06	29.66	
1968-04-04	30.95	
1968-04-02	29.31	
1968-02-28	32.11	
1968-02-26	29.65	
1968-02-24	31.32	
1968-02-22	30.43	
1968-02-20	28.14	
1968-02-17	28.76	
1968-02-15	29.60	
1968-02-13	28.47	
1968-02-11	27.40	
1968-02-09	29.49	
1968-02-06	28.66	
1968-02-04	28.01	
1968-02-02	31.81	
1968-01-31	32.01	
1968-01-28	27.99	
1968-01-26	29.93	
1968-01-24	29.63	
1968-01-22	28.90	
1968-01-20	28.83	
1968-01-18	29.65	
1968-01-16	29.21	
1967-12-26	28.83	
1967-12-24	30.56	
1967-12-22	32.11	
1967-12-19	28.90	
1967-12-17	30.21	
1967-12-15	30.99	
1967-12-13	31.18	
1967-12-11	29.42	
1967-12-09	31.96	
1967-12-07	34.79	
1967-12-05	32.12	
1967-12-03	31.30	
1967-12-01	32.93	
1967-11-29	32.19	
1967-11-27	31.74	
1967-11-25	30.61	
1967-11-23	32.82	
1967-11-21	33.59	
1968-05-01	28.80	
1968-04-29	25.90	
1968-04-27	27.87	
1968-04-25	28.17	
1968-04-23	28.33	
1968-04-21	27.59	
1968-04-19	29.78	
1968-04-17	28.11	
1968-04-15	29.87	
1968-04-13	29.53	
1968-04-11	28.98	
1968-04-09	29.65	
1968-04-07	28.49	
1968-04-05	30.19	
1968-04-03	28.64	
1968-02-29	32.03	
1968-02-27	29.89	
1968-02-25	30.21	
1968-02-23	31.50	
1968-02-21	28.41	
1968-02-18	27.77	
1968-02-16	29.27	
1968-02-14	28.61	
1968-02-12	28.34	
1968-02-10	28.53	
1968-02-08	29.22	
1968-02-05	28.39	
1968-02-03	29.00	
1968-02-01	32.12	
1968-01-29	28.43	
1968-01-27	29.15	
1968-01-25	29.93	
1968-01-23	30.21	
1968-01-21	28.23	
1968-01-19	29.62	
1968-01-17	29.64	
1967-12-27	28.69	
1967-12-25	29.04	
1967-12-23	31.85	
1967-12-20	30.79	
1967-12-18	28.68	
1967-12-16	30.80	
1967-12-14	31.18	
1967-12-12	29.82	
1967-12-10	31.10	
1967-12-08	33.01	
1967-12-06	33.50	
1967-12-04	31.34	
1967-12-02	32.43	
1967-11-30	32.88	
1967-11-28	32.12	
1967-11-26	30.71	
1967-11-24	30.99	
1967-11-22	33.10	
1967-11-20	31.54	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1967-11-19	33.07	
1967-11-17	35.23	
1967-11-15	36.23	
1967-11-13	35.61	
1967-11-11	38.46	
1967-11-09	38.81	
1967-11-05	41.59	
1967-11-03	42.41	
1967-11-01	43.20	
1967-10-30	42.80	
1967-10-25	46.02	
1967-10-23	44.64	
1967-10-21	47.12	
1967-10-18	46.62	
1967-10-12	46.86	
1967-10-10	46.58	
1967-09-28	46.43	
1967-09-26	46.87	
1967-09-24	45.87	
1967-09-21	47.92	
1967-09-19	45.08	
1967-09-17	45.48	
1967-09-13	46.71	
1967-09-11	45.68	
1967-09-09	47.23	
1967-09-07	45.47	
1967-09-05	45.04	
1967-09-03	44.06	
1967-09-01	46.40	
1967-08-30	43.05	
1967-08-27	44.48	
1967-08-25	46.18	
1967-08-23	44.61	
1967-08-21	42.14	
1967-08-19	43.21	
1967-08-17	44.60	
1967-08-15	42.61	
1967-08-13	40.70	
1967-08-11	42.18	
1967-08-09	40.75	
1967-08-07	40.48	
1967-08-05	42.88	
1967-08-03	42.46	
1967-08-01	42.39	
1967-07-30	43.77	
1967-07-28	45.96	
1967-07-26	45.78	
1967-07-24	44.59	
1967-07-22	46.33	
1967-07-20	44.67	
1967-07-18	42.08	
1967-07-16	39.78	
1967-07-14	40.84	
1967-07-12	40.32	
1967-07-10	37.39	
1967-11-18	34.56	
1967-11-16	35.38	
1967-11-14	36.48	
1967-11-12	36.06	
1967-11-10	38.80	
1967-11-08	38.81	
1967-11-04	41.98	
1967-11-02	42.38	
1967-10-31	43.98	
1967-10-29	45.08	
1967-10-24	46.12	
1967-10-22	46.05	
1967-10-20	47.77	
1967-10-15	47.47	
1967-10-11	46.60	
1967-09-29	46.58	
1967-09-27	46.57	
1967-09-25	46.48	
1967-09-23	48.10	
1967-09-20	47.82	
1967-09-18	45.08	
1967-09-14	45.98	
1967-09-12	46.58	
1967-09-10	45.74	
1967-09-08	45.87	
1967-09-06	45.00	
1967-09-04	43.21	
1967-09-02	45.51	
1967-08-31	43.43	
1967-08-29	43.92	
1967-08-26	45.63	
1967-08-24	45.48	
1967-08-22	42.52	
1967-08-20	41.72	
1967-08-18	44.15	
1967-08-16	43.99	
1967-08-14	39.70	
1967-08-12	41.77	
1967-08-10	41.01	
1967-08-08	40.27	
1967-08-06	41.29	
1967-08-04	43.39	
1967-08-02	43.67	
1967-07-31	42.58	
1967-07-29	45.01	
1967-07-27	45.56	
1967-07-25	46.57	
1967-07-23	45.02	
1967-07-21	46.75	
1967-07-19	43.54	
1967-07-17	43.00	
1967-07-15	41.05	
1967-07-13	40.57	
1967-07-11	39.47	
1967-07-09	36.41	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1967-07-08	37.14	
1967-07-06	34.76	
1967-07-04	33.58	
1967-07-02	35.73	
1967-06-30	38.67	
1967-06-25	35.70	
1967-06-22	42.28	
1967-06-20	43.35	
1967-06-18	44.87	
1967-06-16	39.51	
1967-06-13	36.06	
1967-06-11	31.98	
1967-06-09	28.80	
1967-06-07	27.65	
1967-06-05	31.62	
1967-06-03	29.07	
1967-06-01	33.98	
1967-05-30	27.58	
1967-05-28	31.95	
1967-05-26	32.94	
1967-05-24	30.80	
1967-05-22	28.85	
1967-05-20	29.61	
1967-05-18	30.66	
1967-05-16	29.51	
1967-05-14	28.45	
1967-05-12	28.93	
1967-05-10	28.64	
1967-05-08	28.28	
1967-05-06	29.00	
1967-05-04	29.61	
1967-05-02	27.35	
1967-04-30	26.52	
1967-04-28	28.40	
1967-04-26	26.42	
1967-04-24	25.11	
1967-04-22	25.20	
1967-04-20	25.59	
1967-04-18	25.90	
1967-04-16	25.73	
1967-04-14	26.64	
1967-04-12	25.49	
1967-04-10	25.69	
1967-04-08	28.03	
1967-04-06	29.06	
1967-04-04	29.33	
1967-04-02	27.69	
1967-03-31	29.59	
1967-03-29	26.01	
1967-03-27	26.54	
1967-03-25	27.57	
1967-03-23	28.16	
1967-03-21	26.68	
1967-03-19	27.63	
1967-03-17	29.11	
1967-07-07	37.27	
1967-07-05	33.32	
1967-07-03	33.94	
1967-07-01	37.32	
1967-06-26	36.99	
1967-06-24	36.68	
1967-06-21	42.94	
1967-06-19	44.84	
1967-06-17	42.16	
1967-06-15	40.93	
1967-06-12	35.92	
1967-06-10	29.20	
1967-06-08	27.44	
1967-06-06	27.45	
1967-06-04	31.16	
1967-06-02	33.12	
1967-05-31	31.12	
1967-05-29	27.81	
1967-05-27	33.92	
1967-05-25	31.31	
1967-05-23	28.79	
1967-05-21	29.37	
1967-05-19	30.20	
1967-05-17	31.51	
1967-05-15	28.46	
1967-05-13	28.68	
1967-05-11	28.42	
1967-05-09	28.68	
1967-05-07	27.12	
1967-05-05	29.81	
1967-05-03	28.23	
1967-05-01	26.87	
1967-04-29	27.70	
1967-04-27	28.21	
1967-04-25	25.90	
1967-04-23	24.84	
1967-04-21	25.20	
1967-04-19	25.90	
1967-04-17	25.68	
1967-04-15	26.04	
1967-04-13	25.50	
1967-04-11	25.64	
1967-04-09	26.24	
1967-04-07	28.49	
1967-04-05	28.85	
1967-04-03	27.83	
1967-04-01	28.59	
1967-03-30	28.87	
1967-03-28	26.16	
1967-03-26	25.94	
1967-03-24	28.86	
1967-03-22	27.13	
1967-03-20	26.38	
1967-03-18	28.82	
1967-03-15	28.02	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1967-03-14	27.24	
1967-03-12	27.16	
1967-03-10	27.68	
1967-03-08	29.78	
1967-02-07	26.71	
1966-12-21	30.17	
1966-12-19	30.92	
1966-12-17	31.00	
1966-12-15	31.93	
1966-12-13	30.97	
1966-12-11	31.58	
1966-12-09	31.94	
1966-12-07	32.61	
1966-12-05	38.24	
1966-11-26	35.98	
1966-11-24	35.90	
1966-11-22	36.81	
1966-11-20	39.38	
1966-11-18	36.62	
1966-11-16	40.54	
1966-11-14	40.53	
1966-11-11	40.43	
1966-11-09	39.43	
1966-11-07	39.20	
1966-11-05	40.78	
1966-11-03	42.18	
1966-11-01	42.04	
1966-10-30	43.60	
1966-10-27	42.99	
1966-10-25	43.55	
1966-10-23	42.02	
1966-10-21	45.58	
1966-10-19	44.72	
1966-10-17	44.31	
1966-10-15	46.11	
1966-10-13	46.67	
1966-10-11	46.78	
1966-10-09	46.05	
1966-10-07	47.48	
1966-10-05	47.28	
1966-10-02	48.38	
1966-09-30	49.20	
1966-09-28	47.85	
1966-09-26	45.60	
1966-09-24	48.87	
1966-09-22	48.13	
1966-09-20	48.47	
1966-09-18	46.81	
1966-09-16	47.80	
1966-09-14	47.11	
1966-09-12	47.20	
1966-09-10	46.91	
1966-09-08	46.06	
1966-09-06	44.97	
1966-09-04	48.40	
1967-03-13	27.61	
1967-03-11	27.47	
1967-03-09	28.36	
1967-03-07	27.53	
1967-01-10	28.66	
1966-12-20	30.88	
1966-12-18	31.02	
1966-12-16	30.80	
1966-12-14	30.40	
1966-12-12	31.89	
1966-12-10	31.90	
1966-12-08	32.36	
1966-12-06	34.55	
1966-11-27	36.30	
1966-11-25	34.59	
1966-11-23	36.50	
1966-11-21	38.99	
1966-11-19	38.90	
1966-11-17	38.79	
1966-11-15	40.42	
1966-11-12	40.41	
1966-11-10	40.82	
1966-11-08	39.50	
1966-11-06	38.87	
1966-11-04	41.59	
1966-11-02	42.91	
1966-10-31	42.46	
1966-10-29	43.89	
1966-10-26	42.94	
1966-10-24	43.90	
1966-10-22	44.46	
1966-10-20	44.68	
1966-10-18	44.23	
1966-10-16	44.61	
1966-10-14	46.55	
1966-10-12	46.45	
1966-10-10	47.09	
1966-10-08	46.73	
1966-10-06	47.20	
1966-10-04	47.49	
1966-10-01	48.88	
1966-09-29	48.99	
1966-09-27	46.93	
1966-09-25	47.27	
1966-09-23	48.87	
1966-09-21	47.69	
1966-09-19	46.70	
1966-09-17	48.08	
1966-09-15	47.08	
1966-09-13	47.58	
1966-09-11	46.80	
1966-09-09	46.05	
1966-09-07	46.15	
1966-09-05	44.22	
1966-09-03	51.83	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1966-09-02	49.52	
1966-08-31	48.98	
1966-08-29	46.91	
1966-08-27	50.10	
1966-08-25	47.62	
1966-08-23	46.80	
1966-08-21	48.64	
1966-08-19	48.22	
1966-08-17	47.62	
1966-08-15	46.60	
1966-08-13	48.20	
1966-08-11	48.14	
1966-08-09	48.34	
1966-08-07	51.52	
1966-08-05	51.50	
1966-08-03	49.64	
1966-08-01	53.06	
1966-07-25	49.38	
1966-07-23	51.36	
1966-07-21	50.32	
1966-07-19	50.74	
1966-07-17	50.57	
1966-07-15	50.53	
1966-07-13	48.91	
1966-07-11	49.24	
1966-07-09	51.66	
1966-07-07	50.21	
1966-07-05	48.22	
1966-06-21	41.70	
1966-06-19	38.09	
1966-06-17	37.74	
1966-06-15	37.03	
1966-06-13	37.00	
1966-06-11	37.51	
1966-06-09	36.80	
1966-06-07	35.30	
1966-06-05	33.66	
1966-06-03	31.72	
1966-06-01	31.20	
1966-05-30	28.11	
1966-05-28	29.56	
1966-05-26	27.21	
1966-05-24	26.06	
1966-05-22	24.21	
1966-05-20	25.50	
1966-05-18	25.64	
1966-05-16	24.30	
1966-05-14	24.90	
1966-05-12	26.00	
1966-05-10	25.20	
1966-05-08	23.93	
1966-05-06	25.91	
1966-05-04	25.48	
1966-05-02	25.13	
1966-04-30	25.80	
1966-09-01	49.91	
1966-08-30	49.67	
1966-08-28	50.50	
1966-08-26	47.36	
1966-08-24	47.41	
1966-08-22	46.30	
1966-08-20	48.70	
1966-08-18	47.80	
1966-08-16	48.07	
1966-08-14	46.90	
1966-08-12	48.30	
1966-08-10	48.24	
1966-08-08	48.38	
1966-08-06	51.54	
1966-08-04	50.52	
1966-08-02	52.21	
1966-07-27	53.46	
1966-07-24	50.30	
1966-07-22	51.27	
1966-07-20	51.09	
1966-07-18	47.95	
1966-07-16	50.52	
1966-07-14	49.82	
1966-07-12	49.13	
1966-07-10	49.01	
1966-07-08	51.17	
1966-07-06	47.95	
1966-06-22	42.06	
1966-06-20	36.16	
1966-06-18	38.78	
1966-06-16	37.38	
1966-06-14	37.98	
1966-06-12	36.91	
1966-06-10	37.37	
1966-06-08	36.01	
1966-06-06	34.50	
1966-06-04	31.74	
1966-06-02	31.91	
1966-05-31	27.12	
1966-05-29	29.24	
1966-05-27	28.31	
1966-05-25	26.10	
1966-05-23	24.10	
1966-05-21	25.56	
1966-05-19	25.86	
1966-05-17	25.10	
1966-05-15	23.81	
1966-05-13	25.17	
1966-05-11	24.78	
1966-05-09	23.58	
1966-05-07	25.56	
1966-05-05	25.94	
1966-05-03	25.54	
1966-05-01	24.75	
1966-04-29	26.65	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1966-04-28	25.20	
1966-04-26	25.67	
1966-04-24	26.20	
1966-04-22	26.31	
1966-04-20	25.78	
1966-04-18	25.05	
1966-04-16	25.95	
1966-04-14	24.76	
1966-04-12	23.98	
1966-04-10	22.10	
1966-04-08	23.15	
1966-04-06	23.40	
1966-04-03	24.74	
1966-04-01	26.00	
1966-03-30	25.56	
1966-03-28	26.38	
1966-03-26	26.32	
1966-03-24	26.07	
1966-03-22	26.90	
1966-03-20	27.15	
1966-03-18	26.54	
1966-03-16	26.28	
1966-03-14	24.99	
1966-03-12	26.62	
1966-03-10	25.64	
1966-03-08	25.23	
1966-03-06	25.49	
1966-03-04	25.08	
1966-03-02	25.76	
1966-02-28	25.60	
1966-02-26	25.72	
1966-02-24	25.80	
1966-02-22	26.20	
1966-02-20	26.53	
1966-02-18	26.95	
1966-02-16	26.22	
1966-02-14	26.21	
1966-02-12	27.83	
1966-02-10	27.83	
1966-02-08	27.38	
1966-02-06	27.25	
1966-02-04	28.38	
1966-02-02	27.48	
1966-01-30	27.41	
1966-01-28	29.87	
1966-01-26	30.14	
1966-01-24	29.47	
1966-01-22	30.80	
1966-01-20	30.52	
1966-01-18	30.01	
1966-01-16	25.53	
1966-01-14	27.38	
1966-01-12	27.80	
1966-01-10	27.46	
1966-01-08	27.12	

Date	Feet below Surface	Feet to Sealevel
1966-04-27	25.70	
1966-04-25	26.40	
1966-04-23	26.30	
1966-04-21	27.03	
1966-04-19	25.40	
1966-04-17	25.25	
1966-04-15	25.55	
1966-04-13	24.03	
1966-04-11	23.88	
1966-04-09	23.04	
1966-04-07	24.00	
1966-04-04	24.78	
1966-04-02	25.77	
1966-03-31	25.50	
1966-03-29	25.27	
1966-03-27	26.18	
1966-03-25	26.41	
1966-03-23	25.37	
1966-03-21	26.50	
1966-03-19	27.73	
1966-03-17	26.00	
1966-03-15	26.33	
1966-03-13	26.36	
1966-03-11	25.64	
1966-03-09	25.39	
1966-03-07	24.99	
1966-03-05	25.28	
1966-03-03	25.40	
1966-03-01	26.15	
1966-02-27	26.00	
1966-02-25	25.40	
1966-02-23	25.80	
1966-02-21	26.20	
1966-02-19	26.50	
1966-02-17	27.27	
1966-02-15	26.40	
1966-02-13	26.72	
1966-02-11	27.22	
1966-02-09	27.20	
1966-02-07	27.80	
1966-02-05	27.63	
1966-02-03	27.84	
1966-01-31	26.30	
1966-01-29	28.58	
1966-01-27	29.34	
1966-01-25	29.70	
1966-01-23	29.45	
1966-01-21	30.64	
1966-01-19	30.40	
1966-01-17	29.64	
1966-01-15	26.50	
1966-01-13	27.36	
1966-01-11	27.46	
1966-01-09	26.40	
1966-01-07	27.18	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1966-01-06	27.50	
1966-01-01	26.40	
1965-12-30	26.10	
1965-12-28	26.87	
1965-12-26	24.47	
1965-12-24	28.87	
1965-12-22	29.15	
1965-12-20	29.16	
1965-12-18	30.65	
1965-12-16	32.52	
1965-12-14	31.69	
1965-12-12	30.40	
1965-12-10	32.97	
1965-12-08	32.20	
1965-12-06	32.39	
1965-12-04	31.48	
1965-12-02	31.97	
1965-11-30	31.70	
1965-11-28	29.89	
1965-11-26	30.09	
1965-11-24	33.29	
1965-11-22	32.47	
1965-11-20	32.88	
1965-11-18	34.28	
1965-11-16	33.97	
1965-11-14	35.21	
1965-11-12	35.10	
1965-11-10	35.85	
1965-11-08	36.64	
1965-11-06	37.78	
1965-11-04	37.31	
1965-11-02	36.87	
1965-10-31	36.54	
1965-10-29	37.68	
1965-10-27	37.16	
1965-10-25	37.96	
1965-10-23	37.67	
1965-10-21	37.98	
1965-10-19	38.08	
1965-10-17	39.17	
1965-10-15	39.69	
1965-10-13	39.46	
1965-10-11	38.77	
1965-10-09	39.35	
1965-10-07	39.30	
1965-09-14	42.74	
1965-09-12	42.47	
1965-09-10	42.08	
1965-09-08	41.10	
1965-09-06	40.22	
1965-09-04	43.88	
1965-09-02	44.33	
1965-08-31	42.26	
1965-08-29	43.40	
1965-08-27	44.90	
1966-01-05	26.50	
1965-12-31	25.88	
1965-12-29	26.58	
1965-12-27	27.30	
1965-12-25	26.41	
1965-12-23	28.87	
1965-12-21	28.96	
1965-12-19	29.30	
1965-12-17	31.79	
1965-12-15	32.21	
1965-12-13	31.04	
1965-12-11	32.34	
1965-12-09	33.12	
1965-12-07	32.30	
1965-12-05	30.95	
1965-12-03	31.95	
1965-12-01	32.10	
1965-11-29	31.67	
1965-11-27	30.16	
1965-11-25	32.78	
1965-11-23	33.40	
1965-11-21	31.96	
1965-11-19	34.14	
1965-11-17	34.04	
1965-11-15	34.71	
1965-11-13	35.50	
1965-11-11	35.37	
1965-11-09	35.88	
1965-11-07	35.58	
1965-11-05	38.13	
1965-11-03	36.23	
1965-11-01	36.42	
1965-10-30	37.32	
1965-10-28	37.53	
1965-10-26	37.72	
1965-10-24	37.32	
1965-10-22	37.70	
1965-10-20	37.67	
1965-10-18	38.80	
1965-10-16	39.56	
1965-10-14	39.94	
1965-10-12	39.49	
1965-10-10	38.10	
1965-10-08	39.64	
1965-09-15	41.98	
1965-09-13	40.96	
1965-09-11	42.28	
1965-09-09	41.71	
1965-09-07	39.92	
1965-09-05	42.25	
1965-09-03	44.01	
1965-09-01	42.38	
1965-08-30	39.62	
1965-08-28	46.28	
1965-08-26	44.01	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1965-08-25	44.00	
1965-08-23	43.50	
1965-08-21	45.49	
1965-08-19	43.01	
1965-08-17	42.57	
1965-08-15	41.79	
1965-08-13	42.50	
1965-08-11	41.11	
1965-08-09	40.25	
1965-08-07	41.98	
1965-08-05	42.12	
1965-08-01	42.79	
1965-07-30	45.19	
1965-07-28	45.58	
1965-07-26	41.33	
1965-07-24	45.16	
1965-07-22	41.29	
1965-07-20	39.77	
1965-07-18	40.48	
1965-07-16	41.83	
1965-07-14	41.19	
1965-07-12	39.61	
1965-07-10	39.41	
1965-07-08	38.11	
1965-07-06	37.45	
1965-07-04	39.49	
1965-07-02	39.56	
1965-06-30	37.44	
1965-06-28	34.75	
1965-06-26	36.31	
1965-06-24	34.85	
1965-06-22	32.37	
1965-06-20	34.18	
1965-06-18	32.72	
1965-06-16	31.01	
1965-06-14	29.57	
1965-06-12	30.70	
1965-06-10	29.99	
1965-06-08	25.60	
1965-06-06	25.77	
1965-06-04	25.51	
1965-06-02	25.23	
1965-05-31	23.33	
1965-05-29	24.36	
1965-05-27	23.71	
1965-05-25	23.40	
1965-05-23	23.91	
1965-05-21	23.64	
1965-05-19	21.70	
1965-05-17	20.53	
1965-05-15	21.45	
1965-05-13	20.98	
1965-05-11	20.91	
1965-05-09	19.23	
1965-05-07	20.86	
1965-08-24	44.58	
1965-08-22	44.34	
1965-08-20	44.84	
1965-08-18	42.30	
1965-08-16	41.80	
1965-08-14	43.16	
1965-08-12	41.10	
1965-08-10	41.44	
1965-08-08	41.40	
1965-08-06	42.47	
1965-08-04	41.38	
1965-07-31	44.16	
1965-07-29	44.84	
1965-07-27	43.43	
1965-07-25	43.34	
1965-07-23	45.48	
1965-07-21	40.71	
1965-07-19	39.03	
1965-07-17	41.21	
1965-07-15	41.24	
1965-07-13	42.37	
1965-07-11	40.89	
1965-07-09	38.58	
1965-07-07	37.42	
1965-07-05	35.34	
1965-07-03	39.40	
1965-07-01	39.63	
1965-06-29	37.12	
1965-06-27	36.57	
1965-06-25	35.96	
1965-06-23	33.51	
1965-06-21	31.68	
1965-06-19	33.98	
1965-06-17	31.74	
1965-06-15	30.09	
1965-06-13	30.96	
1965-06-11	29.36	
1965-06-09	28.43	
1965-06-07	25.52	
1965-06-05	25.73	
1965-06-03	25.64	
1965-06-01	23.42	
1965-05-30	23.71	
1965-05-28	26.40	
1965-05-26	24.34	
1965-05-24	23.30	
1965-05-22	23.47	
1965-05-20	22.20	
1965-05-18	21.27	
1965-05-16	21.61	
1965-05-14	21.77	
1965-05-12	20.50	
1965-05-10	19.80	
1965-05-08	19.96	
1965-05-06	20.86	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1965-05-05	19.68	
1965-05-01	20.73	
1965-04-29	20.31	
1965-04-27	20.48	
1965-04-25	20.35	
1965-04-23	21.81	
1965-04-21	20.39	
1965-04-19	20.22	
1965-04-17	21.12	
1965-04-15	20.77	
1965-04-13	21.27	
1965-04-11	21.47	
1965-04-09	22.16	
1965-04-07	21.61	
1965-04-05	21.33	
1965-04-03	22.18	
1965-04-01	21.79	
1965-03-30	22.44	
1965-03-28	21.77	
1965-03-26	21.70	
1965-03-24	21.26	
1965-03-22	21.58	
1965-03-20	21.68	
1965-03-18	22.38	
1965-03-16	22.06	
1965-03-14	22.23	
1965-03-12	22.90	
1965-03-10	22.90	
1965-03-07	21.86	
1965-03-05	22.49	
1965-03-03	22.76	
1965-03-01	22.69	
1965-02-27	21.13	
1965-02-25	21.63	
1965-02-23	20.84	
1965-02-21	20.46	
1965-02-19	20.77	
1965-02-17	20.90	
1965-02-15	22.09	
1965-02-13	22.04	
1965-02-11	22.43	
1965-02-09	21.78	
1965-02-07	21.55	
1965-02-05	22.09	
1965-02-03	21.47	
1965-02-01	20.71	
1965-01-30	21.79	
1965-01-28	21.72	
1965-01-26	20.75	
1965-01-24	20.36	
1965-01-22	21.31	
1965-01-20	21.56	
1965-01-18	21.16	
1965-01-16	22.11	
1965-01-14	22.53	
1965-05-02	19.66	
1965-04-30	21.11	
1965-04-28	20.50	
1965-04-26	19.20	
1965-04-24	21.70	
1965-04-22	20.59	
1965-04-20	20.32	
1965-04-18	20.49	
1965-04-16	21.13	
1965-04-14	21.38	
1965-04-12	20.58	
1965-04-10	21.72	
1965-04-08	22.21	
1965-04-06	21.30	
1965-04-04	22.35	
1965-04-02	21.90	
1965-03-31	22.23	
1965-03-29	22.04	
1965-03-27	21.99	
1965-03-25	21.40	
1965-03-23	21.54	
1965-03-21	21.71	
1965-03-19	22.34	
1965-03-17	22.23	
1965-03-15	21.41	
1965-03-13	22.88	
1965-03-11	22.77	
1965-03-09	23.10	
1965-03-06	22.17	
1965-03-04	22.65	
1965-03-02	23.11	
1965-02-28	21.17	
1965-02-26	21.40	
1965-02-24	20.83	
1965-02-22	20.66	
1965-02-20	20.45	
1965-02-18	20.32	
1965-02-16	21.87	
1965-02-14	21.44	
1965-02-12	22.26	
1965-02-10	21.87	
1965-02-08	22.00	
1965-02-06	21.71	
1965-02-04	22.66	
1965-02-02	20.95	
1965-01-31	21.57	
1965-01-29	21.81	
1965-01-27	21.33	
1965-01-25	20.85	
1965-01-23	21.25	
1965-01-21	21.56	
1965-01-19	21.03	
1965-01-17	21.77	
1965-01-15	22.21	
1965-01-13	21.67	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1965-01-12	21.26	
1965-01-10	20.51	
1965-01-08	21.37	
1965-01-06	20.69	
1965-01-03	19.18	
1965-01-01	21.11	
1964-12-30	21.07	
1964-12-28	20.68	
1964-12-26	20.37	
1964-12-24	21.37	
1964-12-22	22.11	
1964-12-20	21.62	
1964-12-18	22.37	
1964-12-16	22.00	
1964-12-14	22.63	
1964-12-12	22.19	
1964-12-10	22.76	
1964-12-08	21.99	
1964-12-06	22.78	
1964-12-04	22.72	
1964-12-02	21.48	
1964-11-30	22.11	
1964-11-28	21.22	
1964-11-26	22.47	
1964-11-24	22.72	
1964-11-22	23.68	
1964-11-20	24.49	
1964-11-18	24.48	
1964-11-16	24.62	
1964-11-14	25.26	
1964-11-12	25.04	
1964-11-10	24.83	
1964-11-08	25.25	
1964-11-06	27.01	
1964-11-04	25.83	
1964-10-31	25.27	
1964-10-29	26.46	
1964-10-27	25.82	
1964-10-25	26.23	
1964-10-23	27.57	
1964-10-21	27.76	
1964-10-19	30.41	
1964-10-17	33.80	
1964-10-15	38.12	
1964-10-13	36.21	
1964-10-10	36.00	
1964-10-08	37.88	
1964-10-06	34.84	
1964-10-04	32.82	
1964-10-02	33.42	
1964-09-30	33.48	
1964-09-28	35.17	
1964-09-26	34.09	
1964-09-24	34.08	
1964-09-22	33.30	
1965-01-11	21.09	
1965-01-09	21.43	
1965-01-07	20.98	
1965-01-05	20.80	
1965-01-02	19.37	
1964-12-31	21.97	
1964-12-29	20.80	
1964-12-27	20.12	
1964-12-25	20.88	
1964-12-23	21.66	
1964-12-21	22.02	
1964-12-19	22.06	
1964-12-17	22.46	
1964-12-15	22.20	
1964-12-13	22.40	
1964-12-11	22.27	
1964-12-09	21.88	
1964-12-07	22.49	
1964-12-05	23.13	
1964-12-03	22.71	
1964-12-01	21.97	
1964-11-29	21.22	
1964-11-27	21.52	
1964-11-25	22.59	
1964-11-23	22.73	
1964-11-21	23.82	
1964-11-19	25.02	
1964-11-17	24.53	
1964-11-15	25.17	
1964-11-13	25.09	
1964-11-11	24.38	
1964-11-09	24.94	
1964-11-07	26.89	
1964-11-05	27.71	
1964-11-01	24.83	
1964-10-30	25.79	
1964-10-28	26.00	
1964-10-26	25.71	
1964-10-24	27.33	
1964-10-22	27.76	
1964-10-20	29.20	
1964-10-18	31.01	
1964-10-16	37.50	
1964-10-14	37.52	
1964-10-12	36.00	
1964-10-09	38.06	
1964-10-07	36.63	
1964-10-05	31.59	
1964-10-03	33.39	
1964-10-01	33.26	
1964-09-29	34.10	
1964-09-27	33.91	
1964-09-25	33.63	
1964-09-23	34.52	
1964-09-21	31.70	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1964-09-20	32.68	
1964-09-18	34.19	
1964-09-16	33.78	
1964-09-14	33.64	
1964-09-12	34.65	
1964-09-10	33.88	
1964-09-08	32.16	
1964-09-06	34.89	
1964-09-04	36.72	
1964-09-02	34.94	
1964-08-31	35.01	
1964-08-29	35.60	
1964-08-27	36.09	
1964-08-25	35.32	
1964-08-23	33.53	
1964-08-21	35.07	
1964-08-19	36.33	
1964-08-17	36.80	
1964-08-15	36.46	
1964-08-13	37.34	
1964-08-11	35.37	
1964-08-09	36.89	
1964-08-07	37.76	
1964-08-05	37.20	
1964-08-03	36.17	
1964-08-01	35.40	
1964-07-30	36.00	
1964-07-28	35.27	
1964-07-26	35.67	
1964-07-24	38.60	
1964-07-22	35.66	
1964-07-20	33.60	
1964-07-18	32.88	
1964-07-16	34.25	
1964-07-14	32.63	
1964-07-12	32.89	
1964-07-10	34.22	
1964-07-05	29.62	
1964-07-03	35.77	
1964-07-01	36.26	
1964-06-29	38.00	
1964-06-27	37.99	
1964-06-25	35.19	
1964-06-23	30.31	
1964-06-21	33.70	
1964-06-19	32.70	
1964-06-17	31.15	
1964-06-15	30.20	
1964-06-13	31.55	
1964-06-11	30.74	
1964-06-09	28.61	
1964-06-07	26.19	
1964-06-05	27.07	
1964-06-03	25.39	
1964-06-01	23.58	

Date	Feet below Surface	Feet to Sealevel
1964-09-19	33.57	
1964-09-17	34.60	
1964-09-15	33.78	
1964-09-13	33.73	
1964-09-11	34.97	
1964-09-09	33.97	
1964-09-07	31.17	
1964-09-05	36.51	
1964-09-03	36.68	
1964-09-01	35.20	
1964-08-30	34.20	
1964-08-28	35.60	
1964-08-26	35.37	
1964-08-24	35.11	
1964-08-22	34.72	
1964-08-20	35.83	
1964-08-18	36.37	
1964-08-16	35.87	
1964-08-14	36.79	
1964-08-12	36.02	
1964-08-10	34.91	
1964-08-08	37.61	
1964-08-06	37.12	
1964-08-04	36.54	
1964-08-02	34.01	
1964-07-31	36.00	
1964-07-29	36.10	
1964-07-27	33.98	
1964-07-25	38.28	
1964-07-23	37.04	
1964-07-21	34.61	
1964-07-19	32.49	
1964-07-17	34.19	
1964-07-15	33.21	
1964-07-13	32.60	
1964-07-11	34.00	
1964-07-09	33.01	
1964-07-04	34.23	
1964-07-02	36.20	
1964-06-30	38.50	
1964-06-28	37.90	
1964-06-26	35.15	
1964-06-24	31.85	
1964-06-22	31.16	
1964-06-20	34.20	
1964-06-18	30.30	
1964-06-16	31.29	
1964-06-14	31.63	
1964-06-12	30.19	
1964-06-10	30.21	
1964-06-08	27.92	
1964-06-06	27.07	
1964-06-04	26.91	
1964-06-02	24.34	
1964-05-31	19.71	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1964-05-30	22.38	
1964-05-28	23.19	
1964-05-26	21.89	
1964-05-24	18.25	
1964-05-22	19.11	
1964-05-20	17.90	
1964-05-18	17.51	
1964-05-16	17.08	
1964-05-14	18.06	
1964-05-12	16.77	
1964-05-10	15.66	
1964-05-08	16.45	
1964-05-06	16.74	
1964-05-04	16.23	
1964-05-02	16.93	
1964-04-30	18.26	
1964-04-28	16.86	
1964-04-26	16.50	
1964-04-24	17.79	
1964-04-22	16.73	
1964-04-20	17.62	
1964-04-18	18.52	
1964-04-16	18.46	
1964-04-14	19.00	
1964-04-12	20.20	
1964-04-10	20.89	
1964-04-08	20.30	
1964-04-06	20.01	
1964-04-04	22.20	
1964-04-02	22.16	
1964-03-31	23.12	
1964-03-29	23.52	
1964-03-27	24.73	
1964-03-25	24.88	
1964-03-23	24.66	
1964-03-21	27.10	
1964-03-19	30.89	
1964-03-17	30.87	
1964-03-15	30.52	
1964-03-13	30.92	
1964-03-11	27.12	
1964-03-09	28.37	
1964-03-07	27.94	
1964-03-05	27.94	
1964-03-03	27.68	
1964-03-01	27.48	
1964-02-28	27.01	
1964-02-26	26.42	
1964-02-24	25.95	
1964-02-22	27.55	
1964-02-20	27.58	
1964-02-18	27.19	
1964-02-16	27.63	
1964-02-14	28.58	
1964-02-12	28.35	
1964-05-29	23.86	
1964-05-27	22.75	
1964-05-25	21.32	
1964-05-23	18.61	
1964-05-21	19.29	
1964-05-19	18.13	
1964-05-17	16.53	
1964-05-15	17.46	
1964-05-13	17.43	
1964-05-11	16.97	
1964-05-09	15.98	
1964-05-07	16.53	
1964-05-05	15.97	
1964-05-03	15.58	
1964-05-01	17.85	
1964-04-29	17.73	
1964-04-27	16.01	
1964-04-25	17.67	
1964-04-23	17.20	
1964-04-21	17.51	
1964-04-19	18.00	
1964-04-17	18.51	
1964-04-15	18.50	
1964-04-13	19.23	
1964-04-11	20.66	
1964-04-09	20.89	
1964-04-07	20.30	
1964-04-05	21.52	
1964-04-03	22.17	
1964-04-01	23.01	
1964-03-30	22.11	
1964-03-28	25.30	
1964-03-26	24.80	
1964-03-24	24.78	
1964-03-22	25.06	
1964-03-20	29.64	
1964-03-18	31.15	
1964-03-16	30.16	
1964-03-14	31.21	
1964-03-12	27.67	
1964-03-10	27.17	
1964-03-08	28.38	
1964-03-06	27.94	
1964-03-04	27.38	
1964-03-02	27.81	
1964-02-29	27.47	
1964-02-27	26.91	
1964-02-25	26.09	
1964-02-23	26.81	
1964-02-21	27.58	
1964-02-19	27.01	
1964-02-17	27.35	
1964-02-15	28.49	
1964-02-13	28.56	
1964-02-11	28.36	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1964-02-10	28.22	
1964-02-08	28.71	
1964-02-06	29.01	
1964-02-02	29.06	
1964-01-31	29.04	
1964-01-29	28.77	
1964-01-27	29.12	
1964-01-25	28.41	
1964-01-23	29.40	
1964-01-21	29.26	
1964-01-19	29.18	
1964-01-17	29.80	
1964-01-15	29.33	
1964-01-13	29.21	
1964-01-11	30.02	
1964-01-09	29.42	
1964-01-07	30.46	
1964-01-05	30.31	
1964-01-03	30.71	
1964-01-01	31.36	
1963-12-30	31.61	
1963-12-28	30.67	
1963-12-26	30.23	
1963-12-24	31.11	
1963-12-22	32.29	
1963-12-20	32.27	
1963-12-18	32.31	
1963-12-16	32.07	
1963-12-14	32.12	
1963-12-12	32.67	
1963-12-10	33.21	
1963-12-08	33.79	
1963-12-06	37.30	
1963-12-04	37.00	
1963-12-02	35.98	
1963-11-30	36.41	
1963-11-28	38.40	
1963-11-26	38.63	
1963-11-24	36.32	
1963-11-22	41.13	
1963-11-20	41.08	
1963-11-18	40.66	
1963-11-16	42.06	
1963-11-14	43.17	
1963-11-12	41.18	
1963-11-10	38.69	
1963-11-08	43.06	
1963-11-06	43.13	
1963-11-02	43.22	
1963-10-31	44.15	
1963-10-29	43.73	
1963-10-27	41.57	
1963-10-25	44.98	
1963-10-23	44.40	
1963-10-21	42.51	

Date	Feet below Surface	Feet to Sealevel
1964-02-09	28.67	
1964-02-07	28.70	
1964-02-05	28.38	
1964-02-01	29.25	
1964-01-30	29.07	
1964-01-28	28.94	
1964-01-26	28.18	
1964-01-24	29.14	
1964-01-22	29.13	
1964-01-20	29.20	
1964-01-18	29.28	
1964-01-16	29.99	
1964-01-14	29.49	
1964-01-12	29.41	
1964-01-10	30.06	
1964-01-08	30.03	
1964-01-06	29.67	
1964-01-04	30.61	
1964-01-02	30.73	
1963-12-31	31.99	
1963-12-29	30.93	
1963-12-27	30.19	
1963-12-25	30.14	
1963-12-23	31.69	
1963-12-21	32.30	
1963-12-19	32.28	
1963-12-17	32.21	
1963-12-15	31.70	
1963-12-13	32.51	
1963-12-11	33.12	
1963-12-09	33.21	
1963-12-07	36.60	
1963-12-05	37.67	
1963-12-03	37.14	
1963-12-01	35.88	
1963-11-29	38.50	
1963-11-27	39.39	
1963-11-25	38.39	
1963-11-23	40.30	
1963-11-21	41.30	
1963-11-19	40.85	
1963-11-17	38.63	
1963-11-15	42.99	
1963-11-13	41.69	
1963-11-11	40.37	
1963-11-09	42.11	
1963-11-07	43.54	
1963-11-03	40.82	
1963-11-01	44.39	
1963-10-30	43.81	
1963-10-28	43.25	
1963-10-26	43.73	
1963-10-24	44.18	
1963-10-22	43.88	
1963-10-20	42.48	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1963-10-19	45.46	
1963-10-17	45.57	
1963-10-15	45.28	
1963-10-13	45.43	
1963-10-11	47.51	
1963-10-09	47.00	
1963-10-07	45.51	
1963-10-05	47.30	
1963-10-03	48.69	
1963-10-01	46.86	
1963-09-29	46.61	
1963-09-27	48.50	
1963-09-25	47.87	
1963-09-23	47.29	
1963-09-21	48.69	
1963-09-19	48.65	
1963-09-17	48.00	
1963-09-15	47.50	
1963-09-13	49.74	
1963-09-11	48.57	
1963-09-09	47.97	
1963-09-07	48.67	
1963-09-05	48.43	
1963-09-03	43.92	
1963-09-01	50.28	
1963-08-30	50.34	
1963-08-28	50.07	
1963-08-26	50.09	
1963-08-24	51.67	
1963-08-22	50.99	
1963-08-20	48.84	
1963-08-18	50.54	
1963-08-16	50.82	
1963-08-14	50.16	
1963-08-12	49.31	
1963-08-10	52.06	
1963-08-08	51.45	
1963-08-06	48.19	
1963-08-04	49.41	
1963-08-02	51.00	
1963-07-31	50.49	
1963-07-29	49.78	
1963-07-27	51.14	
1963-07-25	48.51	
1963-07-23	48.31	
1963-07-21	48.14	
1963-07-19	48.18	
1963-07-17	47.87	
1963-07-15	46.93	
1963-07-13	53.70	
1963-07-11	51.60	
1963-07-06	45.52	
1963-07-04	47.40	
1963-07-02	47.79	
1963-06-30	46.15	
1963-10-18	46.50	
1963-10-16	45.61	
1963-10-14	45.29	
1963-10-12	46.68	
1963-10-10	47.27	
1963-10-08	46.40	
1963-10-06	45.03	
1963-10-04	48.45	
1963-10-02	46.69	
1963-09-30	46.23	
1963-09-28	48.39	
1963-09-26	48.43	
1963-09-24	47.38	
1963-09-22	46.69	
1963-09-20	48.98	
1963-09-18	48.24	
1963-09-16	48.00	
1963-09-14	48.72	
1963-09-12	48.79	
1963-09-10	48.08	
1963-09-08	48.41	
1963-09-06	48.71	
1963-09-04	46.69	
1963-09-02	47.79	
1963-08-31	50.57	
1963-08-29	49.89	
1963-08-27	49.81	
1963-08-25	51.17	
1963-08-23	52.66	
1963-08-21	50.13	
1963-08-19	48.03	
1963-08-17	51.26	
1963-08-15	50.55	
1963-08-13	49.79	
1963-08-11	51.81	
1963-08-09	51.89	
1963-08-07	50.52	
1963-08-05	47.57	
1963-08-03	51.02	
1963-08-01	50.13	
1963-07-30	49.52	
1963-07-28	50.88	
1963-07-26	50.02	
1963-07-24	48.82	
1963-07-22	45.91	
1963-07-20	48.79	
1963-07-18	48.63	
1963-07-16	47.70	
1963-07-14	47.92	
1963-07-12	52.80	
1963-07-10	51.04	
1963-07-05	42.65	
1963-07-03	47.57	
1963-07-01	43.98	
1963-06-29	48.28	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1963-06-28	49.23	
1963-06-26	48.51	
1963-06-24	39.66	
1963-06-22	43.01	
1963-06-20	41.45	
1963-06-18	38.28	
1963-06-16	37.89	
1963-06-14	39.12	
1963-06-12	39.09	
1963-06-10	38.68	
1963-06-08	39.80	
1963-06-06	39.65	
1963-06-01	33.25	
1963-05-30	32.16	
1963-05-28	31.09	
1963-05-26	31.92	
1963-05-24	30.16	
1963-05-22	28.22	
1963-05-20	27.20	
1963-05-18	28.00	
1963-05-16	27.71	
1963-05-14	26.90	
1963-05-12	25.68	
1963-05-10	27.79	
1963-05-08	26.24	
1963-05-06	25.40	
1963-05-04	26.60	
1963-05-02	26.49	
1963-04-30	26.20	
1963-04-28	25.04	
1963-04-26	26.78	
1963-04-24	26.64	
1963-04-22	25.00	
1963-04-20	26.90	
1963-04-18	27.30	
1963-04-16	25.53	
1963-04-14	25.41	
1963-04-12	27.73	
1963-04-10	26.87	
1963-04-08	26.00	
1963-04-06	27.42	
1963-04-04	27.57	
1963-04-02	26.21	
1963-03-31	25.78	
1963-03-29	27.77	
1963-03-27	26.67	
1963-03-25	25.20	
1963-03-23	28.14	
1963-03-21	27.37	
1963-03-19	26.78	
1963-03-17	27.13	
1963-03-15	27.70	
1963-03-13	27.18	
1963-03-11	26.30	
1963-03-09	28.02	
1963-06-27	49.50	
1963-06-25	45.90	
1963-06-23	43.48	
1963-06-21	42.16	
1963-06-19	41.13	
1963-06-17	36.75	
1963-06-15	39.34	
1963-06-13	39.33	
1963-06-11	38.87	
1963-06-09	38.14	
1963-06-07	40.19	
1963-06-05	39.05	
1963-05-31	30.51	
1963-05-29	31.53	
1963-05-27	29.90	
1963-05-25	31.56	
1963-05-23	28.14	
1963-05-21	28.18	
1963-05-19	28.09	
1963-05-17	28.02	
1963-05-15	27.38	
1963-05-13	25.10	
1963-05-11	27.69	
1963-05-09	27.17	
1963-05-07	25.55	
1963-05-05	24.74	
1963-05-03	26.71	
1963-05-01	26.50	
1963-04-29	22.68	
1963-04-27	26.47	
1963-04-25	26.81	
1963-04-23	26.07	
1963-04-21	25.92	
1963-04-19	27.61	
1963-04-17	26.58	
1963-04-15	24.95	
1963-04-13	27.73	
1963-04-11	27.03	
1963-04-09	26.40	
1963-04-07	25.11	
1963-04-05	27.53	
1963-04-03	26.39	
1963-04-01	24.35	
1963-03-30	26.51	
1963-03-28	27.12	
1963-03-26	26.69	
1963-03-24	26.55	
1963-03-22	28.18	
1963-03-20	26.58	
1963-03-18	26.72	
1963-03-16	27.58	
1963-03-14	27.62	
1963-03-12	26.79	
1963-03-10	26.87	
1963-03-08	28.52	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1963-03-07	27.42	
1963-03-05	26.79	
1963-03-03	28.62	
1963-03-01	27.10	
1963-02-27	26.40	
1963-02-25	24.93	
1963-02-23	26.27	
1963-02-21	27.11	
1963-02-19	26.31	
1963-02-17	27.43	
1963-02-15	27.48	
1963-02-13	27.00	
1963-02-11	26.54	
1963-02-09	28.25	
1963-02-07	28.27	
1963-02-03	27.24	
1963-02-01	27.13	
1963-01-30	28.18	
1963-01-28	27.58	
1963-01-26	28.17	
1963-01-24	26.86	
1963-01-22	25.03	
1963-01-20	26.70	
1963-01-18	27.12	
1963-01-16	26.79	
1963-01-14	24.80	
1963-01-12	27.86	
1963-01-10	27.94	
1963-01-08	27.28	
1963-01-06	27.60	
1963-01-04	27.75	
1963-01-02	23.87	
1962-12-31	28.25	
1962-12-29	28.87	
1962-12-27	27.02	
1962-12-25	27.03	
1962-12-23	28.28	
1962-12-21	30.98	
1962-12-19	30.95	
1962-12-17	29.57	
1962-12-15	32.00	
1962-12-13	31.01	
1962-12-11	31.37	
1962-12-09	29.61	
1962-12-07	32.06	
1962-12-01	34.21	
1962-11-29	32.60	
1962-11-27	32.61	
1962-11-25	32.82	
1962-11-23	33.93	
1962-11-21	38.03	
1962-11-19	36.00	
1962-11-17	40.25	
1962-11-15	39.71	
1962-11-13	39.38	
1963-03-06	27.35	
1963-03-04	27.01	
1963-03-02	27.90	
1963-02-28	26.84	
1963-02-26	26.31	
1963-02-24	26.31	
1963-02-22	27.40	
1963-02-20	26.45	
1963-02-18	25.10	
1963-02-16	28.28	
1963-02-14	27.50	
1963-02-12	26.88	
1963-02-10	26.91	
1963-02-08	28.26	
1963-02-06	28.17	
1963-02-02	27.08	
1963-01-31	27.53	
1963-01-29	28.18	
1963-01-27	28.01	
1963-01-25	27.83	
1963-01-23	26.08	
1963-01-21	24.63	
1963-01-19	27.41	
1963-01-17	26.82	
1963-01-15	26.21	
1963-01-13	24.50	
1963-01-11	28.04	
1963-01-09	27.51	
1963-01-07	27.28	
1963-01-05	27.73	
1963-01-03	27.61	
1963-01-01	24.70	
1962-12-30	29.08	
1962-12-28	28.29	
1962-12-26	26.13	
1962-12-24	27.21	
1962-12-22	30.48	
1962-12-20	31.15	
1962-12-18	30.62	
1962-12-16	29.66	
1962-12-14	32.13	
1962-12-12	31.98	
1962-12-10	31.00	
1962-12-08	32.06	
1962-12-06	31.68	
1962-11-30	34.59	
1962-11-28	32.50	
1962-11-26	32.69	
1962-11-24	33.87	
1962-11-22	38.50	
1962-11-20	36.95	
1962-11-18	33.82	
1962-11-16	40.24	
1962-11-14	39.38	
1962-11-12	37.97	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1962-11-11	35.60	
1962-11-09	39.60	
1962-11-07	39.64	
1962-11-05	38.37	
1962-11-03	41.49	
1962-11-01	41.41	
1962-10-28	36.90	
1962-10-26	43.13	
1962-10-24	42.63	
1962-10-22	39.76	
1962-10-20	42.80	
1962-10-18	42.70	
1962-10-16	42.08	
1962-10-14	39.02	
1962-10-12	44.50	
1962-10-10	43.56	
1962-10-08	41.79	
1962-10-06	44.30	
1962-10-04	44.10	
1962-10-02	44.93	
1962-09-30	39.99	
1962-09-28	44.75	
1962-09-26	44.08	
1962-09-24	42.10	
1962-09-22	43.80	
1962-09-20	45.00	
1962-09-18	44.37	
1962-09-16	40.30	
1962-09-14	46.83	
1962-09-12	46.35	
1962-09-10	44.98	
1962-09-08	47.00	
1962-09-06	47.10	
1962-09-04	46.09	
1962-09-02	44.70	
1962-08-31	50.12	
1962-08-29	50.03	
1962-08-27	46.57	
1962-08-25	44.62	
1962-08-20	42.00	
1962-08-18	44.42	
1962-08-16	43.13	
1962-08-14	41.04	
1962-08-12	37.81	
1962-08-10	42.47	
1962-08-08	40.20	
1962-08-06	39.30	
1962-08-04	41.60	
1962-08-02	42.33	
1962-07-31	41.00	
1962-07-29	37.47	
1962-07-27	42.89	
1962-07-24	40.30	
1962-07-22	37.00	
1962-07-20	42.50	
1962-11-10	39.15	
1962-11-08	39.88	
1962-11-06	38.28	
1962-11-04	36.12	
1962-11-02	41.62	
1962-10-31	40.65	
1962-10-27	42.80	
1962-10-25	42.63	
1962-10-23	41.64	
1962-10-21	37.34	
1962-10-19	43.19	
1962-10-17	42.47	
1962-10-15	40.50	
1962-10-13	44.40	
1962-10-11	44.23	
1962-10-09	43.45	
1962-10-07	38.37	
1962-10-05	44.99	
1962-10-03	44.75	
1962-10-01	44.40	
1962-09-29	44.25	
1962-09-27	44.85	
1962-09-25	42.81	
1962-09-23	39.59	
1962-09-21	44.90	
1962-09-19	44.91	
1962-09-17	43.11	
1962-09-15	46.74	
1962-09-13	46.38	
1962-09-11	47.31	
1962-09-09	45.35	
1962-09-07	48.08	
1962-09-05	47.00	
1962-09-03	41.26	
1962-09-01	49.11	
1962-08-30	49.90	
1962-08-28	49.29	
1962-08-26	44.00	
1962-08-21	45.32	
1962-08-19	42.00	
1962-08-17	44.42	
1962-08-15	41.91	
1962-08-13	39.89	
1962-08-11	42.00	
1962-08-09	41.00	
1962-08-07	39.73	
1962-08-05	36.47	
1962-08-03	42.00	
1962-08-01	41.36	
1962-07-30	39.77	
1962-07-28	42.81	
1962-07-25	41.13	
1962-07-23	39.54	
1962-07-21	41.15	
1962-07-19	42.90	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1962-07-18	42.04	
1962-07-16	38.34	
1962-07-14	41.28	
1962-07-12	40.68	
1962-07-10	40.45	
1962-07-07	38.90	
1962-07-05	35.12	
1962-06-25	34.75	
1962-06-23	36.53	
1962-06-21	36.18	
1962-06-19	34.19	
1962-06-17	31.18	
1962-06-15	36.38	
1962-06-13	33.10	
1962-06-11	31.11	
1962-06-09	34.80	
1962-06-07	35.37	
1962-06-05	33.18	
1962-06-03	33.42	
1962-06-01	33.15	
1962-05-30	33.25	
1962-05-28	32.63	
1962-05-26	32.91	
1962-05-24	31.60	
1962-05-22	28.30	
1962-05-20	28.60	
1962-05-18	30.08	
1962-05-16	26.78	
1962-05-14	24.67	
1962-05-12	24.93	
1962-05-10	24.15	
1962-05-06	23.11	
1962-05-04	25.25	
1962-05-02	24.32	
1962-04-30	21.92	
1962-04-28	24.23	
1962-04-26	21.90	
1962-04-24	20.70	
1962-04-22	20.40	
1962-04-20	22.21	
1962-04-18	21.57	
1962-04-16	19.94	
1962-04-14	22.40	
1962-04-12	21.96	
1962-04-10	21.33	
1962-04-08	19.87	
1962-04-06	22.17	
1962-04-04	23.56	
1962-04-02	16.76	
1962-03-31	18.58	
1962-03-29	18.13	
1962-03-27	17.93	
1962-03-25	18.61	
1962-03-23	18.92	
1962-03-21	18.32	
1962-07-17	40.19	
1962-07-15	36.10	
1962-07-13	41.29	
1962-07-11	40.63	
1962-07-08	38.60	
1962-07-06	37.90	
1962-06-30	33.00	
1962-06-24	31.30	
1962-06-22	36.76	
1962-06-20	35.49	
1962-06-18	33.78	
1962-06-16	36.34	
1962-06-14	33.69	
1962-06-12	32.16	
1962-06-10	30.38	
1962-06-08	35.22	
1962-06-06	33.50	
1962-06-04	31.91	
1962-06-02	33.42	
1962-05-31	31.25	
1962-05-29	33.28	
1962-05-27	32.49	
1962-05-25	32.93	
1962-05-23	30.08	
1962-05-21	27.35	
1962-05-19	29.87	
1962-05-17	28.48	
1962-05-15	26.28	
1962-05-13	22.60	
1962-05-11	25.06	
1962-05-09	24.34	
1962-05-05	26.18	
1962-05-03	25.00	
1962-05-01	23.23	
1962-04-29	22.43	
1962-04-27	23.34	
1962-04-25	20.94	
1962-04-23	19.95	
1962-04-21	22.37	
1962-04-19	22.03	
1962-04-17	20.95	
1962-04-15	20.63	
1962-04-13	21.93	
1962-04-11	21.81	
1962-04-09	20.25	
1962-04-07	21.99	
1962-04-05	22.40	
1962-04-03	25.01	
1962-04-01	17.71	
1962-03-30	18.30	
1962-03-28	18.05	
1962-03-26	17.71	
1962-03-24	18.99	
1962-03-22	18.73	
1962-03-20	17.67	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1962-03-19	18.01	
1962-03-17	19.91	
1962-03-15	22.58	
1962-03-13	22.07	
1962-03-11	22.30	
1962-03-09	23.11	
1962-03-05	23.00	
1962-02-25	25.00	
1962-02-15	25.00	
1962-02-07	23.56	
1962-01-31	25.00	
1962-01-20	25.50	
1962-01-15	22.45	
1962-01-13	23.72	
1962-01-11	23.80	
1962-01-09	23.08	
1962-01-07	22.89	
1962-01-05	24.33	
1961-12-31	24.00	
1961-12-27	23.38	
1961-12-25	24.30	
1961-12-23	26.21	
1961-12-21	26.27	
1961-12-19	25.71	
1961-12-17	26.34	
1961-12-15	27.12	
1961-12-13	26.47	
1961-12-11	25.56	
1961-12-09	25.63	
1961-12-07	28.35	
1961-12-05	27.72	
1961-12-03	29.15	
1961-12-01	29.04	
1961-11-29	28.61	
1961-11-27	28.33	
1961-11-25	28.30	
1961-11-23	29.20	
1961-11-21	29.08	
1961-11-19	30.18	
1961-11-17	30.76	
1961-11-15	30.45	
1961-11-13	28.30	
1961-11-11	31.75	
1961-11-09	32.35	
1961-11-07	32.89	
1961-11-04	34.90	
1961-11-02	35.02	
1961-10-31	35.64	
1961-10-29	35.75	
1961-10-27	36.63	
1961-10-25	35.90	
1961-10-23	33.70	
1961-10-21	37.50	
1961-10-19	37.20	
1961-10-17	36.09	
1961-10-18	19.12	
1961-10-16	20.50	
1961-10-14	22.36	
1961-10-12	21.28	
1961-10-10	23.21	
1961-10-08	22.77	
1961-02-28	24.00	
1961-02-20	25.50	
1961-02-10	24.00	
1961-02-05	23.60	
1961-01-25	26.65	
1961-01-16	24.32	
1961-01-14	23.11	
1961-01-12	23.36	
1961-01-10	23.81	
1961-01-08	22.28	
1961-01-06	24.42	
1961-01-04	23.95	
1961-12-28	24.31	
1961-12-26	21.89	
1961-12-24	25.58	
1961-12-22	26.39	
1961-12-20	26.21	
1961-12-18	25.52	
1961-12-16	27.13	
1961-12-14	27.48	
1961-12-12	26.89	
1961-12-10	25.47	
1961-12-08	28.60	
1961-12-06	27.61	
1961-12-04	28.51	
1961-12-02	29.41	
1961-11-30	29.72	
1961-11-28	28.45	
1961-11-26	28.43	
1961-11-24	28.67	
1961-11-22	29.00	
1961-11-20	27.80	
1961-11-18	30.86	
1961-11-16	30.61	
1961-11-14	30.01	
1961-11-12	29.43	
1961-11-10	32.30	
1961-11-08	33.46	
1961-11-05	33.00	
1961-11-03	34.51	
1961-11-01	34.92	
1961-10-30	34.80	
1961-10-28	37.60	
1961-10-26	37.28	
1961-10-24	34.91	
1961-10-22	35.22	
1961-10-20	37.30	
1961-10-18	36.66	
1961-10-16	35.37	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1961-10-15	36.68	
1961-10-13	38.35	
1961-10-11	37.64	
1961-10-09	36.98	
1961-10-07	40.01	
1961-10-05	39.84	
1961-10-03	38.26	
1961-10-01	39.49	
1961-09-29	41.27	
1961-09-27	42.71	
1961-09-25	40.10	
1961-09-23	43.69	
1961-09-21	42.83	
1961-09-19	43.10	
1961-09-17	45.26	
1961-09-15	46.32	
1961-09-13	45.20	
1961-09-11	43.40	
1961-09-09	46.20	
1961-09-07	44.30	
1961-09-05	42.60	
1961-09-01	45.47	
1961-08-30	43.00	
1961-08-28	40.95	
1961-08-26	45.12	
1961-08-24	44.79	
1961-08-22	45.01	
1961-08-20	44.57	
1961-08-18	44.90	
1961-08-16	43.53	
1961-08-14	42.23	
1961-08-12	42.55	
1961-08-10	42.52	
1961-08-08	41.92	
1961-08-06	40.68	
1961-08-04	42.53	
1961-08-02	41.89	
1961-07-31	41.00	
1961-07-29	41.06	
1961-07-27	40.28	
1961-07-25	38.60	
1961-07-23	37.34	
1961-07-21	39.67	
1961-07-19	39.00	
1961-07-17	36.50	
1961-07-15	39.21	
1961-07-13	39.55	
1961-07-11	36.60	
1961-07-09	29.29	
1961-07-07	29.63	
1961-07-05	29.20	
1961-07-03	31.57	
1961-07-01	38.58	
1961-06-29	37.87	
1961-06-27	34.25	
1961-10-14	38.48	
1961-10-12	37.96	
1961-10-10	37.51	
1961-10-08	39.12	
1961-10-06	40.00	
1961-10-04	38.71	
1961-10-02	37.85	
1961-09-30	41.03	
1961-09-28	42.00	
1961-09-26	41.84	
1961-09-24	42.77	
1961-09-22	43.33	
1961-09-20	43.53	
1961-09-18	42.20	
1961-09-16	46.86	
1961-09-14	45.13	
1961-09-12	45.00	
1961-09-10	45.95	
1961-09-08	44.98	
1961-09-06	43.54	
1961-09-02	45.74	
1961-08-31	44.43	
1961-08-29	42.60	
1961-08-27	40.90	
1961-08-25	45.05	
1961-08-23	44.83	
1961-08-21	45.01	
1961-08-19	45.22	
1961-08-17	44.60	
1961-08-15	43.04	
1961-08-13	40.89	
1961-08-11	42.60	
1961-08-09	41.82	
1961-08-07	40.91	
1961-08-05	42.24	
1961-08-03	41.88	
1961-08-01	40.15	
1961-07-30	41.41	
1961-07-28	40.51	
1961-07-26	39.45	
1961-07-24	37.43	
1961-07-22	39.53	
1961-07-20	39.22	
1961-07-18	38.30	
1961-07-16	38.04	
1961-07-14	38.71	
1961-07-12	39.20	
1961-07-10	34.10	
1961-07-08	29.63	
1961-07-06	29.21	
1961-07-04	30.85	
1961-07-02	36.10	
1961-06-30	38.59	
1961-06-28	35.80	
1961-06-26	32.90	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1961-06-25	33.19	
1961-06-23	34.60	
1961-06-21	34.05	
1961-06-19	33.00	
1961-06-17	34.54	
1961-06-15	33.80	
1961-06-13	32.50	
1961-06-11	30.70	
1961-06-09	32.57	
1961-06-07	34.30	
1961-06-05	31.50	
1961-06-03	30.82	
1961-06-01	27.95	
1961-05-30	24.15	
1961-05-28	24.80	
1961-05-26	26.39	
1961-05-24	26.00	
1961-05-22	24.39	
1961-05-20	25.04	
1961-05-18	25.03	
1961-05-16	24.31	
1961-05-14	22.62	
1961-05-12	24.39	
1961-05-10	22.89	
1961-05-08	21.38	
1961-05-06	23.09	
1961-05-04	23.04	
1961-05-02	21.80	
1961-04-30	21.43	
1961-04-28	22.80	
1961-04-26	22.08	
1961-04-24	21.53	
1961-04-22	22.80	
1961-04-20	22.03	
1961-04-18	20.90	
1961-04-16	20.57	
1961-04-14	22.52	
1961-04-12	21.70	
1961-04-10	20.80	
1961-04-08	23.00	
1961-04-06	23.12	
1961-04-04	22.30	
1961-04-02	21.90	
1961-03-31	24.10	
1961-03-29	21.85	
1961-03-27	19.88	
1961-03-25	22.31	
1961-03-23	20.97	
1961-03-21	19.99	
1961-03-19	19.69	
1961-03-17	22.50	
1961-03-15	21.80	
1961-03-13	20.20	
1961-03-11	21.71	
1961-03-09	21.50	

Date	Feet below Surface	Feet to Sealevel
1961-06-24	34.87	
1961-06-22	34.32	
1961-06-20	34.04	
1961-06-18	32.47	
1961-06-16	34.45	
1961-06-14	33.71	
1961-06-12	31.53	
1961-06-10	32.37	
1961-06-08	33.10	
1961-06-06	34.25	
1961-06-04	30.80	
1961-06-02	29.69	
1961-05-31	26.20	
1961-05-29	23.70	
1961-05-27	26.47	
1961-05-25	26.12	
1961-05-23	25.50	
1961-05-21	22 78	
1961-05-19	25.04	
1961-05-17	25.19	
1961-05-15	23.15	
1961-05-13	24.41	
1961-05-11	23.67	
1961-05-09	22.52	
1961-05-07	20.19	
1961-05-05	23.08	
1961-05-03	22.49	
1961-05-01	21.80	
1961-04-29	22.92	
1961-04-27	22.69	
1961-04-25	21.87	
1961-04-23	22.56	
1961-04-21	22.81	
1961-04-19	21.30	
1961-04-17	20.09	
1961-04-15	22.40	
1961-04-13	22.57	
1961-04-11	21.32	
1961-04-09	20.30	
1961-04-07	24.03	
1961-04-05	23.20	
1961-04-03	20.80	
1961-04-01	24.14	
1961-03-30	22.80	
1961-03-28	21.30	
1961-03-26	20.50	
1961-03-24	21.56	
1961-03-22	20.60	
1961-03-20	19.40	
1961-03-18	22.58	
1961-03-16	22.15	
1961-03-14	20.85	
1961-03-12	19.73	
1961-03-10	21.73	
1961-03-08	21.35	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1961-03-07	21.05	
1961-03-04	23.08	
1961-03-02	22.87	
1961-02-28	21.93	
1961-02-26	21.63	
1961-02-24	24.50	
1961-02-22	22.90	
1961-02-20	21.25	
1961-02-18	23.82	
1961-02-16	23.24	
1961-02-14	22.50	
1961-02-12	21.18	
1961-02-10	23.40	
1961-02-08	22.80	
1961-02-06	22.30	
1961-02-04	24.37	
1961-02-02	24.23	
1961-01-31	23.60	
1961-01-24	23.58	
1961-01-22	23.10	
1961-01-20	24.23	
1961-01-18	23.93	
1961-01-16	22.60	
1961-01-14	25.38	
1961-01-12	25.56	
1961-01-10	25.20	
1961-01-08	24.00	
1961-01-06	24.97	
1961-01-04	24.30	
1960-12-31	25.78	
1960-12-29	25.20	
1960-12-27	24.49	
1960-12-25	23.73	
1960-12-23	26.80	
1960-12-21	26.52	
1960-12-19	25.83	
1960-12-17	26.98	
1960-12-15	26.90	
1960-12-13	25.86	
1960-12-11	26.35	
1960-12-09	27.41	
1960-12-07	27.64	
1960-12-05	25.80	
1960-12-03	28.31	
1960-12-01	28.80	
1960-11-29	26.88	
1960-11-27	25.19	
1960-11-25	26.50	
1960-11-23	29.08	
1960-11-21	27.33	
1960-11-19	30.74	
1960-11-17	31.10	
1960-11-15	30.78	
1960-11-13	30.58	
1960-11-11	33.34	
1961-03-05	22.00	
1961-03-03	22.77	
1961-03-01	22.56	
1961-02-27	21.20	
1961-02-25	24.06	
1961-02-23	24.20	
1961-02-21	22.08	
1961-02-19	20.77	
1961-02-17	23.50	
1961-02-15	23.10	
1961-02-13	21.20	
1961-02-11	23.65	
1961-02-09	22.69	
1961-02-07	22.78	
1961-02-05	21.99	
1961-02-03	24.20	
1961-02-01	24.23	
1961-01-25	24.00	
1961-01-23	22.76	
1961-01-21	24.09	
1961-01-19	24.00	
1961-01-17	23.76	
1961-01-15	24.24	
1961-01-13	25.50	
1961-01-11	25.52	
1961-01-09	23.40	
1961-01-07	24.89	
1961-01-05	24.82	
1961-01-01	23.27	
1960-12-30	25.51	
1960-12-28	24.63	
1960-12-26	21.32	
1960-12-24	26.56	
1960-12-22	26.33	
1960-12-20	26.20	
1960-12-18	25.89	
1960-12-16	27.24	
1960-12-14	26.11	
1960-12-12	25.34	
1960-12-10	26.39	
1960-12-08	27.34	
1960-12-06	27.37	
1960-12-04	26.99	
1960-12-02	28.55	
1960-11-30	27.76	
1960-11-28	25.83	
1960-11-26	25.33	
1960-11-24	29.06	
1960-11-22	28.30	
1960-11-20	27.95	
1960-11-18	30.76	
1960-11-16	30.78	
1960-11-14	30.02	
1960-11-12	33.30	
1960-11-10	32.12	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1960-11-09	31.74	
1960-11-07	30.32	
1960-11-05	35.90	
1960-11-03	35.62	
1960-11-01	34.72	
1960-10-30	32.90	
1960-10-28	37.78	
1960-10-26	37.11	
1960-10-24	35.20	
1960-10-22	38.08	
1960-10-20	37.89	
1960-10-18	36.50	
1960-10-16	33.20	
1960-10-14	37.63	
1960-10-12	37.69	
1960-10-10	36.52	
1960-10-08	40.31	
1960-10-06	39.97	
1960-10-04	38.69	
1960-09-30	41.01	
1960-09-28	38.70	
1960-09-26	37.88	
1960-09-24	36.00	
1960-09-22	38.99	
1960-09-20	39.24	
1960-09-18	36.65	
1960-09-16	40.80	
1960-09-14	38.64	
1960-09-12	36.85	
1960-09-10	41.09	
1960-09-08	40.70	
1960-09-06	38.00	
1960-09-04	37.10	
1960-09-02	41.79	
1960-08-31	40.61	
1960-08-29	39.50	
1960-08-27	41.45	
1960-08-25	39.80	
1960-08-23	38.80	
1960-08-21	36.27	
1960-08-19	40.34	
1960-08-17	39.50	
1960-08-15	37.20	
1960-08-13	39.55	
1960-08-11	39.31	
1960-08-09	38.80	
1960-08-07	36.63	
1960-08-05	39.71	
1960-08-03	39.40	
1960-08-01	39.60	
1960-07-30	39.83	
1960-07-28	38.50	
1960-07-26	36.50	
1960-07-24	38.21	
1960-07-22	41.12	
1960-11-08	31.17	
1960-11-06	31.31	
1960-11-04	35.87	
1960-11-02	35.35	
1960-10-31	33.05	
1960-10-29	37.83	
1960-10-27	37.40	
1960-10-25	36.40	
1960-10-23	32.93	
1960-10-21	38.00	
1960-10-19	37.60	
1960-10-17	34.40	
1960-10-15	37.15	
1960-10-13	37.69	
1960-10-11	37.34	
1960-10-09	35.72	
1960-10-07	40.33	
1960-10-05	39.43	
1960-10-01	35.90	
1960-09-29	40.30	
1960-09-27	38.79	
1960-09-25	33.90	
1960-09-23	39.15	
1960-09-21	39.09	
1960-09-19	38.31	
1960-09-17	38.65	
1960-09-15	41.05	
1960-09-13	38.20	
1960-09-11	37.20	
1960-09-09	42.20	
1960-09-07	39.80	
1960-09-05	34.52	
1960-09-03	41.40	
1960-09-01	41.70	
1960-08-30	39.98	
1960-08-28	37.25	
1960-08-26	40.90	
1960-08-24	39.99	
1960-08-22	37.45	
1960-08-20	40.11	
1960-08-18	40.03	
1960-08-16	38.28	
1960-08-14	36.00	
1960-08-12	39.01	
1960-08-10	38.99	
1960-08-08	38.60	
1960-08-06	39.47	
1960-08-04	39.71	
1960-08-02	39.84	
1960-07-31	39.01	
1960-07-29	39.60	
1960-07-27	37.23	
1960-07-25	36.30	
1960-07-23	40.85	
1960-07-21	41.05	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1960-07-20	41.05	
1960-07-18	38.88	
1960-07-16	37.30	
1960-07-14	39.06	
1960-07-12	36.00	
1960-07-10	33.50	
1960-07-08	36.80	
1960-07-06	34.62	
1960-07-02	35.45	
1960-06-30	34.65	
1960-06-28	33.88	
1960-06-26	31.80	
1960-06-24	34.80	
1960-06-22	34.40	
1960-06-20	32.24	
1960-06-18	33.94	
1960-06-16	33.79	
1960-06-14	33.44	
1960-06-12	28.70	
1960-06-10	32.22	
1960-06-08	31.20	
1960-06-06	28.70	
1960-06-04	31.20	
1960-06-02	31.08	
1960-05-31	25.30	
1960-05-27	27.91	
1960-05-25	26.69	
1960-05-23	24.40	
1960-05-21	24.52	
1960-05-19	24.16	
1960-05-17	23.25	
1960-05-15	22.90	
1960-05-13	24.90	
1960-05-11	24.30	
1960-05-09	23.40	
1960-05-07	25.15	
1960-05-05	26.20	
1960-05-03	26.05	
1960-05-01	27.90	
1960-04-29	29.03	
1960-04-27	28.23	
1960-04-25	27.58	
1960-04-23	28.03	
1960-04-21	29.52	
1960-04-19	28.52	
1960-04-17	28.90	
1960-04-15	30.60	
1960-04-13	31.60	
1960-04-11	29.04	
1960-04-09	28.51	
1960-04-07	27.96	
1960-04-05	27.42	
1960-04-03	27.55	
1960-04-01	28.28	
1960-03-30	28.20	
1960-07-19	39.98	
1960-07-17	36.52	
1960-07-15	39.80	
1960-07-13	39.32	
1960-07-11	35.10	
1960-07-09	33.58	
1960-07-07	36.30	
1960-07-05	33.00	
1960-07-01	34.74	
1960-06-29	34.30	
1960-06-27	32.90	
1960-06-25	35.00	
1960-06-23	34.54	
1960-06-21	33.45	
1960-06-19	30.19	
1960-06-17	34.03	
1960-06-15	33.79	
1960-06-13	31.69	
1960-06-11	32.17	
1960-06-09	31.67	
1960-06-07	30.09	
1960-06-05	29.50	
1960-06-03	31.31	
1960-06-01	27.56	
1960-05-28	26.86	
1960-05-26	27.41	
1960-05-24	26.30	
1960-05-22	22.45	
1960-05-20	24.34	
1960-05-18	23.97	
1960-05-16	22.50	
1960-05-14	24.31	
1960-05-12	24.49	
1960-05-10	24.17	
1960-05-08	24.20	
1960-05-06	26.35	
1960-05-04	26.77	
1960-05-02	26.38	
1960-04-30	28.51	
1960-04-28	28.22	
1960-04-26	28.15	
1960-04-24	27.91	
1960-04-22	28.40	
1960-04-20	29.54	
1960-04-18	26.92	
1960-04-16	30.40	
1960-04-14	31.62	
1960-04-12	30.49	
1960-04-10	28.31	
1960-04-08	28.35	
1960-04-06	27.53	
1960-04-04	27.13	
1960-04-02	28.25	
1960-03-31	28.22	
1960-03-29	28.37	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1960-03-28	27.97	
1960-03-26	28.79	
1960-03-24	28.87	
1960-03-22	28.58	
1960-03-20	28.64	
1960-03-18	29.49	
1960-03-16	29.41	
1960-03-14	29.43	
1960-03-12	29.90	
1960-03-10	30.35	
1960-03-08	31.00	
1960-03-06	29.72	
1960-03-04	29.95	
1960-03-02	30.34	
1960-02-29	29.91	
1960-02-27	32.80	
1960-02-25	32.67	
1960-02-23	30.80	
1960-02-21	26.47	
1960-02-19	28.08	
1960-02-17	26.83	
1960-02-15	26.79	
1960-02-13	26.98	
1960-02-11	27.09	
1960-02-09	26.78	
1960-02-07	26.78	
1960-02-05	27.44	
1960-02-03	27.60	
1960-02-01	27.10	
1960-01-30	28.24	
1960-01-28	27.98	
1960-01-26	27.57	
1960-01-24	27.48	
1960-01-22	28.05	
1960-01-20	27.41	
1960-01-18	26.60	
1960-01-16	28.13	
1960-01-14	28.40	
1960-01-12	27.70	
1960-01-10	27.37	
1960-01-08	28.23	
1960-01-05	27.97	
1960-01-03	28.24	
1960-01-01	27.86	
1959-12-30	28.33	
1959-12-28	27.33	
1959-12-26	27.41	
1959-12-24	29.85	
1959-12-22	29.80	
1959-12-20	29.25	
1959-12-18	30.62	
1959-12-16	30.22	
1959-12-14	29.31	
1959-12-12	30.64	
1959-12-10	31.00	
1959-12-27	28.09	
1959-12-25	28.82	
1959-12-23	28.50	
1959-12-21	28.11	
1959-12-19	29.49	
1959-12-17	29.12	
1959-12-15	29.45	
1959-12-13	29.20	
1959-12-11	29.94	
1959-12-09	31.27	
1959-12-07	29.36	
1959-12-05	29.85	
1959-12-03	30.11	
1959-12-01	30.34	
1959-11-28	31.02	
1959-11-26	32.99	
1959-11-24	31.60	
1959-11-22	27.54	
1959-11-20	27.62	
1959-11-18	27.40	
1959-11-16	26.85	
1959-11-14	26.00	
1959-11-12	27.28	
1959-11-10	27.11	
1959-11-08	26.41	
1959-11-06	27.70	
1959-11-04	27.83	
1959-11-02	27.48	
1959-10-31	27.03	
1959-10-29	28.20	
1959-10-27	27.91	
1959-10-25	28.00	
1959-10-23	28.16	
1959-10-21	27.90	
1959-10-19	27.20	
1959-10-17	27.03	
1959-10-15	27.82	
1959-10-13	28.40	
1959-10-11	27.40	
1959-10-09	28.37	
1959-10-06	27.99	
1959-10-04	28.73	
1959-10-02	26.75	
1959-09-30	28.94	
1959-09-28	28.08	
1959-09-26	26.80	
1959-09-24	28.76	
1959-09-22	30.24	
1959-09-20	29.60	
1959-09-18	30.47	
1959-09-16	30.51	
1959-09-14	29.91	
1959-09-12	29.68	
1959-09-10	30.90	
1959-09-08	31.01	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1959-12-08	30.12	
1959-12-06	30.80	
1959-12-04	32.60	
1959-12-02	32.61	
1959-11-30	32.49	
1959-11-28	31.90	
1959-11-26	33.26	
1959-11-24	32.27	
1959-11-22	32.67	
1959-11-20	34.38	
1959-11-18	34.54	
1959-11-16	34.43	
1959-11-14	34.42	
1959-11-12	32.43	
1959-11-10	32.35	
1959-11-06	42.70	
1959-11-04	43.02	
1959-11-02	40.94	
1959-10-31	41.90	
1959-10-29	44.47	
1959-10-27	42.78	
1959-10-25	41.30	
1959-10-23	44.42	
1959-10-21	45.10	
1959-10-19	42.52	
1959-10-17	43.43	
1959-10-15	44.30	
1959-10-13	43.40	
1959-10-11	43.13	
1959-10-09	45.92	
1959-10-07	45.79	
1959-10-05	44.10	
1959-10-03	48.11	
1959-10-01	46.78	
1959-09-29	46.23	
1959-09-27	47.70	
1959-09-25	52.54	
1959-09-23	49.89	
1959-09-21	47.50	
1959-09-19	49.92	
1959-09-17	49.97	
1959-09-15	50.05	
1959-09-13	51.52	
1959-09-11	52.50	
1959-09-09	52.60	
1959-09-05	53.91	
1959-09-03	53.79	
1959-09-01	54.17	
1959-08-30	54.30	
1959-08-28	55.40	
1959-08-26	55.74	
1959-08-24	52.00	
1959-08-22	55.10	
1959-08-20	54.71	
1959-08-18	53.30	
1959-12-07	30.10	
1959-12-05	31.85	
1959-12-03	32.60	
1959-12-01	32.34	
1959-11-29	31.87	
1959-11-27	31.97	
1959-11-25	33.26	
1959-11-23	32.18	
1959-11-21	33.58	
1959-11-19	34.49	
1959-11-17	34.43	
1959-11-15	34.30	
1959-11-13	34.31	
1959-11-11	32.40	
1959-11-09	32.40	
1959-11-05	42.98	
1959-11-03	42.25	
1959-11-01	41.17	
1959-10-30	44.47	
1959-10-28	44.10	
1959-10-26	42.20	
1959-10-24	44.41	
1959-10-22	45.27	
1959-10-20	44.30	
1959-10-18	41.90	
1959-10-16	44.43	
1959-10-14	44.27	
1959-10-12	42.57	
1959-10-10	45.58	
1959-10-08	45.20	
1959-10-06	45.40	
1959-10-04	45.02	
1959-10-02	47.52	
1959-09-30	47.02	
1959-09-28	45.80	
1959-09-26	50.25	
1959-09-24	51.27	
1959-09-22	49.07	
1959-09-20	46.80	
1959-09-18	50.28	
1959-09-16	49.59	
1959-09-14	49.70	
1959-09-12	52.03	
1959-09-10	53.03	
1959-09-06	53.80	
1959-09-04	53.90	
1959-09-02	54.02	
1959-08-31	53.62	
1959-08-29	55.07	
1959-08-27	55.68	
1959-08-25	53.71	
1959-08-23	53.50	
1959-08-21	55.07	
1959-08-19	54.54	
1959-08-17	51.33	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1959-08-16	53.23	
1959-08-14	55.80	
1959-08-12	54.90	
1959-08-10	52.11	
1959-08-08	55.10	
1959-08-05	53.74	
1959-08-03	51.56	
1959-08-01	53.89	
1959-07-30	52.00	
1959-07-26	49.50	
1959-07-24	52.87	
1959-07-20	50.53	
1959-07-18	51.71	
1959-07-15	50.30	
1959-07-13	47.05	
1959-07-11	47.00	
1959-07-09	47.70	
1959-07-07	46.87	
1959-07-05	42.96	
1959-07-03	45.89	
1959-07-01	45.80	
1959-06-25	48.22	
1959-06-20	48.00	
1959-06-16	46.18	
1959-06-14	43.60	
1959-06-12	44.57	
1959-06-10	43.86	
1959-06-05	41.75	
1959-06-03	40.00	
1959-06-01	38.03	
1959-05-30	37.86	
1959-05-28	36.65	
1959-05-26	35.54	
1959-05-24	32.83	
1959-05-22	35.82	
1959-05-20	34.99	
1959-05-18	32.80	
1959-05-16	31.93	
1959-05-14	32.23	
1959-05-12	31.97	
1959-05-10	30.10	
1959-05-08	32.89	
1959-05-06	31.50	
1959-05-04	29.21	
1959-05-02	27.13	
1959-04-30	25.00	
1959-04-28	22.39	
1959-04-26	23.10	
1959-04-24	24.90	
1959-04-22	24.39	
1959-04-20	21.58	
1959-04-18	24.83	
1959-04-16	23.70	
1959-04-14	18.67	
1959-04-12	18.50	
1959-08-15	55.65	
1959-08-13	54.88	
1959-08-11	54.89	
1959-08-09	52.90	
1959-08-07	55.31	
1959-08-04	53.43	
1959-08-02	53.30	
1959-07-31	53.70	
1959-07-29	53.20	
1959-07-25	52.61	
1959-07-21	50.64	
1959-07-19	49.81	
1959-07-16	50.80	
1959-07-14	46.90	
1959-07-12	44.72	
1959-07-10	47.49	
1959-07-08	47.33	
1959-07-06	46.06	
1959-07-04	45.60	
1959-07-02	45.31	
1959-06-30	46.27	
1959-06-21	48.40	
1959-06-17	46.30	
1959-06-15	44.37	
1959-06-13	43.99	
1959-06-11	44.23	
1959-06-09	43.00	
1959-06-04	40.80	
1959-06-02	39.28	
1959-05-31	35.50	
1959-05-29	37.75	
1959-05-27	36.68	
1959-05-25	34.39	
1959-05-23	35.55	
1959-05-21	35.06	
1959-05-19	34.35	
1959-05-17	31.19	
1959-05-15	31.84	
1959-05-13	32.46	
1959-05-11	31.27	
1959-05-09	31.18	
1959-05-07	31.84	
1959-05-05	30.85	
1959-05-03	27.09	
1959-05-01	26.61	
1959-04-29	24.06	
1959-04-27	21.57	
1959-04-25	23.42	
1959-04-23	25.30	
1959-04-21	23.02	
1959-04-19	22.80	
1959-04-17	24.00	
1959-04-15	22.45	
1959-04-13	17.77	
1959-04-11	18.90	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1959-04-10	19.79	
1959-04-05	19.80	
1959-04-02	19.69	
1959-03-31	20.10	
1959-03-29	19.35	
1959-03-27	20.94	
1959-03-25	21.32	
1959-03-23	20.03	
1959-03-21	19.24	
1959-03-19	19.49	
1959-03-17	19.21	
1959-03-15	18.20	
1959-03-13	19.73	
1959-03-11	19.32	
1959-03-09	18.41	
1959-03-07	19.32	
1959-03-05	20.22	
1959-03-03	19.73	
1959-03-01	18.90	
1959-02-27	20.84	
1959-02-25	20.59	
1959-02-23	20.51	
1959-02-21	20.70	
1959-02-19	20.64	
1959-02-17	20.28	
1959-02-15	18.90	
1959-02-13	19.81	
1959-02-11	19.68	
1959-02-09	19.23	
1959-02-07	20.65	
1959-02-05	19.99	
1959-02-03	19.99	
1959-02-01	18.43	
1959-01-30	20.18	
1959-01-28	19.40	
1959-01-26	18.80	
1959-01-24	20.45	
1959-01-22	19.39	
1959-01-20	18.91	
1959-01-18	17.75	
1959-01-16	19.16	
1959-01-14	19.05	
1959-01-12	18.83	
1959-01-10	20.72	
1959-01-08	19.17	
1959-01-06	19.34	
1959-01-03	18.90	
1959-01-01	19.30	
1958-12-30	20.39	
1958-12-28	18.50	
1958-12-26	19.45	
1958-12-24	22.12	
1958-12-22	21.21	
1958-12-20	22.90	
1958-12-18	22.20	
1959-04-09	19.40	
1959-04-03	20.00	
1959-04-01	19.87	
1959-03-30	20.16	
1959-03-28	20.51	
1959-03-26	20.86	
1959-03-24	20.71	
1959-03-22	18.25	
1959-03-20	19.79	
1959-03-18	19.09	
1959-03-16	18.73	
1959-03-14	19.61	
1959-03-12	19.24	
1959-03-10	18.77	
1959-03-08	18.50	
1959-03-06	19.78	
1959-03-04	19.40	
1959-03-02	19.66	
1959-02-28	19.75	
1959-02-26	20.65	
1959-02-24	20.57	
1959-02-22	20.00	
1959-02-20	20.15	
1959-02-18	20.72	
1959-02-16	19.62	
1959-02-14	19.40	
1959-02-12	19.62	
1959-02-10	18.96	
1959-02-08	19.70	
1959-02-06	20.13	
1959-02-04	19.84	
1959-02-02	19.73	
1959-01-31	19.42	
1959-01-29	20.31	
1959-01-27	18.80	
1959-01-25	19.00	
1959-01-23	20.80	
1959-01-21	18.71	
1959-01-19	18.60	
1959-01-17	18.78	
1959-01-15	19.08	
1959-01-13	19.11	
1959-01-11	19.60	
1959-01-09	20.65	
1959-01-07	19.35	
1959-01-05	18.72	
1959-01-02	19.20	
1958-12-31	19.89	
1958-12-29	20.48	
1958-12-27	18.99	
1958-12-25	22.80	
1958-12-23	22.38	
1958-12-21	21.60	
1958-12-19	23.09	
1958-12-17	22.10	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1958-12-16	22.12	
1958-12-14	22.08	
1958-12-12	22.82	
1958-12-10	23.08	
1958-12-08	22.31	
1958-12-06	22.92	
1958-12-04	22.93	
1958-12-02	23.25	
1958-11-30	23.62	
1958-11-28	24.52	
1958-11-26	27.05	
1958-11-24	27.52	
1958-11-22	29.30	
1958-11-20	32.15	
1958-11-18	34.81	
1958-11-16	36.22	
1958-11-14	39.38	
1958-11-12	38.30	
1958-11-10	36.43	
1958-11-08	39.50	
1958-11-06	39.95	
1958-11-03	41.63	
1958-11-01	43.34	
1958-10-30	45.01	
1958-10-28	44.68	
1958-10-26	39.95	
1958-10-24	43.00	
1958-10-20	41.30	
1958-10-18	42.05	
1958-10-16	42.85	
1958-10-14	41.55	
1958-10-12	38.18	
1958-10-10	42.95	
1958-10-08	42.05	
1958-10-04	42.06	
1958-10-02	43.48	
1958-09-30	43.21	
1958-09-28	40.72	
1958-09-26	45.30	
1958-09-24	44.43	
1958-09-22	43.29	
1958-09-20	43.20	
1958-09-18	44.40	
1958-09-16	44.28	
1958-09-14	42.10	
1958-09-12	44.39	
1958-09-10	43.92	
1958-09-08	43.22	
1958-09-06	43.38	
1958-09-04	43.85	
1958-09-02	42.49	
1958-08-31	44.00	
1958-08-29	46.65	
1958-08-27	44.90	
1958-08-25	44.42	
1958-12-15	21.12	
1958-12-13	22.50	
1958-12-11	22.90	
1958-12-09	22.89	
1958-12-07	22.84	
1958-12-05	22.92	
1958-12-03	22.72	
1958-12-01	23.50	
1958-11-29	24.15	
1958-11-27	26.12	
1958-11-25	26.92	
1958-11-23	27.65	
1958-11-21	30.45	
1958-11-19	33.89	
1958-11-17	34.81	
1958-11-15	38.90	
1958-11-13	37.95	
1958-11-11	38.19	
1958-11-09	35.76	
1958-11-07	39.28	
1958-11-05	42.60	
1958-11-02	38.40	
1958-10-31	44.02	
1958-10-29	44.50	
1958-10-27	43.00	
1958-10-25	42.70	
1958-10-23	42.95	
1958-10-19	37.82	
1958-10-17	42.05	
1958-10-15	42.28	
1958-10-13	40.73	
1958-10-11	42.31	
1958-10-09	41.95	
1958-10-05	39.98	
1958-10-03	43.65	
1958-10-01	43.14	
1958-09-29	42.31	
1958-09-27	43.85	
1958-09-25	45.68	
1958-09-23	44.40	
1958-09-21	41.65	
1958-09-19	44.32	
1958-09-17	44.21	
1958-09-15	43.39	
1958-09-13	43.80	
1958-09-11	44.42	
1958-09-09	43.45	
1958-09-07	42.45	
1958-09-05	43.49	
1958-09-03	44.21	
1958-09-01	39.74	
1958-08-30	45.52	
1958-08-28	46.28	
1958-08-26	44.46	
1958-08-24	45.44	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1958-08-23	46.90	
1958-08-21	48.12	
1958-08-19	46.38	
1958-08-17	46.20	
1958-08-15	48.25	
1958-08-13	47.60	
1958-08-11	47.28	
1958-08-09	49.45	
1958-08-07	49.72	
1958-08-05	48.00	
1958-07-31	45.70	
1958-07-29	44.48	
1958-07-27	46.62	
1958-07-25	46.13	
1958-07-23	44.21	
1958-07-21	41.88	
1958-07-19	41.10	
1958-07-17	40.42	
1958-07-15	39.93	
1958-07-13	37.99	
1958-07-11	38.19	
1958-07-09	37.72	
1958-07-07	36.72	
1958-07-05	37.18	
1958-07-03	39.24	
1958-07-01	38.89	
1958-06-29	39.10	
1958-06-27	39.84	
1958-06-25	37.75	
1958-06-23	38.00	
1958-06-21	39.50	
1958-06-19	39.00	
1958-06-17	37.72	
1958-06-15	34.80	
1958-06-13	36.48	
1958-06-11	35.82	
1958-06-09	35.15	
1958-06-07	34.55	
1958-06-05	34.65	
1958-06-03	33.95	
1958-06-01	32.90	
1958-05-30	33.10	
1958-05-28	32.12	
1958-05-26	29.00	
1958-05-24	31.05	
1958-05-22	33.15	
1958-05-19	29.99	
1958-05-17	31.32	
1958-05-15	28.52	
1958-05-13	26.65	
1958-05-11	23.34	
1958-05-09	22.92	
1958-05-07	22.15	
1958-05-03	21.51	
1958-05-01	21.50	
1958-08-22	47.70	
1958-08-20	47.41	
1958-08-18	47.21	
1958-08-16	47.92	
1958-08-14	48.15	
1958-08-12	47.50	
1958-08-10	49.15	
1958-08-08	49.62	
1958-08-06	49.70	
1958-08-01	47.00	
1958-07-30	44.62	
1958-07-28	44.48	
1958-07-26	45.72	
1958-07-24	45.50	
1958-07-22	43.25	
1958-07-20	40.70	
1958-07-18	41.00	
1958-07-16	40.55	
1958-07-14	38.98	
1958-07-12	38.20	
1958-07-10	38.10	
1958-07-08	37.45	
1958-07-06	35.15	
1958-07-04	39.24	
1958-07-02	38.89	
1958-06-30	38.85	
1958-06-28	39.59	
1958-06-26	38.40	
1958-06-24	38.10	
1958-06-22	38.70	
1958-06-20	40.22	
1958-06-18	38.12	
1958-06-16	36.69	
1958-06-14	36.05	
1958-06-12	35.85	
1958-06-10	34.94	
1958-06-08	33.15	
1958-06-06	34.90	
1958-06-04	34.00	
1958-06-02	32.48	
1958-05-31	32.90	
1958-05-29	33.10	
1958-05-27	30.48	
1958-05-25	29.15	
1958-05-23	31.95	
1958-05-20	30.82	
1958-05-18	28.36	
1958-05-16	31.19	
1958-05-14	26.55	
1958-05-12	25.15	
1958-05-10	23.91	
1958-05-08	22.52	
1958-05-05	22.00	
1958-05-02	21.55	
1958-04-30	21.92	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1958-04-29	21.66	
1958-04-27	19.52	
1958-04-25	23.92	
1958-04-23	22.70	
1958-04-21	21.78	
1958-04-19	22.18	
1958-04-17	21.85	
1958-04-15	18.60	
1958-04-13	14.25	
1958-04-11	15.30	
1958-04-09	15.10	
1958-04-07	14.78	
1958-04-05	14.31	
1958-04-03	15.00	
1958-04-01	15.86	
1958-03-30	14.02	
1958-03-28	15.28	
1958-03-26	16.28	
1958-03-24	16.61	
1958-03-22	15.38	
1958-03-20	17.58	
1958-03-18	15.98	
1958-03-16	15.50	
1958-03-14	16.57	
1958-03-12	16.87	
1958-03-10	16.75	
1958-03-08	16.94	
1958-03-06	16.55	
1958-03-04	17.08	
1958-03-02	15.72	
1958-02-28	17.48	
1958-02-26	16.60	
1958-02-24	15.72	
1958-02-22	16.08	
1958-02-20	16.70	
1958-02-18	16.19	
1958-02-16	14.72	
1958-02-14	16.15	
1958-02-12	15.94	
1958-02-10	15.38	
1958-02-08	15.65	
1958-02-06	16.39	
1958-01-31	17.40	
1958-01-29	18.29	
1958-01-27	16.80	
1958-01-25	16.51	
1958-01-23	17.89	
1958-01-21	17.12	
1958-01-19	15.60	
1958-01-17	17.32	
1958-01-15	17.90	
1958-01-13	18.60	
1958-01-11	19.52	
1958-01-09	18.02	
1958-01-07	16.76	
1958-04-28	21.17	
1958-04-26	21.28	
1958-04-24	23.31	
1958-04-22	21.10	
1958-04-20	21.12	
1958-04-18	22.44	
1958-04-16	20.06	
1958-04-14	15.45	
1958-04-12	15.00	
1958-04-10	14.71	
1958-04-08	15.10	
1958-04-06	13.14	
1958-04-04	14.81	
1958-04-02	15.19	
1958-03-31	15.33	
1958-03-29	15.01	
1958-03-27	16.10	
1958-03-25	16.22	
1958-03-23	14.58	
1958-03-21	16.88	
1958-03-19	16.06	
1958-03-17	15.68	
1958-03-15	16.37	
1958-03-13	16.91	
1958-03-11	16.80	
1958-03-09	15.70	
1958-03-07	17.62	
1958-03-05	16.58	
1958-03-03	16.82	
1958-03-01	17.33	
1958-02-27	16.20	
1958-02-25	16.08	
1958-02-23	15.40	
1958-02-21	16.18	
1958-02-19	16.82	
1958-02-17	15.89	
1958-02-15	15.72	
1958-02-13	16.46	
1958-02-11	15.62	
1958-02-09	15.22	
1958-02-07	16.19	
1958-02-05	16.56	
1958-01-30	17.74	
1958-01-28	17.38	
1958-01-26	15.11	
1958-01-24	17.42	
1958-01-22	17.43	
1958-01-20	16.75	
1958-01-18	16.50	
1958-01-16	17.70	
1958-01-14	18.18	
1958-01-12	18.32	
1958-01-10	18.02	
1958-01-08	17.41	
1958-01-06	16.75	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1958-01-05	17.20	
1958-01-03	18.28	
1958-01-01	17.20	
1957-12-30	17.61	
1957-12-28	22.10	
1957-12-26	17.31	
1957-12-24	18.15	
1957-12-22	19.29	
1957-12-20	20.97	
1957-12-18	19.76	
1957-12-16	19.81	
1957-12-14	19.72	
1957-12-12	20.83	
1957-12-10	20.68	
1957-12-08	20.19	
1957-12-06	22.30	
1957-12-04	22.50	
1957-12-02	21.40	
1957-11-30	20.80	
1957-11-28	22.20	
1957-11-26	24.00	
1957-11-24	22.40	
1957-11-22	26.15	
1957-11-20	25.89	
1957-11-18	24.09	
1957-11-16	27.15	
1957-11-14	28.98	
1957-11-12	30.60	
1957-11-10	34.00	
1957-11-08	35.60	
1957-11-06	35.53	
1957-11-04	34.65	
1957-11-02	35.78	
1957-10-31	36.88	
1957-10-29	36.40	
1957-10-27	33.32	
1957-10-25	38.57	
1957-10-23	38.29	
1957-10-21	36.24	
1957-10-19	36.02	
1957-10-17	37.90	
1957-10-15	38.19	
1957-10-13	37.10	
1957-10-11	40.52	
1957-10-09	40.42	
1957-10-05	42.22	
1957-10-03	43.47	
1957-10-01	42.40	
1957-09-29	38.65	
1957-09-27	42.40	
1957-09-25	41.62	
1957-09-23	40.62	
1957-09-21	42.70	
1957-09-19	43.55	
1957-09-17	42.88	

Date	Feet below Surface	Feet to Sealevel
1958-01-04	18.29	
1958-01-02	16.65	
1957-12-31	18.52	
1957-12-29	19.00	
1957-12-27	18.92	
1957-12-25	17.62	
1957-12-23	18.43	
1957-12-21	20.17	
1957-12-19	19.69	
1957-12-17	19.82	
1957-12-15	19.28	
1957-12-13	20.50	
1957-12-11	20.60	
1957-12-09	20.20	
1957-12-07	20.60	
1957-12-05	22.19	
1957-12-03	21.52	
1957-12-01	20 03	
1957-11-29	21.23	
1957-11-27	23.24	
1957-11-25	23.74	
1957-11-23	23.75	
1957-11-21	26.22	
1957-11-19	25.08	
1957-11-17	25.50	
1957-11-15	28.59	
1957-11-13	29.60	
1957-11-11	32.06	
1957-11-09	35.45	
1957-11-07	35.71	
1957-11-05	35.61	
1957-11-03	33.20	
1957-11-01	36.95	
1957-10-30	36.90	
1957-10-28	35.72	
1957-10-26	37.70	
1957-10-24	38.29	
1957-10-22	37.37	
1957-10-20	32.22	
1957-10-18	37.21	
1957-10-16	38.82	
1957-10-14	38.00	
1957-10-12	40.10	
1957-10-10	41.10	
1957-10-08	40.40	
1957-10-04	43.19	
1957-10-02	43.30	
1957-09-30	41.15	
1957-09-28	41.47	
1957-09-26	42.62	
1957-09-24	41.33	
1957-09-22	39.05	
1957-09-20	44.22	
1957-09-18	43.41	
1957-09-16	41.55	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1957-09-15	39.71	
1957-09-13	42.55	
1957-09-11	42.39	
1957-09-09	41.43	
1957-09-07	41.82	
1957-09-05	41.92	
1957-09-03	42.87	
1957-09-01	41.60	
1957-08-30	44.76	
1957-08-28	44.40	
1957-08-26	46.28	
1957-08-24	46.60	
1957-08-22	49.33	
1957-08-20	47.15	
1957-08-18	48.39	
1957-08-16	48.08	
1957-08-14	46.70	
1957-08-10	44.38	
1957-08-08	46.40	
1957-08-06	43.79	
1957-08-04	44.20	
1957-08-02	44.82	
1957-07-31	41.69	
1957-07-29	40.40	
1957-07-27	39.80	
1957-07-25	39.63	
1957-07-23	38.77	
1957-07-21	38.00	
1957-07-19	37.47	
1957-07-17	35.41	
1957-07-15	34.78	
1957-07-13	34.41	
1957-07-11	35.38	
1957-07-09	33.03	
1957-07-07	31.21	
1957-07-05	30.73	
1957-07-03	31.00	
1957-07-01	31.00	
1957-06-29	31.10	
1957-06-27	31.59	
1957-06-25	29.10	
1957-06-23	30.44	
1957-06-21	31.18	
1957-06-19	30.13	
1957-06-17	29.52	
1957-06-15	28.11	
1957-06-13	27.49	
1957-06-11	27.24	
1957-06-09	26.19	
1957-06-07	27.53	
1957-06-05	26.38	
1957-06-03	25.03	
1957-06-01	25.81	
1957-05-30	24.20	
1957-05-28	23.80	
1957-09-14	41.80	
1957-09-12	42.12	
1957-09-10	41.80	
1957-09-08	40.27	
1957-09-06	42.49	
1957-09-04	41.71	
1957-09-02	40.93	
1957-08-31	43.70	
1957-08-29	44.55	
1957-08-27	45.59	
1957-08-25	45.00	
1957-08-23	48.00	
1957-08-21	48.63	
1957-08-19	46.80	
1957-08-17	47.42	
1957-08-15	46.93	
1957-08-13	45.01	
1957-08-09	44.85	
1957-08-07	45.50	
1957-08-05	42.51	
1957-08-03	45.04	
1957-08-01	43.00	
1957-07-30	41.20	
1957-07-28	38.60	
1957-07-26	39.80	
1957-07-24	39.00	
1957-07-22	38.80	
1957-07-20	38.92	
1957-07-18	36.28	
1957-07-16	35.67	
1957-07-14	34.00	
1957-07-12	34.90	
1957-07-10	33.79	
1957-07-08	31.82	
1957-07-06	31.15	
1957-07-04	30.36	
1957-07-02	30.70	
1957-06-30	30.50	
1957-06-28	31.50	
1957-06-26	31.78	
1957-06-24	28.80	
1957-06-22	30.79	
1957-06-20	30.14	
1957-06-18	29.88	
1957-06-16	27.40	
1957-06-14	27.91	
1957-06-12	27.17	
1957-06-10	27.15	
1957-06-08	27.40	
1957-06-06	26.40	
1957-06-04	26.28	
1957-06-02	25.10	
1957-05-31	26.12	
1957-05-29	24.12	
1957-05-27	21.55	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1957-05-26	21.90	
1957-05-24	24.72	
1957-05-22	24.35	
1957-05-20	22.71	
1957-05-18	23.40	
1957-05-16	24.13	
1957-05-14	22.47	
1957-05-11	23.30	
1957-05-09	23.82	
1957-05-07	23.54	
1957-05-05	18.15	
1957-05-03	23.20	
1957-05-01	22.69	
1957-04-29	20.70	
1957-04-27	21.35	
1957-04-25	21.64	
1957-04-23	20.90	
1957-04-21	19.62	
1957-04-19	20.63	
1957-04-17	18.76	
1957-04-15	16.41	
1957-04-13	16.68	
1957-04-11	17.22	
1957-04-09	16.18	
1957-04-07	13.79	
1957-04-05	16.58	
1957-04-03	16.91	
1957-04-01	16.50	
1957-03-30	16.21	
1957-03-28	16.45	
1957-03-26	15.97	
1957-03-24	15.20	
1957-03-22	17.48	
1957-03-20	16.62	
1957-03-18	15.58	
1957-03-16	15.95	
1957-03-14	15.60	
1957-03-12	16.50	
1957-03-10	15.40	
1957-03-08	17.12	
1957-03-06	17.45	
1957-03-04	16.86	
1957-03-02	17.70	
1957-02-28	18.18	
1957-02-26	17.93	
1957-02-24	19.84	
1957-02-22	21.00	
1957-02-20	21.00	
1957-02-18	20.90	
1957-02-16	19.80	
1957-02-14	20.40	
1957-02-12	19.22	
1957-02-09	18.78	
1957-02-07	19.57	
1957-02-05	17.18	
1957-05-25	24.20	
1957-05-23	24.50	
1957-05-21	23.01	
1957-05-19	21.90	
1957-05-17	23.80	
1957-05-15	23.18	
1957-05-13	22.33	
1957-05-10	24.00	
1957-05-08	24.32	
1957-05-06	22.71	
1957-05-04	21.50	
1957-05-02	22.20	
1957-04-30	21.70	
1957-04-28	19.64	
1957-04-26	21.60	
1957-04-24	21.62	
1957-04-22	20.14	
1957-04-20	20.63	
1957-04-18	19.83	
1957-04-16	17.12	
1957-04-14	15.55	
1957-04-12	16.97	
1957-04-10	15.90	
1957-04-08	15.79	
1957-04-06	15.19	
1957-04-04	16.91	
1957-04-02	17.30	
1957-03-31	15.24	
1957-03-29	16.83	
1957-03-27	15.91	
1957-03-25	16.59	
1957-03-23	17.11	
1957-03-21	16.80	
1957-03-19	16.27	
1957-03-17	15.01	
1957-03-15	16.47	
1957-03-13	17.42	
1957-03-11	15.83	
1957-03-09	17.10	
1957-03-07	17.60	
1957-03-05	17.81	
1957-03-03	16.50	
1957-03-01	17.80	
1957-02-27	18.22	
1957-02-25	19.89	
1957-02-23	20.74	
1957-02-21	20.80	
1957-02-19	21.10	
1957-02-17	18.10	
1957-02-15	20.00	
1957-02-13	19.58	
1957-02-10	17.50	
1957-02-08	20.50	
1957-02-06	17.77	
1957-02-04	18.10	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1957-02-03	16.25	
1957-02-01	18.96	
1957-01-30	19.69	
1957-01-28	22.77	
1957-01-26	22.65	
1957-01-24	23.59	
1957-01-22	23.29	
1957-01-20	23.19	
1957-01-18	23.20	
1957-01-16	22.08	
1957-01-14	21.22	
1957-01-12	21.82	
1957-01-10	20.22	
1957-01-05	18.00	
1956-12-28	19.49	
1956-12-26	19.40	
1956-12-24	18.40	
1956-12-22	19.90	
1956-12-20	22.80	
1956-12-18	20.29	
1956-12-16	19.80	
1956-12-14	22.06	
1956-12-12	23.10	
1956-12-10	27.00	
1956-12-08	24.15	
1956-12-06	22.92	
1956-12-04	24.00	
1956-12-02	24.90	
1956-11-30	23.76	
1956-11-28	24.22	
1956-11-25	26.00	
1956-11-22	27.26	
1956-11-20	26.92	
1956-11-18	24.50	
1956-11-16	30.49	
1956-11-14	36.20	
1956-11-12	30.25	
1956-11-10	30.85	
1956-11-08	31.17	
1956-11-06	31.33	
1956-11-04	30.10	
1956-11-02	33.59	
1956-10-31	33.91	
1956-10-29	33.02	
1956-10-27	33.43	
1956-10-25	33.81	
1956-10-23	33.86	
1956-10-21	34.11	
1956-10-19	35.64	
1956-10-17	39.20	
1956-10-15	35.12	
1956-10-13	35.09	
1956-10-11	34.99	
1956-10-09	34.83	
1956-10-07	34.40	
1957-02-02	17.25	
1957-01-31	18.68	
1957-01-29	22.73	
1957-01-27	21.20	
1957-01-25	23.50	
1957-01-23	23.89	
1957-01-21	23.37	
1957-01-19	23.50	
1957-01-17	22.75	
1957-01-15	21.70	
1957-01-13	21.25	
1957-01-11	21.79	
1957-01-09	18.28	
1956-12-31	19.00	
1956-12-27	23.00	
1956-12-25	15.78	
1956-12-23	18.80	
1956-12-21	20.00	
1956-12-19	23.00	
1956-12-17	20.28	
1956-12-15	21.00	
1956-12-13	22.83	
1956-12-11	22.39	
1956-12-09	23.51	
1956-12-07	22.90	
1956-12-05	23.48	
1956-12-03	27.20	
1956-12-01	25.18	
1956-11-29	23.58	
1956-11-27	24.29	
1956-11-23	22.94	
1956-11-21	22.51	
1956-11-19	23.45	
1956-11-17	29.30	
1956-11-15	30.20	
1956-11-13	29.91	
1956-11-11	28.90	
1956-11-09	31.65	
1956-11-07	31.38	
1956-11-05	30.54	
1956-11-03	32.00	
1956-11-01	33.20	
1956-10-30	33.29	
1956-10-28	32.45	
1956-10-26	33.95	
1956-10-24	33.40	
1956-10-22	34.59	
1956-10-20	35.31	
1956-10-18	35.40	
1956-10-16	35.48	
1956-10-14	33.90	
1956-10-12	35.32	
1956-10-10	35.19	
1956-10-08	34.01	
1956-10-06	34.72	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1956-10-05	35.64	
1956-10-03	36.02	
1956-10-01	32.51	
1956-09-29	36.18	
1956-09-27	36.69	
1956-09-25	35.90	
1956-09-21	36.70	
1956-09-19	36.77	
1956-09-17	36.31	
1956-09-15	36.91	
1956-09-13	38.14	
1956-09-11	36.60	
1956-09-09	35.90	
1956-09-07	37.76	
1956-09-05	36.13	
1956-09-03	35.49	
1956-09-01	38.50	
1956-08-30	38.70	
1956-08-28	40.00	
1956-08-26	36.48	
1956-08-24	36.70	
1956-08-22	36.95	
1956-08-20	37.30	
1956-08-18	37.92	
1956-08-16	41.70	
1956-08-14	37.00	
1956-08-12	32.58	
1956-08-10	34.65	
1956-08-08	33.78	
1956-08-06	31.92	
1956-08-04	32.12	
1956-08-02	31.90	
1956-07-31	32.04	
1956-07-29	32.80	
1956-07-27	34.92	
1956-07-25	33.94	
1956-07-23	33.52	
1956-07-21	33.10	
1956-07-19	33.80	
1956-07-17	33.15	
1956-07-15	31.60	
1956-07-13	31.08	
1956-07-11	31.59	
1956-07-09	28.73	
1956-07-07	29.49	
1956-07-05	30.00	
1956-07-03	32.10	
1956-06-30	30.32	
1956-06-28	30.59	
1956-06-26	29.20	
1956-06-22	30.89	
1956-06-20	30.18	
1956-06-18	29.15	
1956-06-16	31.42	
1956-06-14	30.25	
1956-10-04	35.92	
1956-10-02	37.67	
1956-09-30	34.70	
1956-09-28	35.49	
1956-09-26	35.92	
1956-09-22	35.88	
1956-09-20	36.82	
1956-09-18	36.43	
1956-09-16	35.52	
1956-09-14	38.51	
1956-09-12	38.00	
1956-09-10	36.07	
1956-09-08	37.21	
1956-09-06	37.71	
1956-09-04	36.72	
1956-09-02	36.60	
1956-08-31	39.25	
1956-08-29	38.18	
1956-08-27	35.96	
1956-08-25	36.84	
1956-08-23	37.03	
1956-08-21	37.11	
1956-08-19	36.40	
1956-08-17	38.13	
1956-08-15	37.42	
1956-08-13	35.22	
1956-08-11	33.75	
1956-08-09	34.23	
1956-08-07	36.10	
1956-08-05	31.33	
1956-08-03	32.71	
1956-08-01	31.71	
1956-07-30	31.92	
1956-07-28	34.92	
1956-07-26	34.11	
1956-07-24	33.96	
1956-07-22	32.50	
1956-07-20	33.62	
1956-07-18	33.39	
1956-07-16	32.11	
1956-07-14	32.72	
1956-07-12	31.47	
1956-07-10	29.82	
1956-07-08	29.00	
1956-07-06	29.55	
1956-07-04	31.30	
1956-07-01	28.00	
1956-06-29	30.80	
1956-06-27	29.08	
1956-06-25	29.62	
1956-06-21	30.63	
1956-06-19	29.20	
1956-06-17	29.50	
1956-06-15	30.80	
1956-06-13	29.93	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1956-06-12	26.70	
1956-06-10	24.55	
1956-06-08	24.85	
1956-06-06	22.72	
1956-06-04	18.10	
1956-06-02	19.42	
1956-05-31	18.28	
1956-05-29	17.63	
1956-05-27	16.40	
1956-05-25	17.72	
1956-05-23	16.20	
1956-05-20	8.01	
1956-05-18	13.69	
1956-05-16	9.66	
1956-05-14	9.37	
1956-05-12	10.40	
1956-05-10	10.40	
1956-05-08	9.93	
1956-05-06	8.72	
1956-05-04	10.96	
1956-05-02	10.30	
1956-04-30	9.95	
1956-04-28	10.81	
1956-04-26	10.70	
1956-04-24	10.48	
1956-04-22	10.40	
1956-04-20	9.99	
1956-04-18	9.58	
1956-04-16	8.18	
1956-04-14	9.18	
1956-04-12	9.88	
1956-04-10	9.72	
1956-04-08	9.53	
1956-04-06	10.16	
1956-04-04	10.12	
1956-04-02	9.50	
1956-03-31	10.82	
1956-03-29	10.09	
1956-03-27	10.36	
1956-03-25	9.50	
1956-03-23	11.28	
1956-03-21	11.51	
1956-03-15	11.65	
1956-03-08	11.84	
1956-03-05	10.43	
1956-03-03	10.35	
1956-03-01	10.30	
1956-02-28	11.91	
1956-02-26	10.12	
1956-02-24	10.88	
1956-02-20	11.12	
1956-02-17	11.01	
1956-02-15	10.55	
1956-02-13	10.10	
1956-02-10	11.20	
1956-06-11	26.22	
1956-06-09	26.33	
1956-06-07	22.92	
1956-06-05	19.59	
1956-06-03	19.00	
1956-06-01	18.82	
1956-05-30	18.02	
1956-05-28	15.65	
1956-05-26	17.05	
1956-05-24	16.85	
1956-05-22	16.05	
1956-05-19	10.51	
1956-05-17	9.90	
1956-05-15	9.66	
1956-05-13	9.30	
1956-05-11	10.20	
1956-05-09	10.08	
1956-05-07	10.08	
1956-05-05	10.38	
1956-05-03	10.47	
1956-05-01	10.23	
1956-04-29	10.20	
1956-04-27	10.67	
1956-04-25	10.55	
1956-04-23	9.91	
1956-04-21	10.50	
1956-04-19	9.37	
1956-04-17	8.90	
1956-04-15	7.78	
1956-04-13	10.69	
1956-04-11	10.00	
1956-04-09	9.75	
1956-04-07	10.10	
1956-04-05	10.19	
1956-04-03	9.63	
1956-04-01	9.85	
1956-03-30	10.37	
1956-03-28	10.03	
1956-03-26	9.97	
1956-03-24	10.97	
1956-03-22	11.52	
1956-03-20	11.55	
1956-03-10	11.75	
1956-03-07	11.72	
1956-03-04	9.16	
1956-03-02	11.30	
1956-02-29	11.10	
1956-02-27	10.57	
1956-02-25	11.10	
1956-02-22	12.36	
1956-02-19	10.50	
1956-02-16	10.54	
1956-02-14	10.58	
1956-02-12	10.59	
1956-02-09	11.48	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1956-02-08	11.48	
1956-02-05	12.00	
1956-02-01	13.90	
1956-01-25	13.80	
1956-01-19	13.22	
1956-01-17	13.93	
1956-01-15	12.80	
1956-01-09	13.27	
1956-01-07	14.49	
1956-01-05	14.60	
1955-12-28	13.75	
1955-12-26	12.16	
1955-12-24	14.34	
1955-12-22	14.83	
1955-12-08	15.90	
1955-11-23	15.21	
1955-11-21	15.70	
1955-11-19	17.66	
1955-11-12	17.54	
1955-11-10	18.09	
1955-11-08	17.42	
1955-11-06	17.40	
1955-11-04	20.65	
1955-11-02	21.20	
1955-10-31	21.09	
1955-10-29	23.37	
1955-10-27	24.47	
1955-10-24	23.84	
1955-10-22	25.06	
1955-10-20	27.90	
1955-10-18	27.78	
1955-10-14	29.50	
1955-10-12	30.28	
1955-10-10	30.61	
1955-10-01	32.49	
1955-09-29	33.41	
1955-09-26	31.88	
1955-09-24	34.00	
1955-09-22	35.53	
1955-09-20	35.90	
1955-09-18	36.98	
1955-09-16	35.99	
1955-09-14	33.60	
1955-09-12	34.19	
1955-09-10	35.50	
1955-09-08	36.24	
1955-09-06	35.00	
1955-08-08	34.90	
1955-08-06	37.13	
1955-08-04	36.75	
1955-06-20	25.68	
1955-06-18	26.94	
1955-06-16	25.65	
1955-06-14	23.60	
1955-06-11	23.69	
1956-02-07	11.32	
1956-02-02	13.68	
1956-01-31	14.38	
1956-01-20	13.35	
1956-01-18	13.62	
1956-01-16	12.72	
1956-01-10	13.20	
1956-01-08	14.37	
1956-01-06	14.54	
1955-12-30	15.08	
1955-12-27	13.50	
1955-12-25	13.14	
1955-12-23	14.55	
1955-12-09	16.71	
1955-12-07	15.98	
1955-11-22	15.40	
1955-11-20	15.73	
1955-11-18	17.69	
1955-11-11	18.50	
1955-11-09	17.96	
1955-11-07	17.47	
1955-11-05	18.80	
1955-11-03	20.97	
1955-11-01	21.99	
1955-10-30	21.45	
1955-10-28	24.74	
1955-10-25	22.66	
1955-10-23	24.53	
1955-10-21	25.73	
1955-10-19	28.45	
1955-10-15	28.30	
1955-10-13	29.68	
1955-10-11	30.73	
1955-10-02	30.65	
1955-09-30	33.35	
1955-09-28	33.95	
1955-09-25	32.00	
1955-09-23	35.12	
1955-09-21	35.56	
1955-09-19	36.02	
1955-09-17	35.91	
1955-09-15	35.60	
1955-09-13	34.23	
1955-09-11	33.90	
1955-09-09	35.98	
1955-09-07	36.10	
1955-08-09	33.51	
1955-08-07	36.47	
1955-08-05	36.33	
1955-08-03	36.92	
1955-06-19	25.60	
1955-06-17	27.31	
1955-06-15	24.83	
1955-06-12	22.45	
1955-06-10	24.08	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1955-06-09	23.63	
1955-06-07	23.28	
1955-06-05	23.15	
1955-06-03	23.01	
1955-06-01	22.07	
1955-05-30	18.70	
1955-05-28	21.80	
1955-05-23	21.15	
1955-05-21	22.60	
1955-05-19	21.61	
1955-05-14	20.70	
1955-05-12	20.80	
1955-05-08	21.45	
1955-05-06	20.76	
1955-05-04	21.00	
1955-04-29	20.62	
1955-04-27	19.31	
1955-04-23	18.93	
1955-04-21	18.40	
1955-04-19	17.72	
1955-04-15	18.21	
1955-04-13	17.21	
1955-04-11	16.03	
1955-04-09	18.98	
1955-04-07	18.70	
1955-04-05	18.00	
1955-04-03	16.50	
1955-04-01	19.33	
1955-03-30	19.30	
1955-03-14	18.52	
1955-03-12	20.02	
1955-03-10	19.80	
1955-03-05	20.12	
1955-03-03	19.19	
1955-03-01	18.99	
1955-02-26	18.71	
1955-02-24	19.22	
1955-02-22	17.00	
1955-01-25	16.80	
1955-01-23	17.40	
1955-01-21	17.80	
1955-01-19	19.16	
1955-01-08	20.61	
1955-01-06	22.40	
1954-12-27	20.60	
1954-12-25	18.93	
1954-12-23	21.10	
1954-12-21	20.02	
1954-12-19	17.36	
1954-12-17	21.58	
1954-12-15	21.12	
1954-12-12	17.45	
1954-12-10	22.10	
1954-12-08	22.46	
1954-12-02	24.00	
1955-06-08	23.19	
1955-06-06	22.71	
1955-06-04	23.77	
1955-06-02	22.48	
1955-05-31	21.03	
1955-05-29	20.10	
1955-05-27	22.30	
1955-05-22	22.10	
1955-05-20	22.23	
1955-05-15	18.91	
1955-05-13	21.51	
1955-05-11	20.62	
1955-05-07	20.03	
1955-05-05	20.76	
1955-04-30	20.35	
1955-04-28	19.50	
1955-04-26	18.85	
1955-04-22	19.61	
1955-04-20	18.07	
1955-04-16	17.50	
1955-04-14	17.80	
1955-04-12	17.00	
1955-04-10	16.31	
1955-04-08	19.16	
1955-04-06	18.37	
1955-04-04	17.42	
1955-04-02	18.66	
1955-03-31	19.31	
1955-03-29	18.52	
1955-03-13	18.40	
1955-03-11	20.51	
1955-03-09	20.00	
1955-03-04	19.12	
1955-03-02	18.99	
1955-02-27	17.85	
1955-02-25	19.20	
1955-02-23	18.60	
1955-01-26	16.73	
1955-01-24	16.33	
1955-01-22	18.00	
1955-01-20	17.10	
1955-01-09	18.90	
1955-01-07	21.70	
1955-01-05	21.92	
1954-12-26	17.15	
1954-12-24	21.00	
1954-12-22	20.30	
1954-12-20	19.00	
1954-12-18	21.30	
1954-12-16	21.52	
1954-12-14	20.46	
1954-12-11	21.56	
1954-12-09	22.65	
1954-12-07	22.03	
1954-12-01	25.57	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1954-11-30	25.43	
1954-11-28	24.20	
1954-11-26	24.82	
1954-11-24	25.30	
1954-11-17	25.10	
1954-11-14	21.62	
1954-11-12	25.40	
1954-11-10	25.70	
1954-11-08	24.28	
1954-11-06	24.70	
1954-11-04	25.93	
1954-11-02	25.54	
1954-10-23	27.90	
1954-10-21	29.01	
1954-10-19	29.09	
1954-10-17	28.70	
1954-10-15	30.25	
1954-10-13	30.60	
1954-10-10	29.37	
1954-10-08	30.53	
1954-10-06	31.06	
1954-10-04	29.90	
1954-10-02	31.90	
1954-09-29	31.77	
1954-09-27	31.05	
1954-09-15	33.88	
1954-09-12	33.14	
1954-09-10	34.67	
1954-09-08	34.60	
1954-09-06	39.50	
1954-09-04	36.60	
1954-09-02	36.61	
1954-08-31	36.47	
1954-08-29	35.18	
1954-08-27	36.65	
1954-08-25	36.64	
1954-08-23	35.48	
1954-08-21	37.33	
1954-08-19	37.13	
1954-08-17	36.90	
1954-08-15	35.85	
1954-08-13	38.38	
1954-08-11	36.78	
1954-08-09	35.90	
1954-08-07	39.30	
1954-08-05	38.84	
1954-07-26	34.62	
1954-07-24	38.10	
1954-07-22	38.10	
1954-07-18	33.70	
1954-07-16	34.49	
1954-07-14	32.84	
1954-07-12	28.95	
1954-07-10	24.03	
1954-07-08	25.60	
1954-11-29	25.05	
1954-11-27	24.30	
1954-11-25	25.30	
1954-11-22	22.25	
1954-11-16	24.82	
1954-11-13	25.25	
1954-11-11	25.66	
1954-11-09	25.48	
1954-11-07	22.95	
1954-11-05	25.72	
1954-11-03	25.69	
1954-10-24	27.03	
1954-10-22	28.76	
1954-10-20	29.22	
1954-10-18	28.97	
1954-10-16	29.95	
1954-10-14	30.30	
1954-10-11	29.42	
1954-10-09	30.25	
1954-10-07	30.91	
1954-10-05	30.60	
1954-10-03	28.71	
1954-09-30	31.70	
1954-09-28	31.40	
1954-09-16	33.91	
1954-09-13	32.79	
1954-09-11	34.71	
1954-09-09	34.58	
1954-09-07	33.10	
1954-09-05	34.69	
1954-09-03	37.07	
1954-09-01	36.20	
1954-08-30	36.40	
1954-08-28	36.70	
1954-08-26	36.50	
1954-08-24	36.84	
1954-08-22	36.30	
1954-08-20	37.78	
1954-08-18	36.29	
1954-08-16	36.52	
1954-08-14	37.52	
1954-08-12	37.03	
1954-08-10	36.69	
1954-08-08	37.85	
1954-08-06	39.80	
1954-08-04	38.13	
1954-07-25	38.10	
1954-07-23	38.40	
1954-07-21	37.80	
1954-07-17	34.10	
1954-07-15	33.80	
1954-07-13	31.22	
1954-07-11	23.53	
1954-07-09	24.69	
1954-07-07	25.83	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1954-07-06	26.59	
1954-05-24	25.38	
1954-05-22	26.30	
1954-05-20	24.82	
1954-05-18	23.73	
1954-05-16	24.55	
1954-05-14	23.00	
1954-05-12	22.52	
1954-05-10	21.62	
1954-05-08	20.38	
1954-05-06	21.05	
1954-05-04	19.92	
1954-05-02	17.28	
1954-04-30	23.85	
1954-04-28	22.70	
1954-04-26	22.10	
1954-04-24	23.76	
1954-04-22	23.11	
1954-04-20	23.03	
1954-04-18	20.90	
1954-04-16	22.41	
1954-04-14	22.21	
1954-04-07	21.89	
1954-04-05	22.39	
1954-04-03	22.82	
1954-04-01	22.93	
1954-03-30	22.45	
1954-03-28	21.40	
1954-03-26	23.32	
1954-03-24	22.22	
1954-03-22	22.11	
1954-03-20	23.28	
1954-03-18	23.68	
1954-03-16	23.85	
1954-03-14	23.00	
1954-03-12	24.09	
1954-03-10	23.41	
1954-03-08	22.35	
1954-03-06	23.90	
1954-03-04	23.93	
1954-03-02	23.53	
1954-02-28	21.69	
1954-02-26	23.38	
1954-02-24	22.32	
1954-02-22	23.51	
1954-02-20	23.48	
1954-02-18	24.01	
1954-02-16	23.81	
1954-02-14	22.82	
1954-02-12	24.04	
1954-02-10	23.50	
1954-02-08	22.38	
1954-02-06	22.10	
1954-02-04	22.51	
1954-02-02	22.54	
1954-05-25	25.03	
1954-05-23	25.70	
1954-05-21	25.31	
1954-05-19	23.93	
1954-05-17	24.23	
1954-05-15	22.83	
1954-05-13	22.70	
1954-05-11	22.50	
1954-05-09	19.80	
1954-05-07	20.62	
1954-05-05	20.88	
1954-05-03	19.60	
1954-05-01	23.10	
1954-04-29	23.84	
1954-04-27	22.03	
1954-04-25	22.05	
1954-04-23	23.72	
1954-04-21	23.15	
1954-04-19	22.30	
1954-04-17	21.95	
1954-04-15	22.38	
1954-04-13	21.41	
1954-04-06	22.39	
1954-04-04	21.23	
1954-04-02	22.89	
1954-03-31	22.80	
1954-03-29	21.78	
1954-03-27	23.03	
1954-03-25	22.12	
1954-03-23	22.95	
1954-03-21	21.60	
1954-03-19	23.10	
1954-03-17	23.90	
1954-03-15	23.65	
1954-03-13	24.30	
1954-03-11	24.00	
1954-03-09	23.41	
1954-03-07	22.37	
1954-03-05	24.14	
1954-03-03	23.80	
1954-03-01	22.51	
1954-02-27	23.04	
1954-02-25	23.11	
1954-02-23	23.00	
1954-02-21	21.89	
1954-02-19	23.80	
1954-02-17	24.04	
1954-02-15	23.90	
1954-02-13	23.58	
1954-02-11	24.13	
1954-02-09	22.49	
1954-02-07	21.82	
1954-02-05	21.95	
1954-02-03	22.64	
1954-01-31	22.82	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1954-01-30	23.43	
1954-01-28	23.14	
1954-01-26	22.36	
1954-01-12	19.95	
1954-01-10	19.70	
1954-01-07	20.30	
1954-01-05	20.45	
1953-12-28	18.76	
1953-12-26	18.32	
1953-12-24	20.30	
1953-12-05	22.60	
1953-12-03	21.27	
1953-12-01	20.85	
1953-11-24	23.39	
1953-11-22	23.56	
1953-11-20	25.16	
1953-11-18	25.06	
1953-11-16	24.70	
1953-11-14	25.41	
1953-11-12	25.81	
1953-11-10	25.45	
1953-11-08	26.58	
1953-11-06	28.02	
1953-11-04	27.96	
1953-11-02	26.71	
1953-10-31	28.08	
1953-10-29	27.53	
1953-10-26	27.03	
1953-10-24	28.66	
1953-10-22	36.88	
1953-10-17	32.40	
1953-10-03	42.12	
1953-09-29	41.38	
1953-09-26	41.52	
1953-09-23	41.93	
1953-09-20	40.33	
1953-09-14	40.31	
1953-07-12	26.82	
1953-06-28	31.13	
1953-06-12	23.55	
1953-06-10	21.99	
1953-06-08	20.20	
1953-06-06	21.70	
1953-06-04	21.96	
1953-06-02	21.03	
1953-05-29	19.64	
1953-05-27	19.28	
1953-05-24	18.75	
1953-05-22	18.33	
1953-05-20	18.96	
1953-05-11	17.73	
1953-05-09	17.94	
1953-05-07	17.00	
1953-05-05	16.18	
1953-05-03	15.30	
1954-01-29	23.34	
1954-01-27	22.63	
1954-01-25	21.52	
1954-01-11	19.60	
1954-01-09	20.67	
1954-01-06	20.45	
1953-12-29	20.17	
1953-12-27	17.95	
1953-12-25	18.95	
1953-12-06	21.63	
1953-12-04	22.76	
1953-12-02	21.11	
1953-11-25	23.96	
1953-11-23	22.53	
1953-11-21	24.58	
1953-11-19	25.40	
1953-11-17	25.05	
1953-11-15	24.48	
1953-11-13	25.62	
1953-11-11	25.64	
1953-11-09	25.63	
1953-11-07	27.78	
1953-11-05	27.96	
1953-11-03	27.63	
1953-11-01	27.10	
1953-10-30	28.11	
1953-10-28	27.17	
1953-10-25	28.08	
1953-10-23	31.59	
1953-10-18	31.26	
1953-10-04	41.03	
1953-09-30	41.80	
1953-09-28	41.50	
1953-09-25	49.10	
1953-09-22	42.37	
1953-09-19	42.44	
1953-08-09	32.62	
1953-07-05	26.65	
1953-06-27	28.49	
1953-06-11	23.17	
1953-06-09	21.53	
1953-06-07	20.90	
1953-06-05	21.79	
1953-06-03	21.97	
1953-05-30	19.35	
1953-05-28	19.54	
1953-05-25	16.90	
1953-05-23	19.11	
1953-05-21	18.50	
1953-05-18	17.54	
1953-05-10	17.87	
1953-05-08	17.67	
1953-05-06	17.12	
1953-05-04	15.10	
1953-05-02	15.86	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1953-05-01	15.96	
1953-04-29	15.93	
1953-04-27	14.96	
1953-04-25	15.90	
1953-04-23	16.21	
1953-04-21	15.36	
1953-04-16	16.62	
1953-04-14	15.62	
1953-04-12	15.30	
1953-04-10	16.18	
1953-04-08	16.20	
1953-04-04	16.20	
1953-04-02	16.52	
1953-03-30	15.55	
1953-03-28	16.83	
1953-03-26	16.47	
1953-03-23	15.87	
1953-03-19	17.29	
1953-03-17	16.94	
1953-03-15	15.73	
1953-03-13	16.50	
1953-03-11	16.40	
1953-03-05	16.02	
1953-02-27	16.49	
1953-02-25	16.92	
1953-02-13	17.30	
1953-02-10	17.09	
1953-02-08	17.07	
1953-02-06	17.38	
1953-02-04	17.90	
1953-01-31	17.94	
1953-01-29	18.63	
1953-01-27	26.05	
1953-01-11	18.38	
1953-01-04	17.15	
1953-01-02	15.78	
1952-12-31	17.28	
1952-12-29	16.70	
1952-12-27	16.61	
1952-12-25	17.61	
1952-12-23	18.05	
1952-12-21	17.42	
1952-12-19	18.60	
1952-12-17	18.41	
1952-12-15	18.28	
1952-12-13	19.56	
1952-12-11	19.37	
1952-12-09	18.40	
1952-12-06	19.04	
1952-12-04	19.16	
1952-12-02	19.20	
1952-11-26	19.88	
1952-11-24	19.26	
1952-11-22	21.57	
1952-11-20	21.78	
1953-04-30	15.72	
1953-04-28	15.73	
1953-04-26	15.05	
1953-04-24	16.22	
1953-04-22	15.94	
1953-04-20	14.61	
1953-04-15	15.73	
1953-04-13	15.12	
1953-04-11	16.05	
1953-04-09	16.10	
1953-04-05	14.90	
1953-04-03	16.40	
1953-03-31	15.80	
1953-03-29	15.62	
1953-03-27	16.83	
1953-03-24	16.00	
1953-03-22	16.58	
1953-03-18	17.06	
1953-03-16	16.30	
1953-03-14	16.38	
1953-03-12	16.24	
1953-03-10	16.16	
1953-03-04	15.55	
1953-02-26	16.18	
1953-02-14	16.80	
1953-02-12	17.20	
1953-02-09	16.87	
1953-02-07	17.15	
1953-02-05	17.50	
1953-02-03	16.67	
1953-01-30	18.43	
1953-01-28	18.11	
1953-01-18	18.46	
1953-01-10	18.65	
1953-01-03	17.15	
1953-01-01	17.17	
1952-12-30	17.01	
1952-12-28	16.37	
1952-12-26	16.77	
1952-12-24	18.22	
1952-12-22	17.63	
1952-12-20	18.34	
1952-12-18	18.25	
1952-12-16	18.42	
1952-12-14	18.99	
1952-12-12	19.69	
1952-12-10	19.23	
1952-12-07	17.77	
1952-12-05	19.05	
1952-12-03	19.22	
1952-11-27	19.76	
1952-11-25	19.28	
1952-11-23	20.18	
1952-11-21	21.89	
1952-11-19	21.86	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1952-11-18	21.82	
1952-11-16	22.59	
1952-11-14	22.41	
1952-11-12	22.37	
1952-11-10	21.56	
1952-11-08	22.92	
1952-11-06	23.15	
1952-11-04	23.85	
1952-11-02	24.04	
1952-10-31	25.18	
1952-10-29	25.72	
1952-10-27	25.53	
1952-10-25	27.52	
1952-10-23	27.25	
1952-10-21	27.68	
1952-10-19	27.50	
1952-10-17	27.99	
1952-10-15	27.85	
1952-10-13	27.63	
1952-10-11	29.34	
1952-10-09	28.99	
1952-10-07	28.50	
1952-10-02	30.00	
1952-09-23	29.62	
1952-09-21	29.52	
1952-09-19	30.45	
1952-09-17	30.43	
1952-09-15	30.67	
1952-09-13	32.63	
1952-09-11	31.53	
1952-09-09	30.45	
1952-09-07	30.13	
1952-09-05	29.80	
1952-09-03	29.01	
1952-09-01	30.38	
1952-08-30	31.68	
1952-08-26	30.08	
1952-08-24	29.82	
1952-08-22	30.22	
1952-08-20	29.86	
1952-08-18	30.28	
1952-08-16	30.84	
1952-08-13	29.78	
1952-08-11	28.45	
1952-08-09	29.95	
1952-08-07	29.92	
1952-08-05	28.84	
1952-08-03	29.58	
1952-08-01	30.27	
1952-07-30	29.65	
1952-07-28	29.14	
1952-07-26	28.93	
1952-07-24	28.94	
1952-07-20	27.36	
1952-07-18	28.50	
1952-11-17	21.29	
1952-11-15	22.67	
1952-11-13	22.40	
1952-11-11	22.52	
1952-11-09	22.60	
1952-11-07	23.17	
1952-11-05	23.14	
1952-11-03	24.02	
1952-11-01	25.27	
1952-10-30	25.53	
1952-10-28	25.56	
1952-10-26	26.80	
1952-10-24	27.87	
1952-10-22	27.56	
1952-10-20	28.00	
1952-10-18	27.80	
1952-10-16	28.20	
1952-10-14	28.22	
1952-10-12	27.79	
1952-10-10	28.98	
1952-10-08	28.71	
1952-10-03	29.91	
1952-10-01	30.06	
1952-09-22	29.23	
1952-09-20	30.44	
1952-09-18	30.46	
1952-09-16	30.52	
1952-09-14	32.10	
1952-09-12	33.30	
1952-09-10	32.00	
1952-09-08	29.42	
1952-09-06	30.21	
1952-09-04	29.31	
1952-09-02	28.35	
1952-08-31	31.77	
1952-08-29	32.07	
1952-08-25	29.33	
1952-08-23	30.09	
1952-08-21	30.05	
1952-08-19	30.25	
1952-08-17	30.13	
1952-08-14	29.80	
1952-08-12	29.42	
1952-08-10	29.68	
1952-08-08	29.97	
1952-08-06	29.40	
1952-08-04	28.63	
1952-08-02	30.27	
1952-07-31	29.90	
1952-07-29	29.16	
1952-07-27	28.75	
1952-07-25	28.87	
1952-07-22	28.12	
1952-07-19	27.84	
1952-07-17	28.78	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1952-07-16	27.51	
1952-07-08	25.04	
1952-06-24	26.05	
1952-06-22	26.53	
1952-06-20	27.75	
1952-06-18	27.50	
1952-06-16	25.94	
1952-06-14	25.80	
1952-06-12	25.89	
1952-06-07	25.47	
1952-06-05	23.92	
1952-05-24	23.28	
1952-05-22	23.37	
1952-05-18	21.61	
1952-05-16	22.93	
1952-05-14	21.50	
1952-05-12	20.71	
1952-05-10	22.32	
1951-12-23	21.24	
1951-12-21	21.42	
1951-12-19	21.69	
1951-12-15	21.85	
1951-12-12	21.46	
1951-12-09	21.00	
1951-12-07	21.71	
1951-12-05	21.27	
1951-10-10	25.77	
1951-10-08	25.47	
1951-10-06	26.82	
1951-10-04	26.65	
1951-10-02	25.96	
1951-09-30	24.97	
1951-09-28	26.82	
1951-09-26	26.51	
1951-09-24	26.08	
1951-09-22	27.19	
1951-09-20	27.74	
1951-09-17	25.16	
1951-09-15	27.66	
1951-09-13	27.13	
1951-09-11	25.88	
1951-09-09	25.09	
1951-09-06	24.90	
1951-09-04	23.53	
1951-09-02	21.16	
1951-08-31	25.27	
1951-08-29	26.28	
1951-08-26	27.94	
1951-08-23	29.31	
1951-08-21	28.08	
1951-08-19	26.53	
1951-08-17	28.35	
1951-08-15	28.47	
1951-08-12	28.60	
1951-08-10	28.57	
1952-07-15	27.65	
1952-07-07	25.03	
1952-06-23	25.46	
1952-06-21	27.46	
1952-06-19	27.86	
1952-06-17	27.22	
1952-06-15	25.73	
1952-06-13	25.64	
1952-06-08	24.67	
1952-06-06	25.56	
1952-05-25	23.33	
1952-05-23	23.03	
1952-05-19	21.72	
1952-05-17	22.60	
1952-05-15	22.40	
1952-05-13	21.38	
1952-05-11	21.07	
1952-05-09	22.63	
1951-12-22	21.26	
1951-12-20	21.73	
1951-12-18	21.69	
1951-12-14	21.86	
1951-12-10	20.87	
1951-12-08	21.71	
1951-12-06	21.54	
1951-12-04	21.29	
1951-10-09	25.91	
1951-10-07	26.13	
1951-10-05	27.14	
1951-10-03	26.05	
1951-10-01	25.58	
1951-09-29	26.54	
1951-09-27	26.32	
1951-09-25	26.54	
1951-09-23	25.58	
1951-09-21	27.80	
1951-09-18	26.70	
1951-09-16	26.00	
1951-09-14	27.57	
1951-09-12	27.10	
1951-09-10	25.15	
1951-09-07	25.68	
1951-09-05	24.05	
1951-09-03	20.96	
1951-09-01	24.11	
1951-08-30	25.96	
1951-08-27	26.15	
1951-08-25	29.25	
1951-08-22	28.84	
1951-08-20	27.42	
1951-08-18	28.15	
1951-08-16	28.50	
1951-08-13	28.18	
1951-08-11	28.73	
1951-08-09	28.80	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1951-08-08	28.51	
1951-08-06	27.50	
1951-08-04	29.27	
1951-08-01	30.11	
1951-07-30	28.06	
1951-07-28	28.69	
1951-07-26	28.39	
1951-07-23	26.05	
1951-07-21	26.32	
1951-07-19	25.70	
1951-07-17	25.18	
1951-07-15	24.38	
1951-07-13	24.13	
1951-07-10	23.12	
1951-07-07	21.50	
1951-07-05	18.12	
1951-07-03	22.58	
1951-07-01	22.38	
1951-06-29	23.79	
1951-06-27	23.53	
1951-06-25	23.12	
1951-06-23	23.59	
1951-06-21	23.90	
1951-06-12	21.70	
1951-06-10	20.52	
1951-06-08	21.20	
1951-06-06	22.04	
1951-06-04	20.40	
1951-06-02	20.27	
1951-05-31	19.96	
1951-05-29	19.85	
1951-05-27	18.03	
1951-05-25	20.07	
1951-05-23	19.40	
1951-05-20	19.19	
1951-05-18	18.56	
1951-05-16	18.40	
1951-05-14	16.51	
1951-05-12	15.87	
1951-05-10	15.75	
1951-05-08	14.39	
1951-05-06	11.51	
1951-05-03	14.31	
1951-05-01	11.69	
1951-04-29	8.72	
1951-04-27	12.30	
1951-04-25	11.74	
1951-04-23	10.17	
1951-04-21	12.78	
1951-04-18	12.10	
1951-04-16	9.93	
1951-04-14	11.89	
1951-04-12	12.00	
1951-04-10	11.40	
1951-04-08	9.33	
1951-08-07	28.00	
1951-08-05	28.04	
1951-08-02	30.15	
1951-07-31	28.76	
1951-07-29	28.70	
1951-07-27	28.42	
1951-07-25	27.88	
1951-07-22	25.03	
1951-07-20	26.38	
1951-07-18	25.06	
1951-07-16	24.40	
1951-07-14	24.40	
1951-07-12	24.54	
1951-07-08	21.50	
1951-07-06	20.62	
1951-07-04	22.11	
1951-07-02	22.59	
1951-06-30	23.44	
1951-06-28	23.80	
1951-06-26	23.10	
1951-06-24	23.59	
1951-06-22	23.90	
1951-06-19	23.64	
1951-06-11	21.76	
1951-06-09	21.12	
1951-06-07	21.71	
1951-06-05	21.94	
1951-06-03	20.05	
1951-06-01	19.74	
1951-05-30	20.06	
1951-05-28	19.10	
1951-05-26	20.01	
1951-05-24	19.70	
1951-05-22	19.49	
1951-05-19	19.14	
1951-05-17	17.64	
1951-05-15	17.92	
1951-05-13	14.60	
1951-05-11	16.00	
1951-05-09	15.59	
1951-05-07	13.23	
1951-05-04	14.12	
1951-05-02	13.37	
1951-04-30	9.40	
1951-04-28	12.14	
1951-04-26	12.43	
1951-04-24	11.10	
1951-04-22	8.39	
1951-04-20	12.96	
1951-04-17	11.50	
1951-04-15	8.96	
1951-04-13	11.84	
1951-04-11	12.02	
1951-04-09	9.80	
1951-04-07	12.40	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1951-04-06	12.72	
1951-04-04	12.37	
1951-04-02	10.90	
1951-03-31	13.21	
1951-03-29	12.82	
1951-03-27	11.65	
1951-03-25	10.20	
1951-03-23	13.17	
1951-03-21	13.42	
1951-03-12	12.38	
1951-03-10	14.59	
1951-03-08	15.07	
1951-03-06	13.31	
1951-03-04	13.46	
1951-03-02	14.32	
1951-02-28	12.86	
1951-02-25	10.43	
1951-02-23	14.46	
1951-02-21	13.50	
1951-02-19	11.60	
1951-02-17	15.22	
1951-02-15	15.45	
1951-02-13	15.79	
1951-02-11	10.95	
1951-02-09	15.14	
1951-02-07	14.17	
1951-02-05	12.90	
1950-12-03	12.35	
1950-12-01	15.71	
1950-11-29	15.16	
1950-11-27	10.96	
1950-11-25	15.91	
1950-11-23	16.60	
1950-11-21	16.02	
1950-11-09	17.73	
1950-11-01	20.16	
1950-10-23	16.20	
1950-10-21	21.99	
1950-10-19	22.47	
1950-10-12	23.12	
1950-10-07	24.10	
1950-10-05	23.71	
1950-10-03	23.00	
1950-10-01	22.84	
1950-09-29	23.78	
1950-09-27	24.21	
1950-09-22	24.95	
1950-09-20	24.00	
1950-09-18	20.40	
1950-09-16	23.79	
1950-09-14	24.60	
1950-09-12	24.09	
1950-09-10	22.90	
1950-09-08	24.53	
1950-09-06	22.60	
1951-04-05	12.53	
1951-04-03	12.05	
1951-04-01	11.29	
1951-03-30	13.40	
1951-03-28	12.64	
1951-03-26	10.49	
1951-03-24	13.19	
1951-03-22	13.21	
1951-03-13	13.34	
1951-03-11	10.91	
1951-03-09	14.98	
1951-03-07	14.67	
1951-03-05	12.62	
1951-03-03	14.05	
1951-03-01	13.82	
1951-02-26	11.34	
1951-02-24	14.40	
1951-02-22	13.81	
1951-02-20	12.69	
1951-02-18	10.43	
1951-02-16	15.40	
1951-02-14	15.73	
1951-02-12	13.65	
1951-02-10	14.86	
1951-02-08	14.70	
1951-02-06	13.74	
1950-12-04	11.61	
1950-12-02	15.65	
1950-11-30	15.45	
1950-11-28	15.12	
1950-11-26	12.08	
1950-11-24	15.79	
1950-11-22	16.50	
1950-11-10	16.35	
1950-11-02	20.63	
1950-10-24	19.99	
1950-10-22	17.21	
1950-10-20	22.83	
1950-10-18	22.35	
1950-10-11	23.11	
1950-10-06	23.74	
1950-10-04	23.57	
1950-10-02	21.14	
1950-09-30	24.90	
1950-09-28	24.75	
1950-09-23	24.10	
1950-09-21	25.63	
1950-09-19	23.40	
1950-09-17	20.69	
1950-09-15	24.75	
1950-09-13	24.13	
1950-09-11	21.69	
1950-09-09	24.77	
1950-09-07	23.88	
1950-09-05	18.50	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1950-09-04	19.89	
1950-09-02	26.12	
1950-08-31	25.20	
1950-08-29	23.92	
1950-08-27	22.13	
1950-08-25	25.41	
1950-08-23	24.49	
1950-08-21	19.62	
1950-08-19	24.87	
1950-08-17	24.82	
1950-08-15	22.98	
1950-08-13	20.32	
1950-08-11	23.86	
1950-08-09	23.28	
1950-08-03	22.40	
1950-08-01	21.95	
1950-07-30	21.85	
1950-07-28	22.30	
1950-07-26	21.30	
1950-07-24	19.11	
1950-07-22	20.63	
1950-07-20	20.05	
1950-07-18	20.51	
1950-07-16	19.92	
1950-07-14	21.18	
1950-07-12	20.04	
1950-07-06	14.60	
1950-07-04	15.90	
1950-07-02	19.04	
1950-06-30	21.52	
1950-06-28	20.19	
1950-06-26	19.30	
1950-06-24	20.20	
1950-06-22	18.68	
1950-06-20	17.92	
1950-06-18	16.83	
1950-06-16	18.50	
1950-06-14	17.72	
1950-06-12	16.40	
1950-06-10	17.31	
1950-06-08	16.98	
1950-06-06	15.93	
1950-06-04	14.61	
1950-06-02	13.89	
1950-05-31	12.52	
1950-05-29	11.42	
1950-05-27	11.98	
1950-05-25	12.11	
1950-05-23	9.59	
1950-05-21	7.49	
1950-05-19	7.90	
1950-05-17	5.42	
1950-05-15	2.53	
1950-05-13	7.20	
1950-05-11	7.18	
1950-09-03	21.90	
1950-09-01	25.95	
1950-08-30	24.60	
1950-08-28	21.35	
1950-08-26	25.05	
1950-08-24	25.15	
1950-08-22	23.94	
1950-08-20	20.13	
1950-08-18	24.91	
1950-08-16	23.81	
1950-08-14	19.27	
1950-08-12	24.27	
1950-08-10	23.78	
1950-08-04	22.90	
1950-08-02	22.32	
1950-07-31	21.19	
1950-07-29	22.62	
1950-07-27	22.01	
1950-07-25	20.70	
1950-07-23	19.50	
1950-07-21	20.20	
1950-07-19	20.38	
1950-07-17	19.42	
1950-07-15	21.25	
1950-07-13	20.40	
1950-07-11	18.41	
1950-07-05	16.20	
1950-07-03	17.18	
1950-07-01	22.01	
1950-06-29	20.70	
1950-06-27	19.60	
1950-06-25	19.57	
1950-06-23	19.66	
1950-06-21	18.21	
1950-06-19	16.31	
1950-06-17	18.60	
1950-06-15	17.76	
1950-06-13	17.32	
1950-06-11	16.75	
1950-06-09	17.35	
1950-06-07	16.37	
1950-06-05	15.09	
1950-06-03	14.44	
1950-06-01	13.08	
1950-05-30	12.83	
1950-05-28	11.81	
1950-05-26	12.51	
1950-05-24	11.42	
1950-05-22	6.78	
1950-05-20	8.51	
1950-05-18	6.30	
1950-05-16	5.00	
1950-05-14	3.23	
1950-05-12	7.99	
1950-05-10	5.51	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1950-05-09	4.51	
1950-05-07	2.20	
1950-05-05	4.17	
1950-05-03	2.89	
1950-05-01	-0.87	
1950-04-29	4.81	
1950-04-27	5.52	
1950-04-25	3.06	
1950-04-23	-0.31	
1950-04-21	8.05	
1950-04-19	8.01	
1950-04-17	1.43	
1950-04-15	4.01	
1950-04-13	7.42	
1950-04-11	3.91	
1950-04-09	1.20	
1950-04-07	6.70	
1950-04-05	7.97	
1950-04-03	3.77	
1950-04-01	7.37	
1950-03-30	8.85	
1950-03-28	5.66	
1950-03-26	3.20	
1950-03-24	8.89	
1950-03-22	7.55	
1950-03-20	4.21	
1950-03-18	8.38	
1950-03-16	10.15	
1950-03-05	8.94	
1950-03-03	12.34	
1950-03-01	11.97	
1949-12-06	5.18	
1949-12-04	2.28	
1949-12-02	7.82	
1949-11-30	6.51	
1949-11-28	0.90	
1949-11-26	4.00	
1949-11-24	6.90	
1949-11-22	6.77	
1949-11-20	3.90	
1949-11-18	9.55	
1949-11-14	3.42	
1949-11-12	10.30	
1949-11-10	10.78	
1949-11-08	9.62	
1949-11-06	7.10	
1949-11-04	8.28	
1949-11-02	8.13	
1949-10-31	4.40	
1949-10-29	9.75	
1949-10-27	10.01	
1949-10-25	9.72	
1949-10-23	7.65	
1949-10-21	14.65	
1949-10-19	12.69	

Date	Feet below Surface	Feet to Sealevel
1950-05-08	1.31	
1950-05-06	4.37	
1950-05-04	3.52	
1950-05-02	3.20	
1950-04-30	0.21	
1950-04-28	6.21	
1950-04-26	4.37	
1950-04-24	-1.33	
1950-04-22	2.37	
1950-04-20	8.30	
1950-04-18	6.81	
1950-04-16	2.00	
1950-04-14	8.16	
1950-04-12	6.32	
1950-04-10	0.11	
1950-04-08	4.86	
1950-04-06	7.04	
1950-04-04	6.93	
1950-04-02	4.58	
1950-03-31	9.15	
1950-03-29	8.13	
1950-03-27	2.38	
1950-03-25	5.50	
1950-03-23	8.70	
1950-03-21	7.32	
1950-03-19	5.41	
1950-03-17	9.50	
1950-03-06	8.50	
1950-03-04	11.40	
1950-03-02	12.30	
1950-02-28	11.47	
1949-12-05	1.23	
1949-12-03	4.67	
1949-12-01	7.08	
1949-11-29	5.08	
1949-11-27	2.00	
1949-11-25	5.71	
1949-11-23	6.90	
1949-11-21	3.26	
1949-11-19	5.91	
1949-11-17	9.13	
1949-11-13	4.98	
1949-11-11	11.28	
1949-11-09	9.97	
1949-11-07	6.19	
1949-11-05	8.29	
1949-11-03	7.80	
1949-11-01	7.41	
1949-10-30	6.00	
1949-10-28	10.44	
1949-10-26	10.05	
1949-10-24	6.31	
1949-10-22	11.85	
1949-10-20	13.20	
1949-10-18	11.54	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1949-10-17	8.55	
1949-10-15	12.50	
1949-10-13	14.28	
1949-10-11	13.63	
1949-10-09	11.15	
1949-10-07	15.99	
1949-09-28	14.67	
1949-09-26	9.85	
1949-09-24	13.45	
1949-09-22	15.00	
1949-09-20	15.50	
1949-09-18	14.10	
1949-09-16	15.10	
1949-09-14	15.87	
1949-09-12	13.80	
1949-09-10	15.32	
1949-09-08	14.18	
1949-09-06	8.63	
1949-09-04	12.20	
1949-09-02	16.55	
1949-08-29	15.28	
1949-08-27	16.15	
1949-08-25	15.75	
1949-08-23	15.30	
1949-08-21	12.85	
1949-08-19	16.95	
1949-08-16	15.70	
1949-08-14	14.90	
1949-08-12	15.80	
1949-08-10	15.65	
1949-08-07	11.85	
1949-08-05	14.65	
1949-08-03	13.50	
1949-07-28	12.98	
1949-07-26	12.62	
1949-07-22	12.98	
1949-07-20	12.79	
1949-07-18	9.82	
1949-07-16	11.80	
1949-07-14	11.60	
1949-07-12	9.52	
1949-07-09	7.65	
1949-07-07	8.75	
1949-07-05	8.90	
1949-07-03	9.80	
1949-07-01	12.40	
1949-06-29	11.23	
1949-06-13	7.54	
1949-06-11	8.65	
1949-06-09	7.68	
1949-06-07	5.83	
1949-06-05	4.77	
1949-06-03	5.59	
1949-06-01	3.69	
1949-05-30	-0.02	
1949-10-16	10.45	
1949-10-14	14.80	
1949-10-12	13.79	
1949-10-10	10.21	
1949-10-08	13.60	
1949-10-06	15.21	
1949-09-27	13.92	
1949-09-25	10.89	
1949-09-23	14.48	
1949-09-21	15.59	
1949-09-19	13.63	
1949-09-17	14.60	
1949-09-15	16.00	
1949-09-13	15.15	
1949-09-11	14.05	
1949-09-09	14.47	
1949-09-07	13.90	
1949-09-05	9.40	
1949-09-03	16.60	
1949-09-01	14.88	
1949-08-28	11.35	
1949-08-26	16.25	
1949-08-24	15.60	
1949-08-22	13.00	
1949-08-20	15.90	
1949-08-18	16.43	
1949-08-15	13.28	
1949-08-13	16.00	
1949-08-11	15.90	
1949-08-08	11.55	
1949-08-06	14.29	
1949-08-04	14.18	
1949-07-29	13.60	
1949-07-27	12.78	
1949-07-23	12.70	
1949-07-21	12.85	
1949-07-19	12.29	
1949-07-17	10.17	
1949-07-15	11.80	
1949-07-13	11.60	
1949-07-10	7.92	
1949-07-08	8.58	
1949-07-06	9.38	
1949-07-04	9.28	
1949-07-02	10.70	
1949-06-30	11.78	
1949-06-28	11.08	
1949-06-12	7.69	
1949-06-10	8.45	
1949-06-08	6.71	
1949-06-06	2.18	
1949-06-04	5.92	
1949-06-02	5.20	
1949-05-31	-0.43	
1949-05-29	0.31	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1949-05-28	1.80	
1949-05-26	2.85	
1949-05-24	3.89	
1949-05-22	1.12	
1949-05-20	3.48	
1949-05-18	4.25	
1949-05-16	-1.05	
1949-05-14	0.99	
1949-05-12	1.60	
1949-05-10	0.92	
1949-05-04	0.75	
1949-05-02	-5.90	
1949-04-30	-2.52	
1949-04-28	-0.20	
1949-04-26	-2.08	
1949-04-24	-4.90	
1949-04-22	0.03	
1949-04-20	-0.38	
1949-04-18	-5.00	
1949-04-16	-2.47	
1949-04-14	-0.73	
1949-04-12	-2.04	
1949-04-10	-5.08	
1949-04-08	0.03	
1949-04-06	-1.20	
1949-04-04	-5.89	
1949-04-02	-3.98	
1949-03-31	-0.69	
1949-03-29	-1.70	
1949-03-27	-4.32	
1949-03-25	0.50	
1949-03-23	0.38	
1949-03-21	-4.32	
1949-03-19	-1.54	
1949-03-17	2.50	
1949-03-15	1.23	
1949-03-13	-1.52	
1949-03-11	2.57	
1949-03-09	2.72	
1949-03-07	-3.55	
1949-03-05	1.52	
1949-03-03	2.33	
1949-03-01	1.27	
1949-02-25	2.40	
1949-02-23	2.38	
1949-02-20	-2.10	
1949-02-18	1.78	
1949-02-16	1.22	
1949-02-14	-3.40	
1949-02-12	-1.12	
1949-02-10	2.60	
1949-01-18	-0.10	
1949-01-16	-2.23	
1949-01-14	1.98	
1949-01-08	0.36	

Date	Feet below Surface	Feet to Sealevel
1949-05-27	3.81	
1949-05-25	3.08	
1949-05-23	0.95	
1949-05-21	2.00	
1949-05-19	4.36	
1949-05-17	3.94	
1949-05-15	-0.77	
1949-05-13	2.80	
1949-05-11	0.85	
1949-05-05	2.10	
1949-05-03	-1.90	
1949-05-01	-5.44	
1949-04-29	-0.20	
1949-04-27	-0.59	
1949-04-25	-5.47	
1949-04-23	-3.66	
1949-04-21	-0.05	
1949-04-19	-1 38	
1949-04-17	-4.70	
1949-04-15	-0.52	
1949-04-13	-1.55	
1949-04-11	-5.53	
1949-04-09	-3.50	
1949-04-07	-0.49	
1949-04-05	-2.72	
1949-04-03	-5.46	
1949-04-01	-0.17	
1949-03-30	-0.68	
1949-03-28	-4.82	
1949-03-26	-2.80	
1949-03-24	0.74	
1949-03-22	-0.80	
1949-03-20	-3.58	
1949-03-18	1.76	
1949-03-16	2.21	
1949-03-14	-2.54	
1949-03-12	0.35	
1949-03-10	3.05	
1949-03-08	2.11	
1949-03-06	-1.80	
1949-03-04	2.68	
1949-03-02	1.85	
1949-02-26	0.90	
1949-02-24	1.55	
1949-02-22	1.12	
1949-02-19	0.60	
1949-02-17	2.03	
1949-02-15	0.07	
1949-02-13	-2.87	
1949-02-11	2.70	
1949-01-19	0.42	
1949-01-17	-2.68	
1949-01-15	-1.13	
1949-01-09	-0.91	
1949-01-07	0.75	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1949-01-06	0.96	
1949-01-04	0.73	
1948-12-28	-0.13	
1948-12-26	-2.75	
1948-12-24	-0.96	
1948-12-22	3.19	
1948-12-20	-1.98	
1948-12-18	1.95	
1948-12-16	3.82	
1948-12-14	2.37	
1948-12-12	-1.48	
1948-12-10	2.25	
1948-12-08	1.33	
1948-12-06	-3.01	
1948-12-04	0.28	
1948-12-02	2.15	
1948-11-30	1.78	
1948-11-28	0.26	
1948-11-26	2.51	
1948-11-24	2.41	
1948-11-22	-1.44	
1948-11-20	2.05	
1948-11-18	4.44	
1948-11-16	3.29	
1948-11-14	1.23	
1948-11-12	6.35	
1948-11-10	6.09	
1948-11-08	2.09	
1948-11-06	6.32	
1948-11-04	8.13	
1948-11-02	7.01	
1948-10-31	6.02	
1948-10-29	8.40	
1948-10-27	8.39	
1948-10-25	4.02	
1948-10-23	8.73	
1948-10-21	9.00	
1948-10-19	8.60	
1948-10-17	6.27	
1948-10-15	9.71	
1948-10-13	8.83	
1948-10-11	4.29	
1948-10-09	10.01	
1948-10-07	11.21	
1948-10-05	9.68	
1948-10-03	8.67	
1948-10-01	12.31	
1948-09-29	12.28	
1948-09-27	10.83	
1948-09-25	12.01	
1948-09-23	11.68	
1948-09-21	12.00	
1948-09-19	11.57	
1948-09-17	12.73	
1948-09-15	12.60	

Date	Feet below Surface	Feet to Sealevel
1949-01-05	1.00	
1948-12-29	1.00	
1948-12-27	-2.93	
1948-12-25	-2.01	
1948-12-23	3.00	
1948-12-21	1.88	
1948-12-19	-1.26	
1948-12-17	3.91	
1948-12-15	2.88	
1948-12-13	-2.32	
1948-12-11	1.77	
1948-12-09	1.80	
1948-12-07	0.27	
1948-12-05	-2.66	
1948-12-03	2.18	
1948-12-01	2.30	
1948-11-29	-0.10	
1948-11-27	1.45	
1948-11-25	2.77	
1948-11-23	1.70	
1948-11-21	-1.00	
1948-11-19	4.23	
1948-11-17	4.22	
1948-11-15	0.32	
1948-11-13	5.30	
1948-11-11	6.07	
1948-11-09	5.51	
1948-11-07	2.58	
1948-11-05	8.33	
1948-11-03	8.41	
1948-11-01	4.20	
1948-10-30	8.33	
1948-10-28	8.83	
1948-10-26	7.58	
1948-10-24	5.12	
1948-10-22	8.83	
1948-10-20	9.40	
1948-10-18	5.76	
1948-10-16	10.25	
1948-10-14	9.56	
1948-10-12	8.17	
1948-10-10	5.25	
1948-10-08	10.45	
1948-10-06	10.80	
1948-10-04	7.08	
1948-10-02	10.85	
1948-09-30	12.56	
1948-09-28	11.66	
1948-09-26	11.65	
1948-09-24	11.60	
1948-09-22	11.51	
1948-09-20	11.44	
1948-09-18	12.51	
1948-09-16	12.76	
1948-09-14	12.60	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1948-09-13	11.98	
1948-09-11	11.92	
1948-09-09	11.97	
1948-09-07	8.42	
1948-09-05	9.37	
1948-09-03	13.50	
1948-09-01	13.66	
1948-08-30	13.05	
1948-08-28	14.18	
1948-08-26	13.80	
1948-08-24	10.76	
1948-08-22	9.56	
1948-08-20	12.29	
1948-08-18	12.49	
1948-08-16	11.00	
1948-08-14	11.81	
1948-08-12	11.71	
1948-08-10	11.00	
1948-08-08	9.77	
1948-08-06	10.51	
1948-08-04	10.80	
1948-08-02	9.77	
1948-07-31	11.10	
1948-07-29	12.18	
1948-07-27	11.86	
1948-07-25	11.23	
1948-07-23	11.66	
1948-07-21	11.45	
1948-07-19	11.11	
1948-07-17	11.50	
1948-07-15	10.72	
1948-07-13	9.33	
1948-07-11	5.85	
1948-07-09	2.00	
1948-07-07	5.09	
1948-07-05	8.54	
1948-07-03	10.90	
1948-07-01	11.23	
1948-06-29	10.51	
1948-06-27	8.86	
1948-06-25	11.74	
1948-06-23	10.12	
1948-06-21	6.19	
1948-06-19	10.34	
1948-06-17	10.96	
1948-06-15	9.10	
1948-06-13	7.00	
1948-06-11	10.47	
1948-06-09	8.93	
1948-06-07	5.22	
1948-06-05	9.96	
1948-06-03	9.96	
1948-06-01	5.90	
1948-05-30	5.27	
1948-05-28	6.21	
1948-09-12	11.75	
1948-09-10	12.19	
1948-09-08	11.13	
1948-09-06	8.64	
1948-09-04	10.75	
1948-09-02	13.28	
1948-08-31	13.58	
1948-08-29	13.37	
1948-08-27	14.58	
1948-08-25	12.94	
1948-08-23	9.10	
1948-08-21	12.00	
1948-08-19	12.21	
1948-08-17	12.23	
1948-08-15	11.22	
1948-08-13	11.95	
1948-08-11	11.11	
1948-08-09	9.59	
1948-08-07	10.53	
1948-08-05	10.23	
1948-08-03	10.96	
1948-08-01	9.32	
1948-07-30	11.90	
1948-07-28	12.23	
1948-07-26	11.20	
1948-07-24	11.37	
1948-07-22	11.92	
1948-07-20	11.21	
1948-07-18	11.52	
1948-07-16	11.18	
1948-07-14	10.43	
1948-07-12	5.70	
1948-07-10	5.33	
1948-07-08	3.41	
1948-07-06	8.19	
1948-07-04	9.45	
1948-07-02	11.34	
1948-06-30	11.50	
1948-06-28	8.36	
1948-06-26	11.05	
1948-06-24	11.00	
1948-06-22	9.43	
1948-06-20	7.32	
1948-06-18	10.61	
1948-06-16	9.93	
1948-06-14	6.34	
1948-06-12	9.05	
1948-06-10	9.60	
1948-06-08	8.26	
1948-06-06	5.87	
1948-06-04	10.50	
1948-06-02	7.68	
1948-05-31	3.89	
1948-05-29	5.94	
1948-05-27	5.62	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1948-05-26	4.60	
1948-05-24	-0.13	
1948-05-22	6.09	
1948-05-20	4.68	
1948-05-18	3.65	
1948-05-16	1.25	
1948-05-14	2.96	
1948-05-12	1.82	
1948-05-10	-2.45	
1948-05-08	2.49	
1948-05-06	3.84	
1948-05-04	2.99	
1948-05-02	-1.28	
1948-04-30	2.55	
1948-04-28	2.96	
1948-04-26	1.58	
1948-04-24	4.22	
1948-04-22	3.33	
1948-04-20	2.41	
1948-04-18	-1.90	
1948-04-16	3.07	
1948-04-14	2.20	
1948-04-12	-3.32	
1948-04-10	0.70	
1948-04-08	1.94	
1948-04-06	0.96	
1948-04-04	-2.03	
1948-04-02	3.97	
1948-03-31	3.04	
1948-03-29	-3.61	
1948-03-27	2.49	
1948-03-25	2.41	
1948-03-23	-1.58	
1948-03-21	-1.19	
1948-03-19	1.31	
1948-03-17	1.89	
1948-03-15	0.57	
1948-03-13	3.23	
1948-03-11	2.72	
1948-03-09	1.32	
1948-03-07	-2.34	
1948-03-05	3.70	
1948-03-03	2.53	
1948-03-01	-2.85	
1948-02-28	2.11	
1948-02-26	1.75	
1948-02-24	0.63	
1948-02-22	-1.81	
1948-02-20	2.89	
1948-02-18	2.20	
1948-02-16	0.82	
1948-02-14	1.83	
1948-02-12	1.72	
1948-02-10	0.88	
1948-02-08	-3.07	
1948-05-25	2.64	
1948-05-23	1.89	
1948-05-21	5.89	
1948-05-19	3.01	
1948-05-17	0.50	
1948-05-15	3.95	
1948-05-13	3.70	
1948-05-11	1.21	
1948-05-09	-2.04	
1948-05-07	3.11	
1948-05-05	3.01	
1948-05-03	-2.00	
1948-05-01	2.57	
1948-04-29	2.45	
1948-04-27	3.30	
1948-04-25	2.52	
1948-04-23	3.51	
1948-04-21	3.23	
1948-04-19	-0.87	
1948-04-17	1.37	
1948-04-15	2.71	
1948-04-13	1.63	
1948-04-11	-2.42	
1948-04-09	2.50	
1948-04-07	1.92	
1948-04-05	-2.77	
1948-04-03	1.74	
1948-04-01	3.98	
1948-03-30	1.83	
1948-03-28	-2.59	
1948-03-26	2.06	
1948-03-24	1.05	
1948-03-22	-2.45	
1948-03-20	2.10	
1948-03-18	1.97	
1948-03-16	0.97	
1948-03-14	-2.05	
1948-03-12	2.84	
1948-03-10	2.53	
1948-03-08	-3.21	
1948-03-06	2.71	
1948-03-04	3.27	
1948-03-02	1.77	
1948-02-29	-2.06	
1948-02-27	2.16	
1948-02-25	1.71	
1948-02-23	-2.69	
1948-02-21	2.19	
1948-02-19	1.79	
1948-02-17	2.45	
1948-02-15	-1.30	
1948-02-13	1.43	
1948-02-11	1.60	
1948-02-09	-3.99	
1948-02-07	0.12	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1948-02-06	1.39	
1948-02-04	0.15	
1948-02-02	-3.16	
1948-01-31	3.18	
1948-01-29	2.79	
1948-01-27	1.47	
1948-01-22	1.69	
1948-01-20	0.72	
1948-01-12	-3.55	
1948-01-10	2.35	
1948-01-08	1.60	
1948-01-06	1.38	
1948-01-04	-2.02	
1948-01-02	2.47	
1947-12-31	-2.55	
1947-12-29	-4.03	
1947-12-27	-1.17	
1947-12-25	-2.56	
1947-12-23	-2.07	
1947-12-21	-0.09	
1947-12-19	-4.12	
1947-12-17	-3.51	
1947-12-15	-0.63	
1947-12-13	-4.67	
1947-12-11	-4.70	
1947-12-09	-4.25	
1947-12-07	-1.08	
1947-12-05	-5.79	
1947-12-03	-5.41	
1947-11-28	-5.34	
1947-11-26	-4.31	
1947-11-24	-0.37	
1947-11-22	-5.69	
1947-11-20	-6.90	
1947-11-18	-5.03	
1947-11-16	-2.67	
1947-11-14	-7.27	
1947-11-12	-5.29	
1947-11-10	-4.65	
1947-11-08	-9.42	
1947-11-06	-13.38	
1947-11-04	-12.99	
1947-10-28	-14.05	
1947-10-26	-12.86	
1947-10-24	-15.59	
1947-10-22	-14.23	
1947-10-20	-12.05	
1947-10-18	-15.53	
1947-10-16	-16.05	
1947-10-14	-15.08	
1947-10-12	-14.30	
1947-10-10	-15.77	
1947-10-08	-15.61	
1947-10-06	-12.25	
1947-10-04	-13.74	
1948-02-05	0.92	
1948-02-03	-1.18	
1948-02-01	-2.20	
1948-01-30	3.30	
1948-01-28	2.03	
1948-01-23	2.11	
1948-01-21	1.48	
1948-01-13	1.25	
1948-01-11	-2.60	
1948-01-09	1.70	
1948-01-07	1.35	
1948-01-05	-3.08	
1948-01-03	2.35	
1948-01-01	2.87	
1947-12-30	-0.82	
1947-12-28	-3.08	
1947-12-26	-3.31	
1947-12-24	-0.31	
1947-12-22	-0.90	
1947-12-20	-4.05	
1947-12-18	-4.18	
1947-12-16	-2.54	
1947-12-14	-0.18	
1947-12-12	-4.95	
1947-12-10	-4.89	
1947-12-08	-0.32	
1947-12-06	-6.19	
1947-12-04	-5.99	
1947-12-02	-4.50	
1947-11-27	-4.91	
1947-11-25	-3.45	
1947-11-23	-1.17	
1947-11-21	-7.43	
1947-11-19	-6.20	
1947-11-17	-2.19	
1947-11-15	-5.50	
1947-11-13	-6.58	
1947-11-11	-5.48	
1947-11-09	-5.73	
1947-11-07	-10.91	
1947-11-05	-13.50	
1947-10-29	-14.06	
1947-10-27	-12.13	
1947-10-25	-15.64	
1947-10-23	-15.34	
1947-10-21	-13.99	
1947-10-19	-12.62	
1947-10-17	-15.44	
1947-10-15	-15.88	
1947-10-13	-13.17	
1947-10-11	-15.82	
1947-10-09	-15.68	
1947-10-07	-14.77	
1947-10-05	-12.69	
1947-10-03	-12.24	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1947-10-02	-10.93	
1947-09-30	-11.43	
1947-09-28	-11.45	
1947-09-26	-16.15	
1947-09-24	-17.10	
1947-09-22	-16.18	
1947-09-20	-17.32	
1947-09-18	-17.13	
1947-09-16	-15.73	
1947-09-14	-14.83	
1947-09-12	-17.00	
1947-09-10	-16.10	
1947-09-08	-14.66	
1947-09-06	-16.53	
1947-09-04	-15.88	
1947-09-02	-13.51	
1947-08-31	-15.20	
1947-08-29	-16.68	
1947-08-27	-16.61	
1947-08-25	-17.43	
1947-08-17	-17.04	
1947-08-15	-18.70	
1947-08-13	-18.17	
1947-08-11	-17.28	
1947-08-08	-16.57	
1947-08-06	-15.29	
1947-08-04	-12.24	
1947-08-02	-13.93	
1947-07-31	-14.20	
1947-07-29	-12.62	
1947-07-27	-11.78	
1947-07-25	-13.43	
1947-07-23	-11.21	
1947-07-21	-8.72	
1947-07-19	-12.02	
1947-07-17	-11.18	
1947-07-15	-10.27	
1947-07-13	-8.75	
1947-07-11	-10.57	
1947-07-09	-9.74	
1947-07-07	-8.60	
1947-07-05	-3.33	
1947-07-03	-3.23	
1947-07-01	-5.20	
1947-06-27	-9.34	
1947-06-25	-8.98	
1947-06-16	-2.80	
1947-06-14	-6.08	
1947-06-12	-5.93	
1947-06-10	-5.42	
1947-06-08	-4.64	
1947-06-06	-5.39	
1947-06-04	-3.26	
1947-06-02	-0.01	
1947-05-31	-3.32	
1947-10-01	-11.18	
1947-09-29	-10.19	
1947-09-27	-15.99	
1947-09-25	-16.53	
1947-09-23	-15.15	
1947-09-21	-16.90	
1947-09-19	-17.57	
1947-09-17	-15.86	
1947-09-15	-13.82	
1947-09-13	-16.73	
1947-09-11	-16.41	
1947-09-09	-15.03	
1947-09-07	-15.49	
1947-09-05	-16.22	
1947-09-03	-15.35	
1947-09-01	-14.03	
1947-08-30	-16.50	
1947-08-28	-16.90	
1947-08-26	-16.63	
1947-08-18	-15.92	
1947-08-16	-18.73	
1947-08-14	-18.57	
1947-08-12	-17.23	
1947-08-09	-17.00	
1947-08-07	-15.61	
1947-08-05	-14.69	
1947-08-03	-13.03	
1947-08-01	-14.28	
1947-07-30	-13.20	
1947-07-28	-11.72	
1947-07-26	-13.50	
1947-07-24	-12.33	
1947-07-22	-10.75	
1947-07-20	-9.54	
1947-07-18	-12.23	
1947-07-16	-10.75	
1947-07-14	-8.33	
1947-07-12	-10.35	
1947-07-10	-10.55	
1947-07-08	-9.08	
1947-07-06	-3.17	
1947-07-04	-3.78	
1947-07-02	-4.62	
1947-06-30	-6.50	
1947-06-26	-9.29	
1947-06-24	-8.22	
1947-06-15	-4.30	
1947-06-13	-6.30	
1947-06-11	-7.03	
1947-06-09	-4.05	
1947-06-07	-6.53	
1947-06-05	-4.99	
1947-06-03	-2.74	
1947-06-01	-2.32	
1947-05-30	-3.48	

Ground-water levels, continued.

Date	Feet below Surface	Feet to Sealevel
1947-05-29	-3.21	
1947-05-27	-2.99	
1947-05-25	-3.15	
1947-05-23	-4.35	
1947-05-21	-3.53	
1947-05-19	-1.19	
1947-05-17	-3.73	
1947-05-15	-2.13	
1947-05-13	-1.70	
1947-05-11	-1.68	
1947-05-09	-0.88	
1947-05-07	-1.33	
1947-05-05	-0.18	
1947-04-28	-6.21	
1947-04-26	-3.57	
1947-04-24	-3.11	
1947-04-22	-3.47	
1947-04-20	-5.20	
1947-04-18	-2.24	
1947-04-16	-2.49	
1947-04-14	-6.30	
1947-04-12	-1.61	
1947-04-10	-2.84	
1947-04-08	-5.47	
1947-04-06	-6.10	
1947-04-04	-2.46	
1947-04-02	-2.45	
1947-01-21	-2.33	
1947-01-19	-2.92	
1947-01-17	-1.01	
1947-01-15	-1.20	
1947-01-13	-3.61	
1947-01-11	-2.62	
1947-01-09	-2.06	
1947-01-07	-1.35	
1946-12-31	-0.38	
1946-12-29	-1.70	
1946-12-27	-1.82	
1946-12-25	-4.24	
1946-12-23	-0.27	
1946-12-21	-0.54	
1946-12-19	-0.67	
1946-12-17	-0.20	
1946-12-15	-0.65	
1946-12-13	-0.97	
1946-12-11	-0.06	
1946-12-09	-2.36	
1946-12-07	-0.18	
1946-12-05	-0.88	
1946-12-28	-0.77	
1946-12-26	-4.48	
1946-12-24	-2.30	
1946-12-22	-0.25	
1946-12-20	-0.97	
1946-12-18	-0.25	
1946-12-16	-0.83	
1946-12-14	-0.25	
1946-12-12	-0.57	
1946-12-10	-1.18	
1946-12-08	-1.86	
1946-12-06	-0.76	
1946-12-04	-1.30	

12
East
1/2 - 1 Mile
Lower

FED USGS **USGS2391155**

Agency cd:	USGS	Site no:	441654088154901
Site name:	OU-21/18E/24-0042		
Latitude:	441654	EDR Site id:	USGS2391155
Longitude:	0881549	Dec lat:	44.28165431
Dec lon:	-88.26371693	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NESESWS24 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	650.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	10		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	714	Hole depth:	714
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	1934-09-00	Ground water data end date:	1934-09-00
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1934-09		

Note: The site was flowing, but the head could not be measured without additional equipment.

13
South
1/2 - 1 Mile
Higher

FED USGS **USGS2391121**

Agency cd:	USGS	Site no:	441617088162101
Site name:	OU-21/18E/25-0047		
Latitude:	441617	EDR Site id:	USGS2391121
Longitude:	0881621	Dec lat:	44.27137642
Dec lon:	-88.272606	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NWNWS25 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000

Altitude:	704.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	5		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	545	Hole depth:	545
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	1945-01-01	Ground water data end date:	1945-02-23
Ground water data count:	2		

Ground-water levels, Number of Measurements: 2

Date	Feet below Surface	Feet to Sealevel	Date	Feet below Surface	Feet to Sealevel
1945-02-23	44.75		1945-01-01	48.00	

14
SSW
1/2 - 1 Mile
Higher

FED USGS **USGS2391122**

Agency cd:	USGS	Site no:	441618088164901
Site name:	OU-21/18E/23-0046		
Latitude:	441618	EDR Site id:	USGS2391122
Longitude:	0881649	Dec lat:	44.27165415
Dec lon:	-88.28038381	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	NESESES23 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	720.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	5		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Flat surface		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	568	Hole depth:	568
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00

Peak flow data count: 0
Water quality data end date: 0000-00-00
Ground water data begin date: 1945-01-01
Ground water data count: 2
Water quality data begin date: 0000-00-00
Water quality data count: 0
Ground water data end date: 1945-02-00

Ground-water levels, Number of Measurements: 2

Date	Feet below Surface	Feet to Sealevel	Date	Feet below Surface	Feet to Sealevel
1945-02	69		1945-01-01	61.00	

15
WSW
1/2 - 1 Mile
Higher

FED USGS **USGS2391145**

Agency cd:	USGS	Site no:	441636088173001
Site name:	OU-21/18E/23-0102		
Latitude:	441636	EDR Site id:	USGS2391145
Longitude:	0881730	Dec lat:	44.27665408
Dec lon:	-88.29177268	Coor meth:	M
Coor accr:	F	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	SWNWSWS23 T021N R018E 4
Location map:	APPLETON	Map scale:	62500
Altitude:	650.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	10		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	302	Hole depth:	302
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

E16
NE
1/2 - 1 Mile
Higher

FED USGS **USGS2391183**

Agency cd:	WI001	Site no:	441727088154504
Site name:	USER 1493 6		
Latitude:	441727	EDR Site id:	USGS2391183
Longitude:	0881545	Dec lat:	44.29082103
Dec lon:	-88.26260569	Coor meth:	M
Coor accr:	M	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	Not Reported		
Altitude method:	Not Reported		
Altitude accuracy:	Not Reported		
Altitude datum:	Not Reported		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	Not Reported	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

E17
NE
1/2 - 1 Mile
Higher

FED USGS **USGS2391182**

Agency cd:	USGS	Site no:	441727088154501
Site name:	OU-21/18E/13-0299		
Latitude:	441727	EDR Site id:	USGS2391182
Longitude:	0881545	Dec lat:	44.29082103
Dec lon:	-88.26260569	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	55
State:	55	County:	087
Country:	US	Land net:	SENESWS13 T021N R018E 4
Location map:	KAUKAUNA	Map scale:	24000
Altitude:	710.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	5		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Lower Fox. Wisconsin. Area = 438 sq.mi.		
Topographic:	Flat surface		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	CST

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	602	Hole depth:	602
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	1959-01-01	Ground water data end date:	1959-01-01
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1959-01-01	75.00	

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

State Database: WI Radon

Radon Test Results

Zip	Total Sites	4 - 10 (pCi/L)	> 10 pCi/L	Avg.	Max.
54130	93	27	8	4.7	35.9

Federal EPA Radon Zone for OUTAGAMIE County: 2

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for Zip Code: 54130

Number of sites tested: 3

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	Not Reported	Not Reported	Not Reported	Not Reported
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	1.600 pCi/L	100%	0%	0%

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Scanned Digital USGS 7.5' Topographic Map (DRG)
Source: United States Geologic Survey
A digital raster graphic (DRG) is a scanned image of a U.S. Geological Survey topographic map. The map images are made by scanning published paper maps on high-resolution scanners. The raster image is georeferenced and fit to the Universal Transverse Mercator (UTM) projection.

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 and 2005 from the U.S. Fish and Wildlife Service.

HYDROGEOLOGIC INFORMATION

AQUIFLOW^{R} Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Services
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Services (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Services, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

Wisconsin Well Construction Report File
Source: Department of Natural Resources
Telephone: 608-266-0153
In the past, not all latitude/longitudes were accurate. Many were protracted from centroid (center of the quarter sections given in PLSS). The ones that were not accurate were removed from the well database.

OTHER STATE DATABASE INFORMATION

RADON

State Database: WI Radon
Source: Department of Health & Family Services
Telephone: 608-266-1865
Wisconsin Measurement Summary

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STREET AND ADDRESS INFORMATION

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Fox Shores Apartments
400 Fox Shore Drive
Kaukauna, WI 54130

Inquiry Number: 2655083.6
December 23, 2009

The EDR-City Directory Abstract

Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
800.352.0050
www.edrnet.com

TABLE OF CONTENTS

SECTION

Executive Summary

Findings

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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2009 Enhancements to EDR City Directory Abstract

New for 2009, the EDR City Directory Abstract has been enhanced with additional information and features. These enhancements will make your city directory research process more efficient, flexible, and insightful than ever before. The enhancements will improve the options for selecting adjoining properties, and will speed up your review of the report.

City Directory Report. Three important enhancements have been made to the EDR City Directory Abstract:

1. *Executive Summary.* The report begins with an Executive Summary that lists the sources consulted in the preparation of the report. Where available, a parcel map is also provided within the report, showing the locations of properties researched.

2. *Page Images.* Where available, the actual page source images will be included in the Appendix, so that you can review them for information that may provide additional insight. EDR has copyright permission to include these images.

3. *Findings Listed by Location.* Another useful enhancement is that findings are now grouped by address. This will significantly reduce the time you need to review your abstracts. Findings are provided under each property address, listed in reverse chronological order and referencing the source for each entry.

Options for Selecting Adjoining Properties. Ensuring that the right adjoining property addresses are searched is one of the biggest challenges that environmental professionals face when conducting city directory historical research. EDR's new enhancements make it easier for you to meet this challenge. Now, when you place an order for the EDR City Directory Abstract, you have the following choices for determining which addresses should be researched.

1. *You Select Addresses and EDR Selects Addresses.* Use the "Add Another Address" feature to specify the addresses you want researched. Your selections will be supplemented by addresses selected by EDR researchers using our established research methods. Where available, a digital map will be shown, indicating property lines overlaid on a color aerial photo and their corresponding addresses. Simply use the address list below the map to check off which properties shown on the map you want to include. You may also select other addresses using the "Add Another Address" feature at the bottom of the list.

2. *EDR Selects Addresses.* Choose this method if you want EDR's researchers to select the addresses to be researched for you, using our established research methods.

3. *You Select Addresses.* Use this method for research based solely on the addresses you select or enter into the system.

4. *Hold City Directory Research Option.* If you choose to select your own adjoining addresses, you may pause production of your EDR City Directory Abstract report until you have had a chance to look at your other EDR reports and sources. Sources for property addresses include: your Certified Sanborn Map Report may show you the location of property addresses; the new EDR Property Tax Map Report may show the location of property addresses; and your field research can supplement these sources with additional address information. To use this capability, simply click "Hold City Directory research" box under "Other Options" at the bottom of the page. Once you have determined what addresses you want researched, go to your EDR Order Status page, select the EDR City Directory Abstract, and enter the addresses and submit for production.

Questions? Contact your EDR representative at 800-352-0050. For more information about all of EDR's 2009 report and service enhancements, visit www.edrnet.com/2009enhancements

EXECUTIVE SUMMARY

DESCRIPTION

Environmental Data Resources, Inc.'s (EDR) City Directory Abstract is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's City Directory Abstract includes a search and abstract of available city directory data. For each address, the directory lists the name of the corresponding occupant at five year intervals.

RESEARCH SUMMARY

The following research sources were consulted in the preparation of this report. An "X" indicates where information was identified in the source and provided in this report.

Year	Source	TP	Adjoining	Text Abstract	Source Image
2009	Polk's City Directory	X	X	X	-
2004	Polk's City Directory	X	X	X	-
1999	Polk's City Directory	X	X	X	-
1994	Polk's City Directory	X	X	X	-
1990	Johnson's City Directory	-	X	X	-

FINDINGS

TARGET PROPERTY INFORMATION

ADDRESS

400 Fox Shore Drive
Kaukauna, WI 54130

FINDINGS DETAIL

Target Property research detail.

Year	*Uses*	*Source*
2009	Apts	Polk's City Directory
2004	Apts	Polk's City Directory
1999	Apts	Polk's City Directory
1994	Apts	Polk's City Directory

FINDINGS

ADJOINING PROPERTY DETAIL

The following Adjoining Property addresses were researched for this report. Detailed findings are provided for each address.

Bicentennial Ct

440 Bicentennial Ct

Year	Uses	Source
2009	Apts	Polk's City Directory
2004	Apts	Polk's City Directory
1999	Apts	Polk's City Directory
1994	Apts	Polk's City Directory
1990	Apts	Johnson's City Directory

500 Bicentennial Ct

Year	Uses	Source
2009	Apts	Polk's City Directory
2004	Apts	Polk's City Directory
1999	Apts	Polk's City Directory

Fox Shore Drive

Fox Shore Drive

Year	Uses	Source
2009	No other addresses listed on street	Polk's City Directory
2004	No other addresses listed on street	Polk's City Directory
1999	No other addresses listed on street	Polk's City Directory
1994	No other addresses listed on street	Polk's City Directory
1990	No other addresses listed on street	Johnson's City Directory

180 Fox Shore Drive

Year	Uses	Source
2009	Ghost Town Fitness Ctr	Polk's City Directory
2004	Ghost Town Fitness Ctr	Polk's City Directory
1999	Ghost Town Fitness Ctr	Polk's City Directory
1994	Physically Fit	Polk's City Directory
1990	Physically Fit	Johnson's City Directory

FINDINGS

410 Fox Shore Drive

Year	*Uses*	*Source*
2009	Apts	Polk's City Directory
2004	Apts	Polk's City Directory
1999	Apts	Polk's City Directory
1994	Apts	Polk's City Directory

FINDINGS

TARGET PROPERTY: ADDRESS NOT LISTED IN RESEARCH SOURCE

The following Target Property addresses were researched for this report, and the addresses were not listed in the research source.

Address Researched	Address Not Listed in Research Source
400 Fox Shore Drive	1990

ADJOINING PROPERTY: ADDRESSES NOT LISTED IN RESEARCH SOURCE

The following Adjoining Property addresses were researched for this report, and the addresses were not listed in research source.

Address Researched	Address Not Listed in Research Source
410 Fox Shore Drive	1990
500 Bicentennial Ct	1994, 1990

Appendix E:

Qualifications

GRS

Global Realty Services Group
1920 Glenneyre
Laguna Beach, California 92651

ANTHONY MUELLER, P.E.

SENIOR PRINCIPAL

OVERVIEW

Mr. Mueller has over 20 years of experience in the consulting and due diligence industry. His varied experience has contributed to a broad understanding of real estate issues, especially as they pertain to the significance of environmental and engineering concerns. After opening a European office to service agreements with the U.S. Department of Defense, Mr. Mueller became involved in the emerging real estate due diligence industry. Since the mid 1990s, Mr. Mueller has worked with clients to conduct and manage Environmental, Property Condition and Seismic Assessments, encompassing a wide variety of properties.

ENVIRONMENTAL ASSESSMENT	Mr. Mueller has performed and/or managed thousands of Phase I and II Environmental Assessments for public entities and for major lending institutions and investors and has acted as a key advisor for Agency and CMBS clients securing properties valued at well over $100,000,000.
PROPERTY CONDITION ASSESSMENT	Utilized engineering background and knowledge of building systems to conduct and/or manage thousands of Property Condition Surveys for lenders, developers and/or investors.

EXPERIENCE

LANDAMERICA ASSESSMENT CORPORATION

National Client Manager

Responsible for direct relationships with select national and local clients. Key roles included:

- Expanding company revenue by increasing sales of assessment services to existing and new clients.
- Customer support utilizing technical background applied to various areas of due diligence services, including, but not limited to, commercial construction process, engineering assessments, and environmental risk assessments.
- Serviced broad range of lenders, including CMBS, Agency, Life Insurance Companies, Bank, and Mortgage Banking community.
- Managed due diligence for Equity players, including buyers, investors, and sale/leaseback firms.
- Promoted cross-selling of non-core services, including appraisal, title, and cost segregation.

AARON & WRIGHT TECHNICAL SERVICES

Director of Technical Services

Managed a regional office and book of national clients for this Houston-based due diligence firm. Key accomplishments include:

- Expansion of client base regionally and nationally.
- Developed service offerings specific to CMBS, Agency, Life Insurance Companies, Bank, Equity, and Mortgage Banking clients.
- Recruited field personnel to establish a national footprint in service

coverage.

- Developed firm's report products and implemented quality control metrics from 1996 – 2004.

AFFILIATIONS

Member, Chicago Real Estate Council

EDUCATION AND CERTIFICATIONS

- Bachelor of Science, Mechanical Engineering, University of Illinois – Chicago
- Professional Engineer - Illinois, Indiana

REPRESENTATIVE SPEAKING ENGAGEMENTS

- Introduction to Environmental Assessments and ASTM/AAI, National Life Company, Chicago
- Introduction to Environmental and Property Condition Assessments, National CMBS Lender, Chicago and New York

ENVIRONMENTAL SITE ASSESSMENT QUESTIONNAIRE

Please complete to the best of your knowledge. For those questions that are not applicable, please respond with an "N/A". For those questions that are unknown, please respond with "unknown".

1. PROPERTY INFORMATION:

Property Name: Fox Shores Apartments		
Property Address: 400 Fox Shores Drive		
City Kaukauna	State Wisconsin	Zip 54130
Assessor's Parcel Number See Attached		
Property Owner & Contact Information: Thomas Vandeyacht Office: (920)380-9631; Cell:(920)213-7145; Email: tomv@vmi-vdi.com		
Date Property Owner Purchased: June, 1998		
Key Site Manager & Contact Information: Thomas Vandeyacht		
Maintenance Supervisor & Contact Information: Thomas Vandeyacht (920)213-7145		

2. COMPLETED BY

Signature	Date 6/11/2018
Printed Name Thomas Vandeyacht	Relation to Subject Property Owner

3. PREVIOUS INVESTIGATIONS

Have any previous environmental investigations been performed at the property, including Phase I ESAs, Phase II Subsurface Investigations, Remediation, Asbestos or Lead-Based Paint surveys?__

Yes, Phase I environmental site assessment

(If yes, please provide copies)

4. PROPERTY DESCRIPTION

Property Size: __2.815 Acres +/-_____ Number of Building(s): __6 Multi Family, 4 Garage,____

Number and Type of Unit(s):___32 2-bed, 1-bath; 24 2-bed, 2-bath_

Number of ground floor units: 28

Size of Building(s): *(SF and amount of floors, 1, 2, etc)*__Two Waterfront Buildings are 14,400 Sq.Ft. on two floors, four Off Water Buildings are 7,456 Sq.Ft., on two floors

Date of Construction: __1983-1991

Date of Addition(s) / Renovation(s): _____

Property Type: (please circle)

Multi-Family Hotel Mobile Home Park Retail/Commercial Industrial Office Other:_____

If **Pre-1978**, are Lead Pamphlets (***EPA Protect Your Family from in Your Home Guide)*** being handed out to tenants?

Historical Use of Property: Rail Road Tracks

5. **SURROUNDING PROPERTY USES** (*Include Roadways*)

DIRECTION	USE
North	**FOX RIVER**
South	**COMMERCIAL**
East	**COMMERCIAL**
West	**MULTIFAMILY**

Are you aware of any potential environmental concerns associated with surrounding properties?

_____ YES ___X___NO

If yes, please describe: _____

_____

6. UTILITIES & SERVICES

Please provide the name of the utility or contractor providing the following:

Electric	Kaukauna Power & Light	Bio-hazardous Waste	_____
Gas	NA	Elevator Maintenance	_____
Potable Water	Kaukauna Utilities	Used Grease	_____
Sanitary Sewer	Kaukauna Utilities	Hazardous Waste	_____
Solid Waste	Van's Waste	Medical Waste	_____

Other contractor provided service(s): _____

7. ON SITE OPERATIONS

Are you aware of any of the following conditions, either past or present, on the property?		
Condition	**Response**	**If yes, please describe**
1. Water-damaged areas	☐ Yes X No	
2. Suspect / Confirmed Mold-affected areas	☐ Yes X No	
3. Stored Chemicals	X Yes ☐ No	General Use and Cleaning
4. Underground Storage Tanks	☐ Yes X No	
5. Aboveground Storage Tanks ➢ (Include Emergency Generators)	☐ Yes X No	

➢ Propane Tanks		
6. PROPOSED Stationary tanks, which includes aboveground storage tanks including emergency generators, propane tanks, etc. **100 gallons or larger**	☐ **Yes X No**	
7. Spills or Releases *(greater than 5-gallons)*	☐ Yes X No	
8. Dump Areas / Landfills	☐ Yes X No	
9. Waste Treatment Systems	☐ Yes X No	
10. Clarifiers / Separators	☐ Yes X No	
11. Vents / Odors	☐ Yes X No	
12. Floor Drains / Sumps	X Yes ☐ No	General Use
13. Stained Soil	☐ Yes X No	
14. Electrical Transformers ➢ Pad-mounted / Pole-mounted	X Yes ☐ No	Kaukauna Power Transformers
15. Hydraulic Lifts / Elevators	☐ Yes X No	
16. Dry Cleaning Operations	☐ Yes X No	
17. Oil / Gas / Water / Monitoring Wells	☐ Yes X No	
18. Water Supply Wells	☐ Yes X No	One well for irrigation
19. Environmental Permits	☐ Yes X No	
20. Abatement Activities ➢ Asbestos/Lead/Mold ➢ Water/Fire Restoration	☐ Yes X No	
21. Mitigation Activities ➢ Radon / Subsurface cleanup ➢ Vapor Intrusion *(i.e. Methane)*	☐ Yes X No	
22. Marketability / Noise Concerns ➢ Have noise issues created a marketability issue at the property?	☐ Yes X No	*If so, why (road, rail, air, etc)*
23. Marketability ➢ What percentage has the occupancy rate been since the original date of construction?	96-99 %	*(If occupancy rate since original date of construction is unknown, list the occupancy rates for known dates, ie. 85% between 1985 and present)*

8. REPORTS REQUESTED:

- If Lead Pamphlets handed out to tenants obtain copy of ***EPA Protect Your Family from in Your Home Guide***
- Rent Roll
- Site Layout Map / Brochure
- Previous Environmental Reports, including, but not limited to:

    - ESAs,
    - Asbestos/Lead-Based Paint Surveys,
    - Mold Inspections,
    - Water Supply Well Testing Reports
- Haz-Waste manifests, including, but not limited to: (most recent) Bio-hazard manifest, waste grease (food-grade)
- Additional reports regarding environmental issues.

Summary Rent Roll

Fox Shores Apartments

Current customers in the period 06/01/2018 - 06/30/2018

Security Deposit based on date 06/01/2018

Customer Name	Unit	Sq Ft	Security Deposit	100% Rented	Vacancy Loss	Loss to Lease	Rent Charges	Misc Charges	Credits	Prior Balance	Total Charged	Total Paid	Credit Balances	Debit Balances
Fox Shores Apartments														
Huss, Linda	B380-1	930	330.00	580.00	0.00	20.00	560.00	0.00	0.00	0.00	560.00	560.00		0.00
Frees, Pamela	B380-2	930	500.00	580.00	0.00	15.00	565.00	40.00	0.00	-615.00	605.00	0.00	-10.00	
Detert, Brittany	B380-3	930	500.00	580.00	0.00	0.00	580.00	0.00	0.00	-580.00	580.00	0.00		0.00
Huss, Kevin	B380-4	930	750.00	580.00	0.00	5.00	575.00	70.00	-20.00	-2.00	625.00	623.00		0.00
Meetz, Mary	B380-5	930	750.00	580.00	0.00	25.00	555.00	90.00	0.00	-645.00	645.00	0.00		0.00
Magnin, Trisha	B380-6	930	750.00	580.00	0.00	5.00	575.00	80.00	0.00	-392.00	655.00	0.00		263.00
Propson, Daniel	B380-7	930	750.00	580.00	0.00	15.00	565.00	0.00	0.00	0.00	565.00	565.00		0.00
Bever, Craig	B380-8	930	500.00	580.00	0.00	25.00	555.00	50.00	0.00	-30.00	605.00	605.00	-30.00	
Micke, Harold Butch	B390-1	930	390.00	580.00	0.00	90.00	490.00	50.00	-50.00	-490.00	490.00	0.00		0.00
Johnson, Ryan	B390-2	930	500.00	580.00	0.00	15.00	565.00	0.00	0.00	0.00	565.00	565.00		0.00
Van De Hey, Brady	B390-3	930	500.00	580.00	0.00	0.00	580.00	0.00	0.00	-580.00	580.00	0.00		0.00
White, Kenneth	B390-4	930	485.00	580.00	0.00	25.00	555.00	50.00	0.00	-635.00	605.00	0.00	-30.00	
Rockey, Angielyn	B390-5	930	750.00	580.00	0.00	25.00	555.00	20.00	0.00	-795.00	575.00	610.00	-830.00	
Dionne, Megan	B390-6	930	750.00	580.00	0.00	25.00	555.00	20.00	0.00	-65.00	575.00	580.00	-70.00	
Smith, Allison	B390-7	930	650.00	580.00	0.00	25.00	555.00	60.00	0.00	-4.00	615.00	615.00	-4.00	
Walbeck, Shelby	B390-8	930	750.00	580.00	0.00	5.00	575.00	80.00	0.00	-20.00	655.00	645.00	-10.00	
Wallace, Cynthia	B400-1	930	750.00	580.00	0.00	0.00	580.00	80.00	0.00	-660.00	660.00	0.00		0.00
Tischendorf, Wayne	B400-2	930	500.00	580.00	0.00	15.00	565.00	0.00	0.00	-565.00	565.00	0.00		0.00
Mc Ginnis, Phyllis	B400-3	930	390.00	580.00	0.00	20.00	560.00	0.00	0.00	-280.00	560.00	280.00		0.00
Johnson, Andrea	B400-4	930	500.00	580.00	0.00	0.00	580.00	0.00	0.00	0.00	580.00	580.00		0.00
Pynenberg, Stepfanie	B400-5	930	750.00	580.00	0.00	25.00	555.00	30.00	0.00	0.00	585.00	585.00		0.00
Tenor, John	B400-6	930	750.00	580.00	0.00	35.00	545.00	70.00	0.00	0.00	615.00	615.00		0.00
Luedke, Nicole	B400-7	930	750.00	580.00	0.00	25.00	555.00	20.00	0.00	0.00	575.00	575.00		0.00
Garcia, Antonio	B400-8	930	1,000.00	580.00	0.00	5.00	575.00	40.00	0.00	-5.00	615.00	615.00	-5.00	
Otis, Julia	B410-1	930	750.00	580.00	0.00	15.00	565.00	40.00	0.00	50.00	605.00	605.00		50.00
Mayo, Jayson	B410-2	930	500.00	580.00	0.00	15.00	565.00	50.00	0.00	-615.00	615.00	0.00		0.00
Jensen, Tammy	B410-3	930	750.00	580.00	0.00	15.00	565.00	30.00	0.00	0.00	595.00	595.00		0.00
Olson, Justin	B410-4	930	750.00	580.00	0.00	15.00	565.00	80.00	0.00	-685.00	645.00	0.00	-40.00	
Moreno, Dan	B410-5	930	500.00	580.00	0.00	25.00	555.00	0.00	0.00	0.00	555.00	555.00		0.00
Seibel, Hollie	B410-6	930	300.00	580.00	0.00	15.00	565.00	50.00	0.00	0.00	615.00	615.00		0.00
Roohr, Kim	B410-7	930	500.00	580.00	290.00	0.00	290.00	0.00	0.00	0.00	290.00	0.00		290.00
Look, Crystal	B410-8	930	750.00	580.00	0.00	5.00	575.00	20.00	0.00	-595.00	595.00	0.00		0.00
Ohm, Nancy	F400-01	1200	750.00	780.00	0.00	10.00	770.00	20.00	0.00	-790.00	790.00	0.00		0.00
Peebles, Daniel	F400-02	1200	750.00	770.00	0.00	20.00	750.00	20.00	0.00	-770.00	770.00	0.00		0.00
Hoheisel, Jiselle	F400-03	1200	750.00	770.00	0.00	50.00	720.00	30.00	0.00	0.00	750.00	750.00		0.00
Vandeyacht, Edriss	F400-04	1200	500.00	780.00	0.00	110.00	670.00	30.00	-30.00	-580.00	670.00	0.00		90.00
Kalota-Kiersten, Michele	F400-05	1200	750.00	780.00	0.00	10.00	770.00	40.00	0.00	-13.97	810.00	810.00	-13.97	
Vandenberg, Joseph	F400-06	1200	750.00	780.00	0.00	40.00	740.00	30.00	0.00	-770.00	770.00	0.00		0.00
Cwiak, A J	F400-07	1200	500.00	770.00	0.00	50.00	720.00	0.00	0.00	0.00	720.00	720.00		0.00
Burmeister, Karen	F400-08	1200	500.00	780.00	0.00	55.00	725.00	20.00	-20.00	0.00	725.00	725.00		0.00
Green, Robert	F400-09	1200	0.00	780.00	0.00	10.00	770.00	0.00	0.00	0.00	770.00	770.00		0.00
Bast, Jan	F400-10	1200	500.00	770.00	0.00	20.00	750.00	0.00	0.00	-750.00	750.00	0.00		0.00
Lapacz, Nicole	F400-11	1200	750.00	770.00	0.00	50.00	720.00	20.00	0.00	-740.00	740.00	0.00		0.00
VACANT	F400-12	1200	0.00	780.00	780.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Geyso, Karen	F410-01	1200	750.00	780.00	0.00	10.00	770.00	20.00	0.00	-790.00	790.00	0.00		0.00
Baer, Agnes	F410-02	1200	510.00	770.00	0.00	60.00	710.00	0.00	0.00	-50.00	710.00	710.00	-50.00	
Mercier, Kristin	F410-03	1200	500.00	770.00	0.00	30.00	740.00	50.00	0.00	0.00	790.00	0.00		790.00

Customer Name	Unit	Sq Ft	Security Deposit	100% Rented	Vacancy Loss	Loss to Lease	Rent Charges	Misc Charges	Credits	Prior Balance	Total Charged	Total Paid	Credit Balances	Debit Balances
Egan, Caitlin	F410-04	1200	500.00	780.00	0.00	0.00	780.00	0.00	0.00	-0.23	780.00	780.00	-0.23	
Thurnau, Raleigh	F410-05	1200	750.00	780.00	0.00	20.00	760.00	20.00	0.00	0.00	780.00	780.00		0.00
Mauel, Deborah	F410-06	1200	750.00	770.00	0.00	20.00	750.00	20.00	0.00	-770.00	770.00	0.00		0.00
Martenson, Mitchell	F410-07	1200	750.00	770.00	0.00	20.00	750.00	20.00	0.00	0.00	770.00	780.00	-10.00	
Jacobson, Marjorie	F410-08	1200	0.00	780.00	0.00	55.00	725.00	0.00	0.00	10.00	725.00	745.00	-10.00	
Schommer, Carol	F410-09	1200	565.00	780.00	0.00	35.00	745.00	20.00	0.00	-80.00	765.00	775.00	-90.00	
Zeman, Bradley	F410-10	1200	500.00	770.00	0.00	30.00	740.00	0.00	0.00	-760.00	740.00	0.00	-20.00	
Willetts, Andrew	F410-11	1200	750.00	770.00	0.00	40.00	730.00	80.00	0.00	10.00	810.00	800.00		20.00
Lugviel, Arno	F410-12	1200	500.00	780.00	0.00	10.00	770.00	0.00	0.00	-790.00	770.00	0.00	-20.00	
Totals for		58,560	33,120.00	37,170.00	1,070.00	1,305.00	34,795.00	1,560.00	-120.00	-15,842.20	36,235.00	20,133.00	-1,243.20	1,503.00

Fox Shores Apartments **Total Units:** 56 **Vacant Units:** 1 **Vacant Rent:** 780.00 **Credit Balances:** 17 **Overall Balance:** 259.80

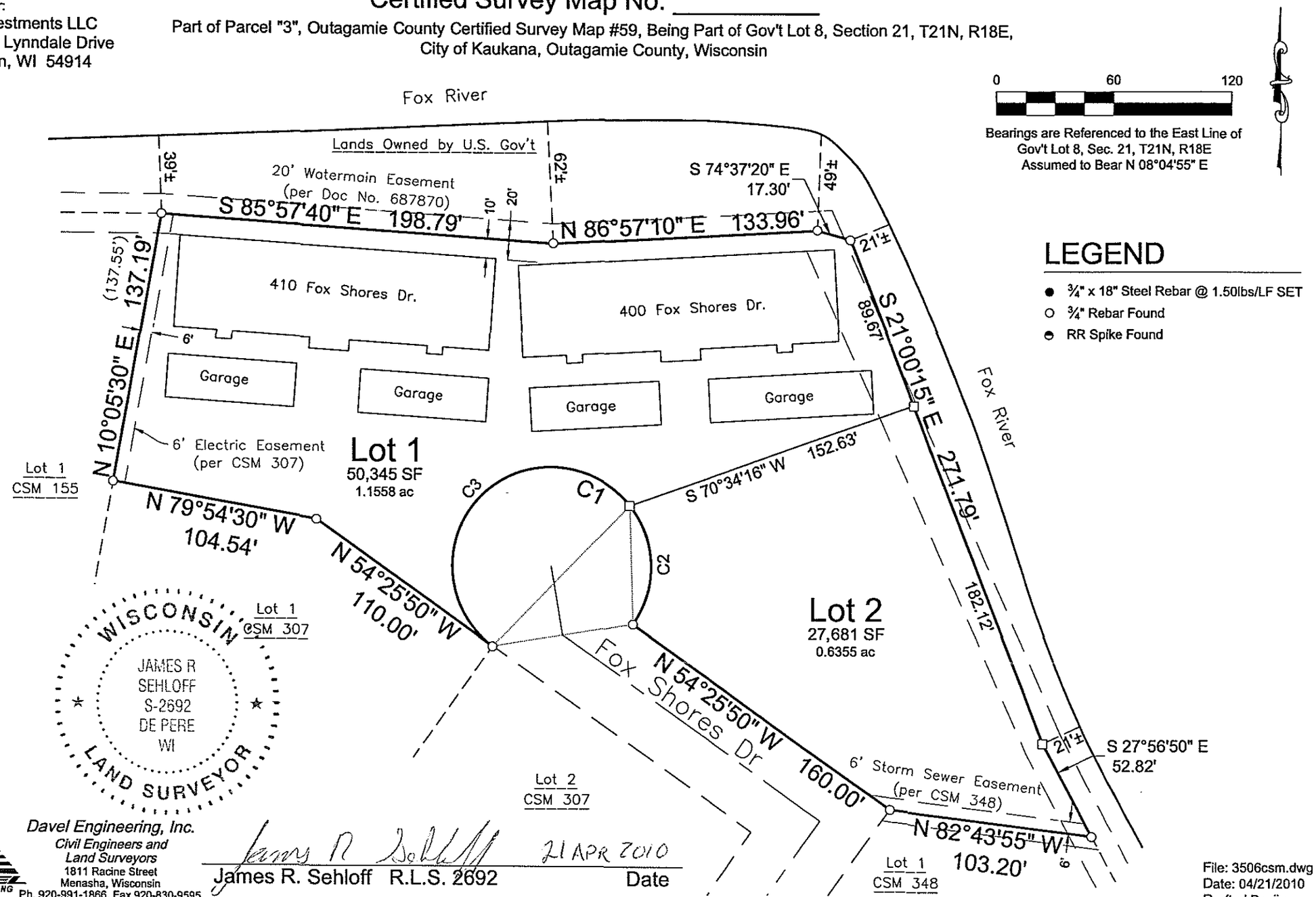
Totals for report	Sq Ft	Security Deposit	100% Rented	Vacancy Loss	Loss to Lease	Rent Charges	Misc Charges	Credits	Prior Balance	Total Charged	Total Paid	Credit Balances	Debit Balances
	58,560	33,120.00	37,170.00	1,070.00	1,305.00	34,795.00	1,560.00	-120.00	-15,842.20	36,235.00	20,133.00	-1,243.20	1,503.00

Total Units: 56 **Vacant Units:** 1 **Vacant Rent:** 780.00 **Credit Balances:** 17 **Overall Balance:** 259.80

Survey for:
Fox Investments LLC
2220 N. Lynndale Drive
Appleton, WI 54914

Certified Survey Map No. _____

Part of Parcel "3", Outagamie County Certified Survey Map #59, Being Part of Gov't Lot 8, Section 21, T21N, R18E,
City of Kaukana, Outagamie County, Wisconsin



0 60 120

Bearings are Referenced to the East Line of
Gov't Lot 8, Sec. 21, T21N, R18E
Assumed to Bear N 08°04'55" E

LEGEND

- ¾" x 18" Steel Rebar @ 1.50lbs/LF SET
- ¾" Rebar Found
- RR Spike Found

Davel Engineering, Inc.
Civil Engineers and
Land Surveyors
1811 Racine Street
Menasha, Wisconsin
Ph. 920-991-1866, Fax 920-830-9595

James R. Sehloff R.L.S. 2692

21 APR 2010
Date

File: 3506csm.dwg
Date: 04/21/2010
Drafted By: jim
Sheet: 1 of 3

FORM NO. 985-A
HCMiller
Stock No. 26273

Certified Survey Map No. _____

Surveyor's Certificate

I, James R. Sehloff, registered land surveyor, hereby certify: That in full compliance with the provisions of Chapter 236 of the Wisconsin Statutes and the subdivision regulations of the City of Kaukauna and Outagamie County, and under the direction of Fox Investments LLC and Thomas R. Vandeyacht & Mary K. Vandeyacht, the property owners of said land, I have surveyed divided and mapped this Certified Survey Map; that such map correctly represents all exterior boundaries and the subdivision of the land surveyed; and that this land is part of Parcel 3, Certified Survey Map #59 located in the City of Kaukauna, Outagamie County, Wisconsin, containing 78,026 Square Feet (1.7913 Acres) of land described as follows:

Beginning at the Northeast corner of Lot 1, Certified Survey Map 155, thence S85°57'40"E, 198.79 feet; thence N86°57'10"E, 133.96 feet; thence S74°37'20"E 17.30 feet; thence S21°00'15"E, 271.79 feet; thence S27°56'50"E, 52.82 feet to the Northeast corner of Lot 1, Certified Survey Map 348; thence along the North line of said Lot 1 N82°43'55"W, 103.20 feet to a point of the Northeasterly right of way of Fox Shores Dr.; thence along the northerly right of way line of said Fox Shores Dr., N54°25'50"W 160.00 feet; thence 235.21 feet along and arc of a curve to the left with a radius of 50.00 feet and a chord which bears S80°34'10"W, 71.00 feet to the East corner of Lot 1, Certified Survey Map 307; thence along the Northerly line of said Lot 1, N54°25'50"W 110.00 feet; thence continuing along said Northerly line, N79°54'30"W 104.54 feet to a point on the East line of said Lot 1 Certified Survey Map 155; thence along said East line, N10°05'30"E 137.19 feet to the point of beginning, subject to all easements and restrictions of record.

Given under my hand this 21 day of APRIL, 2010.

James R. Sehloff, Wisconsin Registered Land Surveyor No. S-2692

WISCONSIN
JAMES R SEHLOFF S-2692 DE PERE WI
LAND SURVEYOR

City of Kaukauna Common Council Approval Certificate

Resolved, that this Certified Survey Map in the City of Kaukauna, Fox Investments LLC and Thomas R. Vandeyacht & Mary K. Vandeyacht, owners, are hereby approved by the Common Council.

Mayor — Date 05/07/10

I hereby certify that the foregoing is a copy of a resolution adopted by the Common Council of the City of Kaukauna.

City Clerk — Date 5/7/10

Owners' Certificate

Thomas R. Vandeyacht and Mary K. Vandeyacht as the property owners, we hereby certify that we caused the land described on this certified survey map to be surveyed, divided and mapped all as shown and represented on this map.

Dated this 26th day of April, 2010

Thomas R. Vandeyacht, property owner

Mary K. Vandeyacht, property owner

NOTARY PUBLIC
WILLIAM R. BISHOP JR
STATE OF WISCONSIN

State of Wisconsin)
)SS
Winnebago County)

Personally came before me on the 26 day of April, 2010, the above the property owner(s) to me known to be the persons who executed the foregoing instrument and acknowledge the same.

William R Bishop Jr
Notary Public, Wisconsin

My Commission Expires 12-15-2013

File: 3506csm.dwg
Date: 04/20/2010
Drafted By: jim
Sheet: 2 of 3

FORM NO. 985-A

HCMiller
Print Evolutionaries

Stock No. 26273

Certified Survey Map No. _____

Corporate Owner's Certificate

Fox Investments LLC, a limited liability company duly organized and existing under and by virtue of the Laws of the State of Wisconsin, as the property owners, do hereby certify that we caused the land above described to be surveyed, divided and mapped all as shown and represented on this map.

IN WITNESS WHEREOF, the said Fox Investments LLC, has caused these presents to be

signed by its authorized representatives, located at, _____, Wisconsin,

this 26 day of April, 2010.

In the Presence of: Fox Investments LLC

Thomas R Vandeyacht
Thomas R. Vandeyacht, Member

Mary K. Vandeyacht, Member

NOTARY PUBLIC
WILLIAM R. BISHOP JR.
STATE OF WISCONSIN

State of Wisconsin)
)ss
Winnebago County)

Personally came before me this 26 day of April, 2010,

the above named, members of said company, and acknowledged that they executed the foregoing instrument as such members as the deed of said company, by its authority.

William R Bishop Jr.
Notary Public, Wisconsin

My commission expires: 12-15-2013

Treasurers' Certificate

We, being the duly elected, qualified and acting Treasurers' of the City of Kaukauna and Outagamie County, do hereby certify that in accordance with the records in our office, there are no unredeemed tax sales and unpaid taxes, or special assessments on and of the land included in this plat.

City Treasurer — Date: 5/7/10

County Treasurer — Date

This Certified Survey Map is contained wholly within the property described in the following recorded instruments:

Owners of Record:	Recording Information:	Parcel Number(s):
Fox Investments LLC	Doc. No. 1289591	32-3-0408-00
Thomas R. Vandeyacht & Mary K. Vandeyacht	Doc. No. 1863117	32-3-0408-04

CURVE TABLE					
Curve	Radius	Chord Direction	Chord Length	Arc Length	Central Angle
C1	50.00'	S 80°50'22" W	71.34'	234.74'	268°59'00"
C2	50.00'	S 80°50'22" W	71.34'	234.74'	268°59'00"
C3	50.00'	S 80°50'22" W	71.34'	234.74'	268°59'00"

WISCONSIN
JAMES R SEHLOFF
S-2692
DE PERE
WI
LAND SURVEYOR

James R. Sehloff Registered Land Surveyor No. S-2692 — 21 APR 2010 Date

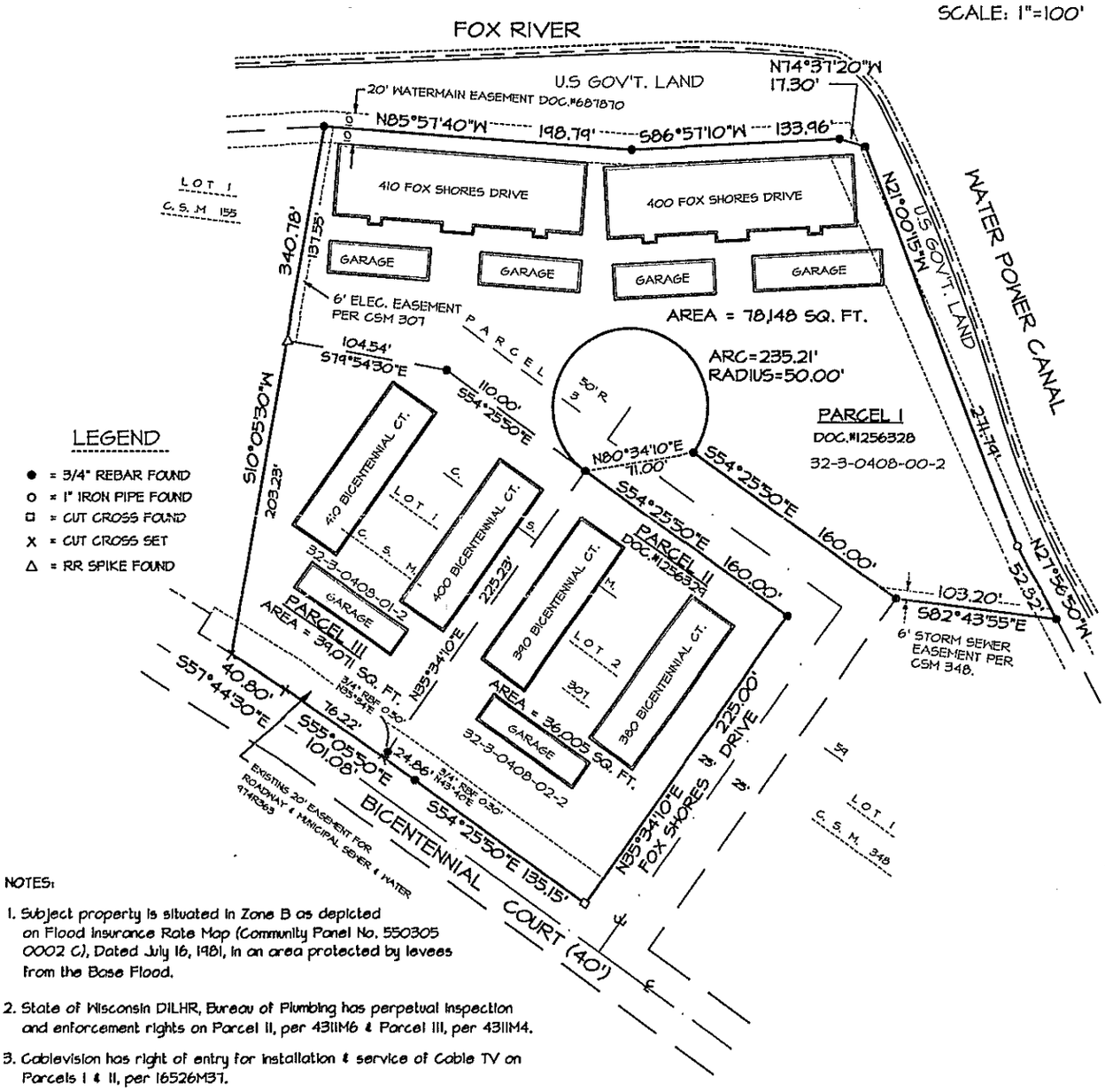
File: 3506csm.dwg
Date: 04/20/2010
Drafted By: jim
Sheet: 3 of 3

PLAT OF SURVEY

Prepared for: Versatile Developments, Inc.
2220 N. Lynndale Drive
Appleton, WI 54914

BEARINGS ARE REFERENCED TO THE RECORDED C.S.M. No. 348.

SCALE: 1"=100'



LEGEND

- ● = 3/4" REBAR FOUND
- o = 1" IRON PIPE FOUND
- □ = CUT CROSS FOUND
- X = CUT CROSS SET
- △ = RR SPIKE FOUND

NOTES:

1. Subject property is situated in Zone B as depicted on Flood Insurance Rate Map (Community Panel No. 550305 0002 C), Dated July 16, 1981, in an area protected by levees from the Base Flood.
2. State of Wisconsin DILHR, Bureau of Plumbing has perpetual inspection and enforcement rights on Parcel II, per 431IM6 & Parcel III, per 431IM4.
3. Cablevision has right of entry for installation & service of Cable TV on Parcels I & II, per 16526M31.
4. Cablevision has installation & service easement for 410 Fox Shores Drive, per 11648M46.

DESCRIPTION

SEE SHEET 2 OF 2

SURVEYOR'S CERTIFICATE

I hereby certify to Fox Investments LLC, AnchorBank, fsb, Donald N. Promer and First American Title Insurance Co., that I have surveyed the above-described property and that the above map is a true representation thereof and shows the size and location of the property, its exterior boundaries, the location of all visible structures and existing or proposed buildings thereon, boundary fences, apparent easements, roadways and visible encroachments, if any.

This survey is made for the use of the present owners of the property, and also those who purchase, mortgage, or guarantee the title thereto within one (1) year from date hereof.

Keith W. Walenski 3-14-01
Keith W. Walenski Date

WISCONSIN
KEITH W. WALENSKI
S-2292
APPLETON, WI
LAND SURVEYOR

HARRIS & ASSOCIATES, INC.
CONSULTING ENGINEERS AND LAND SURVEYORS
2118 NORTH MEADE ST.
APPLETON, WI 54911
TEL: (920) 733-8377
FAX: (920) 733-4731

LS-6983

PLAT OF SURVEY

Prepared for: Versatile Developments, Inc.
2220 N. Lynndale Drive
Appleton, WI 54914

DESCRIPTION

PARCEL I

A parcel of land being a part of Parcel Three (3), Outagamie County Certified Survey Map No. 59, located in the City of Kaukauna, Outagamie County, Wisconsin and being more fully described as follows: Beginning at the Northeast corner of Lot 1, of Outagamie County Certified Survey Map No. 155; thence S10°05'30"W, 137.55 feet along the Easterly line of said Lot 1, C.S.M. # 155, to the Northwest corner of Lot 1, Certified Survey Map No. 307; thence S79°54'30"E, 104.54 feet along the North line of said Lot 1, C.S.M. #307; thence continuing along said North line S54°25'50"E, 110.00 feet to the Northeast corner of said Lot 1; thence along the cul-de-sac curve to the right, 235.21 feet (chord bearing N80°34'10"E, 71.00 feet); thence S54°25'50"E, 160.00 feet along the Northeasterly line of Fox Shores Drive, to the Northwest corner of Lot 1, Certified Survey Map No. 348; thence S82°43'55"E, 103.20 feet along the North line of said Lot 1, C.S.M. No. 348, to the Northeasterly line of Parcel 3, C.S.M. No. 59; thence N27°56'50"W, 52.82 feet along said line; thence N21°00'15"W, 271.79 feet along said Northeasterly line; thence N74°37'20"W, 17.30 feet along the North line of said Parcel 3, C.S.M. No. 59; thence continuing along said North line, S86°57'10"W, 133.96 feet; thence N85°57'40"W, 198.79 feet along said North line to the point of beginning.

PARCEL II

All of Lot Two (2), Certified Survey Map No. 307 recorded in Volume 2 of Certified Survey Maps, page 307, being part of Parcel 3, Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin.

PARCEL III

All of Lot One (1), Certified Survey Map No. 307 recorded in Volume 2 of Certified Survey Maps, page 307, being part of Parcel 3, Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin.



Keith W. Walenski 3-14-01
Keith W. Walenski Date

HARRIS & ASSOCIATES, INC.
CONSULTING ENGINEERS AND LAND SURVEYORS
2710 NORTH MEADE ST.
APPLETON, WI 54911
TEL: (920) 733-6377
FAX: (920) 733-4731

LS-6983a


N
0
100
200
300ft
DISCLAIMER: This map is not guaranteed to be accurate, correct, current, or complete and conclusions drawn are the responsibility of the user.


N
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100
200
300ft
DISCLAIMER: This map is not guaranteed to be accurate, correct, current, or complete and conclusions drawn are the responsibility of the user.


N
0
100
200
300ft
DISCLAIMER: This map is not guaranteed to be accurate, correct, current, or complete and conclusions drawn are the responsibility of the user.

2018 Property Record | Outagamie County, WI

Assessed values not finalized until after Board of Review
Property information is valid as of 6/26/2018 10:43:39 AM

Owner Address

FOX INVESTMENTS LLC
2220 N LYNNDALE DR
APPLETON, WI 54914

Property Information

Parcel ID: 323040800

Document # 1289591

Tax Districts:

SCH D OF KAUKAUNA AREA

HEART OF THE VALLEY METRO SEWER DIST

Owner

FOX INVESTMENTS LLC

Property Description

For a complete legal description, see recorded document.

CSM 6200 LOT 1 (PLATTED OUT OF PRT GOV LOT 8 SEC21-21-18) 1.56AC M/L

Municipality: 241-CITY OF KAUKAUNA

Property Address: 410 FOX SHORES DR

400 FOX SHORES DR

Land Valuation

Code	Acres	Land	Impr.	Total
2	1.56	$95,100	$1,088,600	$1,183,700
	1.56	$95,100	$1,088,600	$1,183,700

Assessment Ratio: Not Available

Fair Market Value: Not Applicable

**No data found for Special Assessment Detail, Delinquent Tax Summary, Payment History in 2018*

2018 Property Record | Outagamie County, WI

Assessed values not finalized until after Board of Review
Property information is valid as of 6/26/2018 10:44:44 AM

Owner Address

FOX INVESTMENTS LLC
2220 N LYNNDALE DR
APPLETON, WI 54914

Property Information

Parcel ID: 323040801

Document # 1400589

Tax Districts:

SCH D OF KAUKAUNA AREA

HEART OF THE VALLEY METRO SEWER DIST

Owner

FOX INVESTMENTS LLC

Property Description

For a complete legal description, see recorded document.

COM SE COR LT 1 CSM 155 N10D E43.02FT TO POB N10D E203.23FT S79D E104.54FT S54D E110FT S35D W225.23FT TO ST N 55D W76.22FT N57D W40.80FT TO POB ALSO D ESC AS LOT 1 CSM VOL 2 PG 307 .83AC

Municipality: 241-CITY OF KAUKAUNA

Property Address: 400 BICENTENNIAL CT

Land Valuation

Code	Acres	Land	Impr.	Total
2	0.83	$73,300	$460,700	$534,000
	0.83	$73,300	$460,700	$534,000

Assessment Ratio: Not Available

Fair Market Value: Not Applicable

**No data found for Special Assessment Detail, Delinquent Tax Summary, Payment History in 2018*

2018 Property Record | Outagamie County, WI

Assessed values not finalized until after Board of Review
Property information is valid as of 6/26/2018 10:45:20 AM

Owner Address

FOX INVESTMENTS LLC
%THOMAS R VANDEYACHT
2220 N LYNNDALE DR
APPLETON, WI 54914

Property Information

Parcel ID: 323040802

Document # 1289591

Tax Districts:

SCH D OF KAUKAUNA AREA

HEART OF THE VALLEY METRO SEWER DIST

Owner

FOX INVESTMENTS LLC

Property Description

For a complete legal description, see recorded document.

CSM 307 LOT 2 (PLATTED OUT OF PRT LOT 1 CSM 59) .83AC M/L #1256329 &

Municipality: 241-CITY OF KAUKAUNA

Property Address: 380 BICENTENNIAL CT

Land Valuation

Code	Acres	Land	Impr.	Total
2	0.83	$73,000	$460,700	$533,700
	0.83	$73,000	$460,700	$533,700

Assessment Ratio: Not Available

Fair Market Value: Not Applicable

**No data found for Special Assessment Detail, Delinquent Tax Summary, Payment History in 2018*

APPENDIX C: INTERVIEWS / FOIAS

PARTNER

Dunn, Rose

From: Dunn, Rose
Sent: Friday, June 15, 2018 5:06 PM
To: 'inspection@kaukauna-wi.org'
Subject: BUILDING & ZONING VIOLATIONS/RECORDS REQUEST - Fox Shores Apartments - 215232.1

BUILDING & ZONING VIOLATIONS/RECORDS REQUEST

Partner Engineering and Science, Inc. is conducting a Phase I Environmental Site Assessment and/or a Property Condition Report Assessment on the following property:

Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project 215232.1

As part of the investigation, we are requesting informally any and all records you have for the above-referenced property pertaining to the following:

a. Current Zoning Designation is:_____
b. The CURRENT USE at the property is permitted in this zoning designation. Yes No
c. Conditional uses established for the property (if any):_____ None

- Please send copies of any unresolved Notices of Violation or Notices to Comply documents filed against the property.
  ____Yes, copies included ____None on record
- How frequently is the property inspected by the Building Department?
  ___During Construction ___To investigate a complaint ___Annually

  ___Never ___Other [please describe] _____

- Date of last inspection:_____ [Please provide a copy, as available.]

- Please send copies of any open building department permits. ___Yes, copies included ___None in records

- Please send copies of the Certificates of Occupancy.

- Please send copies of permits for any current or historic USTs/ASTs.

Please forward any records that exist for the aforementioned property or any other pertinent information, at your earliest convenience. Also, please notify Partner if there are any costs associated with this request prior to processing.

Also, please respond to this email stating whether you received it and/or the approximate date we will have these records, it is very imperative.

Dunn, Rose

From: Dunn, Rose
Sent: Friday, June 15, 2018 5:11 PM
To: 'skenney@kaukauna-wi.org'
Subject: VIOLATIONS/RECORDS REQUEST - Fox Shores Apartments - 215232.1

VIOLATIONS/RECORDS REQUEST

Partner Engineering and Science, Inc. is conducting a Phase I Environmental Site Assessment and/or a Property Condition Report Assessment on the following property:

Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project 215232.1

As part of the investigation, we are requesting, under the Freedom of Information Act, any zoning, building, fire, or environmental health records you have for the above-referenced property pertaining to the following:

- current zoning designation, if the current use is permitted, and conditional uses (if any)
- any unresolved notices of violation/to comply, date of last inspection by the building department, copies of any open building department permits, copies of certificates of occupancy, copies of permits and records for any current or historic storage tanks
- hazardous materials incidents, fire inspection records, outstanding fire code violations
- records of asbestos or lead-based paint, septic system and water well information, human health concerns

Please forward any records that exist for the aforementioned property or any other pertinent information, at your earliest convenience. Also, please notify Partner if there are any costs associated with this request prior to processing. Also, please respond to this email stating whether you received it and/or the approximate date we will have these records, it is very imperative.

Rose Dunn
Team Assistant

PARTNER ENGINEERING AND SCIENCE, INC.
8422 Bellona Lane, Suite 301, Baltimore, MD 21204
O: 410-390-4897 F:443-377-3895

Dunn, Rose

From: Dunn, Rose
Sent: Friday, June 15, 2018 5:12 PM
To: 'dnrrecordsresponse@wisconsin.gov'
Subject: DEQ VIOLATIONS/RECORDS REQUEST - Fox Shores Apartments - 215232.1

DEQ VIOLATIONS/RECORDS REQUEST

Partner Engineering and Science, Inc. is conducting a Phase I Environmental Site Assessment and/or a Property Condition Report Assessment on the following property:

Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project 215232.1

As part of the investigation, we are requesting, under the Freedom of Information Act, any environmental health records you have for the above-referenced property pertaining to the following:

- Current or historical use of hazardous materials and/or hazardous waste
- Groundwater monitoring wells
- Current or historical clarifiers, oil/water separators, grease traps, interceptors
- Incidents of lead or asbestos, fires, leaks [USTs/ASTs] and spills
- Code Violations or Notices to Comply

Please forward any records that exist for the aforementioned property or any other pertinent information, at your earliest convenience. Also, please notify Partner if there are any costs associated with this request prior to processing. Also, please respond to this email stating whether you received it and/or the approximate date we will have these records, it is very imperative.

Rose Dunn
Team Assistant

PARTNER ENGINEERING AND SCIENCE, INC.
8422 Bellona Lane, Suite 301, Baltimore, MD 21204
O: 410-390-4897 F:443-377-3895

Dunn, Rose

From: DNR Records Response <DNRRecordsResponse@wisconsin.gov>
Sent: Friday, June 22, 2018 5:38 PM
To: Dunn, Rose
Cc: DNR Records Response
Subject: RE: 18ORR5941: Fox Shores Apartments, 400 Fox Shores Drive, Kaukauna

Hi Rose,

In response to your open records request, submitted on June 15, 2018, the department has searched for records pertaining to Fox Shores Apartments, 400 Fox Shores Drive, Kaukauna, WI and the following:

- Current of historical use of hazardous materials and/or hazardous waste
- Groundwater monitoring wells
- Current or historical clarifiers, oil/water separators, grease traps, interceptors
- Incidents of lead or asbestos, fires, leaks [USTs/ASTs] and spills
- Code Violations or Notices to Comply

The Wisconsin Department of Natural Resources has concluded its search and located no records responsive to your request. The open records request will be closed. Please let me know if you have any questions.

Sincerely,

We are committed to service excellence.
Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Phil Derge
Phone: (608) 264-6125
Philip.Derge@wisconsin.gov

From: DNR Records Response
Sent: Monday, June 18, 2018 4:59 PM
To: Dunn, Rose <RDunn@partneresi.com>
Cc: DNR Records Response <DNRRecordsResponse@wisconsin.gov>
Subject: 18ORR5941: Fox Shores Apartments, 400 Fox Shores Drive, Kaukauna

Hello,

We have received your request and have begun processing it.

Sincerely,

We are committed to service excellence.
Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

DNR Records Response
Wisconsin Department of Natural Resources
Phone: (608) 266-2177
dnrrecordsresponse@wisconsin.gov


dnr.wi.gov

From: Dunn, Rose [mailto:RDunn@partneresi.com]
Sent: Friday, June 15, 2018 4:12 PM
To: DNR Records Response <DNRRecordsResponse@wisconsin.gov>
Subject: DEQ VIOLATIONS/RECORDS REQUEST - Fox Shores Apartments - 215232.1

DEQ VIOLATIONS/RECORDS REQUEST

Partner Engineering and Science, Inc. is conducting a Phase I Environmental Site Assessment and/or a Property Condition Report Assessment on the following property:

Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project 215232.1

As part of the investigation, we are requesting, under the Freedom of Information Act, any environmental health records you have for the above-referenced property pertaining to the following:

- Current or historical use of hazardous materials and/or hazardous waste
- Groundwater monitoring wells
- Current or historical clarifiers, oil/water separators, grease traps, interceptors
- Incidents of lead or asbestos, fires, leaks [USTs/ASTs] and spills
- Code Violations or Notices to Comply

Please forward any records that exist for the aforementioned property or any other pertinent information, at your earliest convenience. Also, please notify Partner if there are any costs associated with this request prior to processing. Also, please respond to this email stating whether you received it and/or the approximate date we will have these records, it is very imperative.

Rose Dunn
Team Assistant

PARTNER ENGINEERING AND SCIENCE, INC.
8422 Bellona Lane, Suite 301, Baltimore, MD 21204
O: 410-390-4897 F:443-377-3895

Dunn, Rose

From: Dunn, Rose
Sent: Friday, June 15, 2018 5:14 PM
To: 'DSPSSBPlanSchedule@Wi.gov'
Subject: FIRE CODE VIOLATION/ INFORMATION REQUEST - Fox Shores Apartments - 215232.1

FIRE CODE VIOLATION/ INFORMATION REQUEST
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project 215232.1

Partner Engineering and Science, Inc. (Partner), a National Real Estate Due Diligence Firm, is conducting a Property Capital Needs Assessment and/or an Environmental Site Assessment for the above-referenced site(s) on behalf of a financial services client. These assessments are being conducted in accordance with rules and regulations of conventional Freedom of Information Act provisions. Therefore, we are requesting the following information to include in our reports:

- Are there any unresolved Notices of Violation or Notices to Comply documents filed against the property?
  ____Yes ____No [If Yes, please provide details on an attached sheet.]
- How frequently is the property inspected by the Fire Department/Fire Marshal?
  ___During Construction ___To investigate a complaint ___Annually
  ___Never ___Other [please describe] _____
- Date of last inspection:_____
  [Please provide a copy, as available.]
- Are there any current records related to the following: ___Yes ___No
  [If Yes, please provide details on an attached sheet.]
  a. Current or historical use of hazardous materials/waste
  b. Storage or release of hazardous materials/waste
  c. Current or historical underground/aboveground storage tanks [USTs/ASTs]
  d. Current or historic clarifiers
  e. Any HAZMAT responses to the property
  [Please provide copies, as available.]

Additionally (if applicable), please provide information/certification that the sprinkler system is in compliance with the 1999 Edition of the National Fire Protection Association's (NFPA) "Standard for the Installation of Sprinkler Systems" (NFPA 13), and the 1998 edition of the NFPA "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems" (NFPA 25).

Rose Dunn
Team Assistant

PARTNER ENGINEERING AND SCIENCE, INC.
8422 Bellona Lane, Suite 301, Baltimore, MD 21204
O: 410-390-4897 F:443-377-3895

APPENDIX D: QUALIFICATIONS

PARTNER

Education

Bachelor of Science, Civil Engineering, Manhattan College, 1990
Associates Degree, Civil Technology, SUNY Delhi, 1986

Registrations

Engineer in Training Certificate (E.I.T)
HUD MAP and LEAN Certification

Training

HUD MAP and LEAN Certification
Fannie Mae

Highlights

20 years of professional commercial real estate due diligence related experience
Property Condition Assessments (PCAs), Including Equity Scope on all property types
HUD MAP and LEAN Property Condition Needs Assessments (PCNAs)
Fannie Mae and Freddie Mac Physical Needs Assessments (PNAs)
Construction Document Plan and Cost Reviews

Experience Summary

Mr. Hetner is a Senior Assessor for Partner Engineering and Science, Inc. (Partner). His responsibilities include conducting equity scope PCAs for real estate investors on all property types and HUD MAP and LEAN PNAs. Mr. Hetner provides support and training for Partner's Chicago staff. Mr. Hetner has performed hundreds of Property Condition Assessments (PCA) at projects located throughout the US, managed thousands of PCAs and related due diligence reports, dozens of Phase I ESA surveys, over fifty HUD MAP and LEAN PCNAs, and performed over one hundred construction monitoring site visits. Mr. Hetner has also provided many specialty services such as, Construction Plan and Cost Reviews, Property Improvement Plan (PIP) reviews and cost estimates for hotels, equity scope PCAs, multi-family property management, and Fannie Mae and Freddie Mac PNAs.

Prior to entering the commercial real estate due diligence field Mr. Hetner was a structural engineer for a large international engineering company located in New York City and was a Civil Engineer for a mid-sized company located in Long Island, New York.

Project Experience

Spring Creek Apartments, Brooklyn, New York. Conducted a Freddie Mac Scope PCA of the Spring Creek apartment complex a 5,881 unit complex with its own on-site 18-megawatt power plant. The property, valued at over $1.0 billion, was the largest deal in Freddie Mac history.

Thompson Center State Office Building, Chicago, Illinois. Conducted a PCA of the Thompson Center, an approximately 1.8 million square feet, state office tower located in Chicago's central Loop District. The building, a Chicago landmark, features an interior 17-story atrium with 13 floors of balconies overlooking a central rotunda. The building utilizes a thermal storage system for cooling.

Trump/GM Building, New York City, New York. Conducted a PCA of the Trump/GM Building, a 1.8 million square foot, 50-story tower located in midtown Manhattan. The property was valued at over $1.0 billion at the time of the assessment.

Museum Park East and Museum Park Place South, Chicago, Illinois. Performed and managed equity scope PCAs with Reserve Studies for 53-story and 30-story luxury condominium tower properties located in Chicago's South Loop. Served as the generalist engineer while coordinating and managing a team of specialists including façade; roof; elevator; structural; and mechanical, electrical and plumbing (MEP) experts. Compiled the findings and Immediate Repair and Replacement Reserves cost details into comprehensive PCA reports for both properties. The scope of work included Mr. Hetner's development of 20-year reserve budgets for the condominium associations to ensure that condo owner assessment levels were set at consistent levels and were sufficient to cover projected immediate and future repair and maintenance.

Fixed Based Operator (FBO) Buildings, Detroit Metropolitan Airport, Romulus, Michigan. Performed equity scope PCAs for two FBO hangar buildings located within Detroit Metropolitan Airport. Served as the generalist engineer and compiled the findings and Immediate Repair and Replacement Reserves cost details into comprehensive PCA reports for both properties.

Marshall Field Garden Apartments, Chicago, Illinois. Performed a Physical Needs Assessment (Fannie Mae Scope) of a 10 building, 628 unit apartment complex. The complex was constructed in 1929 and is listed on the National Register of Historic Places.

Key Center, Cleveland, Ohio. Performed an equity scope PCA of the Key Center, a mixed-use (office/hotel/parking) complex located in Downtown Cleveland. The complex consists of the 63-story (947 foot tall), 1.39 million square foot Key Center Tower (tallest building between New York City and Chicago); a 27-story full service 400 room Marriott Hotel; a 10-story historical office building constructed in 1890; and, a 982 space parking garage situated below a public plaza.

Willis Tower (formerly Sears Tower), Chicago, Illinois. Performed and managed an equity scope PCA of the iconic 110-story (1,450 foot tall), 4.15 million gross square foot tower. Served as a generalist engineer while coordinating and managing a team of specialists including façade; roof; elevator; structural; fire/life safety; and mechanical, electrical and plumbing (MEP) experts. Acted as liaison between all specialists and Willis Tower staff to ensure timely access was provided and scope requirements were being met. Assisted Partner Equity PCA staff with compiling the findings and Immediate Repair and Replacement Reserves cost details into a comprehensive PCA report.

Contact

jhetner@partneresi.com

Education

B.S., Fisheries and Wildlife Sciences; Aquatic Track, University of Missouri

Highlights

5 years of experience performing environmental due diligence assessments
3 years of experience performing environmental assessments for agencies such as HUD, Fannie Mae, SBA
3 years of completing Property Condition Assessments
2 years of experience performing specialized scope assessments for the oil and gas industry
2 years of experience working alongside the Missouri Department of Conservation and United States Fish and Wildlife Service

Experience Summary

Mr. Chiu is a Project Manager for Partner Engineering and Science, Inc. (Partner). In his role of Project Manager, Mr. Chiu is responsible for performing Phase I Environmental Site Assessments (ESA), Property Condition Assessments (PCA), Naturally Occurring Radioactive Material (NORM) Surveys and Exit Audits in line with the American Society of Testing and Materials (ASTM) standard and US Environmental Protection Agency's All Appropriate Inquiry (AAI) as well as customized client formats. Mr. Chiu's responsibilities as a Project Manager also include reviewing Phase I ESAs and PCAs, and include supervision of in-house and contracted staff, overall responsibility of project scope/design, and the project and task implementation/execution.

Project Management

Mr. Chiu has managed and reviewed projects for multiple National Client Managers. Clients served include equity-level investors, national and regional banks, life insurance companies, mortgage lending agencies and non-profit organizations. Mr. Chiu's daily responsibilities include identifying qualified assessors for various projects, reviewing ESA and PCA reports, and managing site-specific questions clients may have during the course of an assessment. Additionally, Mr. Chiu is responsible for managing project budgets and maintaining profitability for multiple National Client Managers.

Field Work

Prior to working as a Project Manager, Mr. Chiu completed over 400 projects located throughout Texas as well as 17 other states in the country. Mr. Chiu worked closely with state and local regulatory agencies to obtain environmentally significant documents regarding tank removal and subsurface investigations performed onsite. Mr. Chiu has worked for large financial institutions as well as private investors and has also performed work for the Federal Deposit Insurance Corporation, United States Department of Housing and Urban Development, Fannie Mae, and Small Business Administration. Mr. Chiu has also completed Property Condition Assessments for three years for various commercial, industrial, medical, and multi-family properties.

Previous Work

Mr. Chiu served as a project leader for an environmental analysis of a 322-acre former mining site owned by the Missouri Department of Conservation. His team's remediation proposal was ultimately reviewed by various state agencies for submission. Mr. Chiu has conducted numerous multi-parameter limnological and groundwater surveys at across the state of Missouri at sites such as Rocky Forks Conservation Area, Eagle

Bluffs Conservation Area Finger Lakes State Park and Little Dixie State Park and Recreation area. He also has experience working with federal agencies such as the U.S. Fish and Wildlife Service. He worked alongside U.S. Fish and Wildlife professionals sampling the Missouri River for an endangered aquatic species.

Project Experience

Industrial

Heavy Industrial Shipping Port, Houston, TX. Mr. Chiu managed the Phase I Environmental Site assessment of a 600-acre heavy industrial shipping port that included numerous tenants, railroad switch-yards, and deep-water shipping channels. Mr. Chiu worked closely with onsite personnel and state regulatory agencies to identify areas of concern, permitting needs, and historic operations across the property.

Industrial Plating Facility, Royse City, TX. Mr. Chiu performed a Phase I Environmental Site Assessment on an industrial plating facility for a potential purchaser of the property, identifying potential areas of concern.

Polyvinyl Chloride Plant, Lawton, OK. Mr. Chiu performed a Phase I Environmental Site Assessment on a polyvinyl chloride plant (PVC) for a national bank client seeking to identify environmental risk associated with lending on the property.

Airport Refueling Operator, Tulsa, OK and Dallas, TX. Mr. Chiu performed Phase I Environmental Site Assessments on airport refueling centers at international airports in Tulsa, Oklahoma and Dallas, Texas for a potential purchaser of the property, identifying potential areas of concern.

Multi-family

Multi-family, Canon City, Clifton, Buena Vista and Lakewood, CO. Mr. Chiu performed Phase I Environmental Site Assessments and Property Condition Assessments on apartment complexes across the state of Colorado in accordance with the Fannie Mae scope of work.

Multi-family, Tulsa, OK. Mr. Chiu performed Phase I Environmental Site Assessments on apartment complexes in Tulsa, Oklahoma in accordance with the Fannie Mae scope of work.

Multi-family, Little Rock, AR. Mr. Chiu performed Phase I Environmental Site Assessments and Property Condition Assessments on two apartment complexes in Little Rock, Arkansas.

Multi-family, Denton, TX. Mr. Chiu performed a Phase I Environmental Site Assessments on apartment complex in Denton, Texas in accordance with the United States Department of Housing and Urban Development scope of work.

Equity

Office Towers, Honolulu, HI. Mr. Chiu performed Phase I Environmental Site Assessments on four landmark office towers in downtown Honolulu, Hawaii as part of an acquisition for an equity client. The assessments occurred over the course of four days, and included daily briefings and de-briefings with the client.

Historic Office Building, Bentonville, AR. Mr. Chiu performed a Phase I Environmental Site Assessment and a Property Condition Assessment on a historic office building in downtown Bentonville, Arkansas that is home to the original retail location of a large, multi-national retail chain.

Golf Course Portfolio, Grapevine and Mansfield, TX. Mr. Chiu performed a Phase I Environmental Site Assessments on two semi-private golf courses as part of an acquisition for an equity client.

Oil and Gas Industry

Oil and Gas Exploration Yards, Texas, Oklahoma, Louisiana and New Mexico. Mr. Chiu has performed numerous NORM surveys, Phase I Environmental Assessments and Exit Audits for oil and gas exploration properties that include fracking equipment, active and decommissioned wells, machine maintenance, and bulk fuel storage.

Decommissioned Natural Gas Extraction Plant, Andrews, TX. Mr. Chiu performed a Phase I Environmental Site Assessment on a former natural gas extraction plant for a potential purchaser seeking to identify environmental risk associated with the acquisition of the property.

Saltwater Injection Wells, Various Sites, TX. Mr. Chiu performed Phase I Environmental Site Assessments on numerous saltwater injection wells across the state of Texas for an oil and gas exploration service company.

Affiliations

North Texas Commercial Association of Realtors and Real Estate Professional, Young Professional Forum
National Association for Industrial and Office Parks, Developing Leaders

Contact

schiu@partneresi.com

Angelique Crews
Senior Project Manager

Education

Studies in Marine Biology, University of North Carolina at Wilmington
A. A. S. Marine Technology, Cape Fear Community College

Registrations

North Carolina AHERA Asbestos Inspector (License No. 11563)
South Carolina AHEREA Asbestos Inspector (License No. 22418)
Confined Space Entry Certification
Wetland Determination/Stream Identification/Hydric Soils Identification Certification
South Carolina Lead Inspector/Risk Assessor Certification
40-Hour OSHA Training and 8-Hour Annual Refreshers
HUD - Multifamily Property Inspection Certification
National Radon Proficiency Program (NRPP) Residential Measurement Provider (License No. 108203 RT)

Training

EPA/AHERA - Asbestos in Buildings: Inspection and Assessment
OSHA (Occupational Safety and Health Administration) – 40 hour HAZWOPER

Experience Summary

Ms. Crews serves as a Senior Project Manager for Partner Engineering and Science, Inc. (Partner), and has performed assessments on numerous commercial, multi-family and industrial facilities. Ms. Crews is familiar with all standards of Due Diligence Property Assessments and the needs and requirements of a varied number of reporting standards, including the Phase I Environmental Site Assessment (E1527-13), Fannie Mae, Freddie Mac, Housing and Urban Development (HUD) Multi-Family Accelerated Processing (MAP) and LEAN Guidelines, customized client formats or scopes, along with Phase II Subsurface Investigations, soil and groundwater remediation, regulatory compliance audits, asbestos surveys and indoor air quality studies.

Real estate investors, lenders, and real estate equity funds have come to rely on Ms. Crews' advice and judgment to assist them with their real estate business decisions. Prior to joining Partner, Ms. Crews was a Project Manager in charge of the various Phase I Environmental Site Assessments (ESAs) and Phase II subsurface investigations. In that capacity, she was responsible for all ESAs, subsurface work, report reviews, and client relations.

Additionally, Ms. Crews was also an Environmental Scientist/Project Manager for an environmental/engineering firm where she was an integral member of the team. She performed and managed environmental assessment activities on various industrial, commercial, institutional and residential properties such as air monitoring assessments; and, soil and groundwater investigations. She has also managed environmental planning and permit requirements associated with a variety of environmental assessments such as wetland determinations/delineations; comprehensive asbestos surveys and Operations & Maintenance Plans; and, Spill Prevention, Control & Countermeasure Plans. Additionally, she has prepared applicable reports in formats prescribed by various fiduciary institutions and performed peer reviews on environmental site assessments completed by others.

Project Experience

Mixed-Use Complex, Yonkers, New York. Managed the completion of Phase I Environmental Site Assessment to Fannie Mae protocol, inclusive of an ongoing, extensive subsurface groundwater investigation due to the former presence of a former industrial facility, former gasoline service station and current dry cleaning facility.

Mixed-Use Complex, Milwaukee, Wisconsin. Managed the completion of Phase I Environmental Site Assessment to HUD MAP guidelines and radon measurement activities. The assessment was complicated due to the presence of historical tenants that included a foundry, manufacturing gas light facility and an oil warehouse facility.

Healthcare Facility, Dunkirk, New York. Managed the completion of Phase I Environmental Site Assessment on a healthcare facility, which led to the identification of a formerly closed underground storage tank (UST). Ms. Crews oversaw thorough local and regulatory research to identify that the tank was improperly closed, which led to an extensive and ongoing subsurface investigation. Ms. Crews also developed an Operations and Maintenance program for the management of asbestos-containing materials within the facility.

Gasoline service stations, various locations. Conducted, managed, and/or reviewed Phase I Environmental Site Assessments on operating and closed gasoline service stations throughout the continental United States. Conducted extensive reviews of subsurface investigations to evaluate the potential for the presence of residual contamination or undiscovered contamination to remain in place.

Affiliations

The American Association of Radon Scientists and Technologists (AARST)

Speaking

Prudential Mortgage Capital Company (PMCC), Consultant Conference, Charleston, South Carolina, 2015
Ms. Crews presented an overview of the proposed new DRAFT HUD MAP Guide, to include radon testing protocols and the capital needs assessment electronic tool (CAN e-Tool) to colleagues, and peers.

SunTrust Bank, Inc., Team Meeting, Webinar, Charlotte, North Carolina, 2015
Ms. Crews presented a webinar outlining radon guidelines to include testing, result interpretation and mitigation measures and alternatives.

Contact

acrews@partneresi.com

SITE INVESTIGATION REPORT

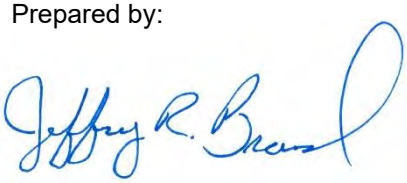
FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

BRRTS #02-45-582746

Stantec

Prepared for:
Fox Investments LLC

Prepared by:



Jeffrey R. Brand
Environmental Scientist



Lynelle P. Caine
Associate



Stu Gross, PG
Associate

Project No. 193706620
June 9, 2020

Design with community in mind

Table of Contents

LIST OF ACRONYMS AND ABBREVIATIONS III

1.0 GENERAL INFORMATION 1

2.0 INTRODUCTION 2
2.1 BACKGROUND INFORMATION 2
2.2 REGIONAL PHYSIOGRAPHY, GEOLOGY, AND HYDROGEOLOGY 3

3.0 INVESTIGATION RATIONALE AND METHODOLOGY 4
3.1 SCOPING INFORMATION 4
3.2 SEQUENCE OF ACTIVITIES 4
3.3 SUB-SLAB VAPOR POINT INSTALLATION AND AIR SAMPLING 5
3.4 SOIL BORING COMPLETION AND SOIL SAMPLING 5
3.5 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING 5
3.6 SUMMARY OF FIELD, LABORATORY, AND OTHER DATA COLLECTED 6

4.0 APPLICABLE CLEAN-UP CRITERIA 7

5.0 SITE INVESTIGATION FINDINGS 8
5.1 SITE HYDROGEOLOGIC CONDITIONS 8
5.2 NATURE AND EXTENT OF SOIL IMPACTS 8
5.3 NATURE AND EXTENT OF GROUNDWATER IMPACTS 9
5.4 MIGRATION PATHWAYS AND POTENTIAL RECEPTORS 9
5.4.1 Groundwater/Surface Water Impacts 9
5.4.2 Utilities 9
5.4.3 Vapor Intrusion 9

6.0 CONCLUSIONS, RECOMMENDATIONS, AND LIMITATIONS 11
6.1 CONCLUSIONS AND RECOMMENDATIONS 11
6.2 LIMITATIONS 11

7.0 REFERENCES 12

8.0 CERTIFICATION 13

Table of Contents – con't

LIST OF FIGURES

Figure 1: Site Location and Local Topography
Figure 2: Site Layout
Figure 3: Site Layout with Soil Boring and Soil Gas Sample Locations
Figure 4: Site Layout with Temporary Monitoring Well Locations
Figure 5: Groundwater Contour Map (08/28/19)
Figure 6: Estimated Extent of Soil Contamination
Figure 7: Estimated Extent of Groundwater Contamination
Figure 8: Cross-Section A-A'
Figure 9: Geologic Cross-Section Figure A-A'

LIST OF TABLES

Table 1: Soil Field Screening Results
Table 2a: Soil Sample RCRA Metals Laboratory Results
Table 2b: Soil Sample PAH Laboratory Results
Table 2c: Soil Sample VOC Laboratory Results
Table 3a: Groundwater Sample RCRA Metals Laboratory Results
Table 3b: Groundwater Sample PAH Laboratory Results
Table 3c: Groundwater Sample VOC Laboratory Results
Table 4: Air Quality Laboratory Results
Table 5: Water Level Elevations

LIST OF APPENDICES

Appendix A: Soil Boring Logs
Appendix B: Soil Boring Abandonment Forms
Appendix C: Monitoring Well Construction and Development Forms
Appendix D: Soil Analytical Reports and Chain-of-Custody Forms
Appendix E: Groundwater Analytical Reports and Chain-of-Custody Forms
Appendix F: Air Analytical Reports and Chain-of-Custody Forms
Appendix G: Partner Engineering and Science, Inc. - Phase II Subsurface Investigation Report
Appendix H: Apartment Building Schematics and Materials Safety Data Sheet

List of Acronyms and Abbreviations

BRRTS	Bureau of Remediation and Redevelopment Tracking System
bgs	Below ground surface
BTV	Background Threshold Value
EPA	Environmental Protection Agency
ES	Enforcement standard
ESA	Environmental Site Assessment
eV	Electronvolt
fbg	Feet below grade
iu	isobutylene
LNAPL	Light Non-Aqueous Phase Liquid
NR140	Chapter NR140 Wisconsin Administrative Code
NR716	Chapter NR716 Wisconsin Administrative Code
NR720	Chapter NR720 Wisconsin Administrative Code
PAH	Polynuclear aromatic hydrocarbons
PAL	Preventive action limit
Partner	Partner Engineering and Science, Inc
PCE	Tetrachloroethene (perchloroethene)
PID	Photoionization detector
PVC	Polyvinyl chloride
RCL	Residual contaminant level
RCRA	Resource Conservation and Recovery Act
REC	Recognized environmental condition
SI	Site Investigation
Stantec	Stantec Consulting Services, Inc.
TA	Test America
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VISL	Vapor Intrusion Screening Level
VOC	Volatile organic compound
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
WGNHS	Wisconsin Geological and Natural History Survey

1.0 General Information

The following is general information required as part of Site Investigation (SI) reports prepared under Chapter NR716 Wisconsin Administrative Code (WAC).

1. Project Title and Purpose	
	Site Investigation Report
2. Key Site Contact Information	
Owner:	GTFC Investments LLC
	180 Fox Shores Drive, Kaukauna, Wisconsin 54130
	Contact: Clay Eiting
Responsible Party:	Fox Investments LLC - Thomas R. Vandeyacht
3. Consultant Information	
	Stantec Consulting Services Inc.
	1165 Scheuring Road, De Pere, Wisconsin 54115
	Contact: Jeffrey R. Brand, Environmental Scientist
	Phone: (920) 278-3208
4. Site Information	
Site Name:	Fox Shores Apartments
Address:	400 Fox Shores Drive, Kaukauna, WI
Location:	City of Kaukauna, Outagamie County, WI 54130 SE ¼ of the NE ¼ of Section 23, T21N, R18E
Coordinates:	Latitude: 44.2809813; Longitude: -88.2752825
5. Regulatory Information	
WDNR Contact:	Jennifer Borski
	Email: jennifer.borski@wisconsin.gov
	625 E County Road Y, STE 700, Oshkosh, WI 54901
	Phone: (920) 424-7887
BRRTS #:	02-45-582746

BRRTS = Bureau of Remediation and Redevelopment Tracking System

2.0 Introduction

This section presents background information, a summary of previous environmental activities or studies, and information on the regional physiographic, geologic, and hydrogeologic conditions.

2.1 BACKGROUND INFORMATION

The Property consists of three parcels comprising approximately 3.22 acres to the north and west of Fox Shores Drive within a mixed commercial and residential area of Kaukauna, Wisconsin. The Property is currently occupied by Fox Shores Apartments for residential use. Current improvements on the Property consist of apartment buildings with paved parking areas and landscaping. Site location and layout are shown on Figures 1 and 2.

According to historical sources, the Property was developed as early as the 1890s. The Property and vicinity were developed as part of the Chicago and Northwest Railroad Shops. Areas of the Site were formerly utilized as a carpentry shop, machine shop, repair shop, engine room, coal room, blacksmith shop, supply warehouses, tin shop, and pipe shed. In 1983 the Property was redeveloped into multi-family residential apartments along Bicentennial Court. Additional apartments were later developed along Fox Shores Drive in 1992. Stantec understands that Partner Engineering and Science, Inc. (Partner) completed a Phase I Environmental Site Assessment (ESA) at the Property during July 2018. Several recognized environmental conditions (RECs) were identified during the Phase I ESAs; some of which included the following:

- The United States Army Corps of Engineers – Parcel J (Kaukauna Power Canal) is an open Environmental Repair Program case on the Wisconsin Bureau for Redevelopment and Remediation Tracking (WI BRRTS) database. The case exists adjacent to the west of the Property and has been identified with lead impacts in soil;
- Ghost Town Fitness Center located at 180 Fox Shores Drive is adjacent to the Site (east) and is associated with arsenic and selenium groundwater impacts;
- Kaukauna Waste Oil Collection Site located at 201 West 2nd Street, 222 3rd Street, and 3rd Street 200 Block is adjacent to the Site (south) and is associated with petroleum soil and groundwater impacts.

To evaluate the RECs, a Phase II ESA was performed by Partner at the Property in November of 2018. As part of the Phase II ESA, five soil borings were completed for the collection of representative soil and groundwater samples along with the installation of three temporary sub-slab vapor sampling points. The Phase II ESA identified Resource Conservation and Recovery Act (RCRA) metals in soil at concentrations in excess of Wisconsin Administrative Code (Wis. Adm. Code) NR720 residual contaminant levels (RCLs). Polynuclear aromatic hydrocarbons (PAHs) were also detected in the groundwater in excess of the Wis. Adm. Code NR140 preventive action limit (PAL) and/or enforcement standards (ES) at the Site. Finally, dichlorodifluoromethane was detected above Wisconsin Department of Natural Resources (WDNR) residential sub-slab vapor risk screening levels. The Partner Phase II ESA report is included in Appendix G.

On December 3, 2018 Stantec was hired by Fox Investments, LLC to notify the WDNR of soil and groundwater contamination at the Site and possible vapor intrusion of dichlorodifluoromethane into Site buildings. On January 7, 2019, the WDNR opened BRRTS case #02-45-582746 for the Site and requested additional investigation to further characterize and define the extent of contamination at the Site and complete remedial actions needed for Site closure. Due to the potential health threat of vapor intrusion, the WDNR requested that immediate actions be taken to investigate potential vapor intrusion impacts within the apartments at the Site.

On February 25, 2019 Stantec conducted ambient air sampling within three apartment units. On February 26, 2019, Stantec personnel installed three sub-slab vapor points (VP-4, VP-5, and VP-6) within the same

three apartment units where the ambient air samples were collected. An additional vapor point was also installed immediately adjacent to original vapor point (VP-2) from the November 2018 Phase II ESA completed by Partner Engineering and Science, Inc. (Partner).

On August 13, 2019 Stantec conducted additional sub-slab vapor sampling at vapor points VP-4, VP-5, and VP-6 within three apartment units at the Site. Samples were collected within the cooling months of summer to contrast earlier samples collected during the heating months of winter. Vapor samples were again sampled for dichlorodifluoromethane using Environmental Protection Agency (EPA) method TO-15.

With elevated dichlorodifluoromethane sub-slab concentrations at the Site, a source for the contamination was investigated. In order to determine a source for the sub-slab vapor issues at the Site, soil and groundwater investigation activities were conducted across the Site from May 2019 to April 2020. Interspersed pieces of foundry slag, and/or coal were identified in many of the borings from two to four feet below ground surface (bgs) and likely represents historic urban fill.

Due to the lack of dichlorodifluoromethane in soil samples collected at the Site, Stantec and the property owner continued to search for potential sources for the vapor intrusion issues. Upon further investigation, it was discovered that extruded polystyrene foam board was used as insulation on the interior foundation walls of the apartment buildings. It was further determined that dichlorodifluoromethane was a component that made up the extruded polystyrene foam insulation.

After determining that the extruded polystyrene foam board used on the apartment building's foundation walls could potentially be the source of the vapor intrusion issues at the Site, discussions were conducted with the DNR. During those discussions, it was determined that construction/building materials are unregulated and that a subsequent release from these materials would not warrant further vapor assessment or require remedial action to be conducted.

Further investigation, however, was warranted to characterize and define the extent of soil and groundwater contamination and aid the creation of a remedial action plan for the Site. To meet assessment requirements by the WDNR, field sampling, laboratory, and investigative activities were performed in accordance to the WDNR approved site investigation workplan submitted to the WDNR April 16, 2019 (Stantec, 2019).

2.2 REGIONAL PHYSIOGRAPHY, GEOLOGY, AND HYDROGEOLOGY

According to the Wisconsin Geological and Natural History Survey (WGNHS), the regional surface geology is described as glacial till of the Glenmore Member of the Kewaunee Formation, deposited by ice of the western part of the Green Bay Glacial Lobe during Wisconsin's last glaciation (WGNHS, 2011). Glacial soils in this area consist of varying amounts of silt and clay with lesser amounts of sand. The Glenmore member is the surficial unit in the very southeastern places in Outagamie County east of the Fox River; however, it is sporadically overlain by lacustrine silt or clay of younger and/or unnamed units (Mickelson et. al. 1984). Results of the SI identified native and non-native soils at the Site.

The bedrock in Outagamie County typically consists of dolomite, limestone, and shale of the Galena Formation of the Sinnipee Group (Luczaj, 2011). Depth to bedrock is estimated to exist between 5 and 50 feet below grade (fbg). Bedrock was believed to be encountered during this investigation of the Property.

The shallow water table is often a subdued expression of surface topography. Shallow groundwater in unconsolidated glacial sediments generally flows from areas of groundwater recharge, such as hills and broad uplands, to areas of groundwater discharge, such as wetlands, rivers, and lakes. Based on the local surface topography, regional shallow groundwater is expected to flow southeast along the Fox River. Other man-made features such as wells, roads, filled areas, buried utility lines, sewers, and drainage ditches may alter the natural shallow groundwater flow direction. The depth to groundwater was observed in site monitoring wells from approximately 3.5 to 6 fbg.

Potable water at the Site is obtained from the City of Kaukauna municipal water system which is supplied by five groundwater wells located throughout the city. Depths of the wells range from 500 to 850 feet deep.

3.0 Investigation Rationale and Methodology

This section presents details for the methods of investigation used during the SI.

3.1 SCOPING INFORMATION

The SI was focused on assessing known or potential environmental concerns discovered at the Site during the previous Phase II ESA. These concerns included:

1. Further evaluating potential vapor intrusion impacts within the apartments at the Site.
2. Further characterize and define the extent of soil and groundwater contamination at the Site and complete remedial actions needed for Site closure.

To address these concerns, 27 soil borings, 4 sub-slab vapor points, and 5 temporary monitoring wells were installed on the Site to define the extent of known contamination identified during the previous investigative work.

3.2 SEQUENCE OF ACTIVITIES

The sequence of activities performed as part of the SI are summarized below.

	Dates	Activity Description
Site Investigation Schedule	10/03/2018	Phase II ESA initiated by Partner Engineering and Science, Inc. with the completion of borings (B1 through B5), installation of vapor sampling points (VP-1 through VP-3), and installation of temporary monitoring wells (B1-GW through B5-GW). (See Appendix G)
	02/25/2019	Ambient air sampling completed in three of the apartment buildings on-site.
	02/26/2019	Collect ambient air samples from apartments. Install and sample sub-slab vapor points (VP-4, VP-5, VP-6) in apartments in which ambient air samples were collected. Install and sample sub-slab vapor point (VP-2R) in water softener shed.
	05/14/2019	Completion of hand auger borings (SB6 through SB10-1).
	08/13/2019	Sample sub-slab vapor points (VP-4, VP-5, VP-6).
	08/21/2019	Completion of borings (SB10-2 through SB17) and installation of temporary monitoring wells (TW10, TW11, TW13, TW15, and TW17). Complete survey and development of temporary wells.
	08/28/2019	Groundwater samples and elevations collected from temporary monitoring wells (TW10, TW11, TW13, TW15, and TW17).
	04/15/20	Complete hand auger borings (HA-1 through HA-14).
	04/16/2020	Groundwater samples and elevations collected from temporary monitoring wells (TW10, TW11, TW13, TW15, and TW17).

3.3 SUB-SLAB VAPOR POINT INSTALLATION AND AIR SAMPLING

On February 25, 2019 Stantec conducted ambient air sampling within three apartment units. On February 26, 2019, Stantec personnel installed three sub-slab vapor points (VP-4, VP-5, and VP-6) within the same three apartment units where the ambient air samples were collected. An additional vapor point was also installed immediately adjacent to original vapor point (VP-2) from the November 2018 Phase II ESA completed by Partner Engineering and Science, Inc. (Partner). Sub-slab vapor point locations can be found on Figure 3. Vapor samples were analyzed for dichlorodifluoromethane using United States Environmental Protection Agency (U.S. EPA) method TO-15.

On August 13, 2019 Stantec conducted additional sub-slab vapor sampling at vapor points VP-4, VP-5, and VP-6 within three apartment units at the Site. Samples were collected within the cooling months of summer to contrast earlier samples collected during the heating months of winter. Vapor samples were again sampled for dichlorodifluoromethane using EPA method TO-15.

3.4 SOIL BORING COMPLETION AND SOIL SAMPLING

Between May 14, 2019 and April 15, 2020, Stantec completed 27 soil borings (SB6 through SB17; HA-1 through HA-14) on the Site by either hand auger or truck mounted GeoProbe® operated by Geiss Soil and Samples, LLC of Merrill Wisconsin. During this time, Stantec personnel collected soil samples from the borings for field screening and laboratory analysis.

Each soil boring was drilled to minimum of 1.5 feet bgs and a maximum depth of 10 feet bgs. Soil was sampled continuously from the ground surface to the total depths explored. Samples were collected for environmental purposes to evaluate if soil and/or groundwater was impacted by previous site uses. Soil boring locations are illustrated on Figure 3. Geologic soil boring logs are presented in Appendix A.

Each soil sampling interval was divided into two aliquots - one used for field screening purposes and one used to supply materials for potential submittal to a laboratory for chemical analysis. The laboratory aliquot for each soil sample was immediately placed in laboratory provided containers, sealed, and placed in a cooler with ice. The other portion of each sample was placed into plastic Ziploc® bags and used for field screening the presence of volatile organic compounds (VOCs) using a photoionization detector (PID) equipped with an 11.7 electronvolt (eV) lamp. All non-disposable soil sampling equipment was washed with a detergent solution and double-rinsed with organic-free tap water before and after each soil sample was collected to prevent sample cross-contamination.

In all borings, the corresponding soil sample(s) exhibiting the highest PID reading or within a specified depth interval was submitted for laboratory analysis for combinations of either VOCs, PAHs, or RCRA metals. Soil samples were submitted under chain-of-custody procedures and analyzed by Eurofins TestAmerica (TA) in Chicago, Illinois.

Soil borings not converted into temporary monitoring wells were immediately abandoned in accordance with Chapter NR 141.25, WAC by backfilling with bentonite after the completion of drilling and soil sampling. WDNR Borehole Abandonment Forms are presented in Appendix B.

3.5 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING

Temporary monitoring wells were installed in five of the soil borings (SB10-2, SB11, SB13, SB15, and SB17) and designated as TW10, TW11, TW13, TW15, and TW17, respectively. The monitoring wells were constructed using 1-inch inner diameter, Schedule 40 polyvinyl chloride (PVC) casing and 10-foot lengths of factory slotted PVC screen (0.010-inch slot) that were positioned to straddle/intersect the water table. Monitoring well locations are shown on Figure 4.

Construction and development of the monitoring wells was conducted in accordance with Chapter NR 141, WAC. Monitoring well sampling was conducted in accordance with WDNR guidance (WDNR, 1996). WDNR Monitoring Well Construction and Well Development Forms are included as Appendix C. The location of each monitoring well was documented using a GPS with the vertical height of the ground

surface and riser elevation surveyed at each monitoring well location. Groundwater samples were collected from the Site monitoring wells on August 28, 2019 and April 16, 2020 using low flow sampling techniques. As part of the groundwater sample collection process, observations were specifically made for the presence of oil droplets or a petroleum sheen, which could indicate the presence of a floating layer of Light Non-Aqueous Phase Liquids (LNAPLs). No evidence for the presence of LNAPLs was observed by Stantec personnel at any of the monitoring wells.

The groundwater removed from the wells was carefully poured into pre-cleaned sample bottles provided by Eurofins TA Laboratories. The bottles were prepared with pre-measured chemical preservatives by the analytical laboratory (i.e., hydrochloric acid for VOC samples and nitric acid for metals samples). Care was exercised during sampling to avoid aeration of the samples and loss of preservative. Groundwater samples for dissolved metals analysis were field filtered prior to filling the sample bottles. New disposable filters were used for each sample.

All sample bottles were packed into a cooler with ice immediately after collection and delivered under chain-of-custody procedures directly to Eurofins TA in Chicago, Illinois. The groundwater samples were analyzed for PAHs, VOCs, and RCRA metals.

3.6 SUMMARY OF FIELD, LABORATORY, AND OTHER DATA COLLECTED

Following is a summary of the types of data collected as part of the SI completed by Stantec.

Data Type	Fox Shores Apartments Property
Completed Borings	27 borings
Physical and visual characteristics (soil)	76 samples
PID field screening data (soil)	76 samples
Elevation data (water table surface)	5 wells
Laboratory analyses (soil) – PAHs	26 samples
Laboratory analyses (soil) – VOCs	26 samples
Laboratory analyses (soil) – RCRA Metals	22 samples
Laboratory analyses (water) – PAHs	10 samples
Laboratory analyses (water) – VOCs	10 samples
Laboratory analyses (water) – RCRA Metals	10 samples
Laboratory analyses (ambient air) – VOCs	3 samples
Laboratory analyses (sub-slab vapor) - VOCs	7 samples

4.0 Applicable Clean-up Criteria

Procedures for establishing soil cleanup standards applicable to sites in Wisconsin with documented soil contamination are specified in NR720. Significant revisions to NR720 were implemented in 2013, with an effective date of November 1, 2013. Soil cleanup standards depend in part on current land use and zoning. Based on the current and planned future use of the property for residential or other non-industrial land uses, the more restrictive non-industrial classification is being used to assess cleanup criteria for the property.

RCLs are numerical soil cleanup standards that are calculated for a minimum of two exposure pathways – direct contact by humans with exposed soil and leaching of contaminants from soil into groundwater. The cleanup standard is the lower of the RCLs calculated for a number of exposure pathways. A variety of methods may be used to calculate RCLs, subject to WDNR approval. The approach used for the Fox Shores Apartments Property was to use an RCL spreadsheet developed by the WDNR's Remediation and Redevelopment Program staff for use by consultants. The spreadsheet (WDNR, 2018) is updated periodically by WDNR staff and utilizes toxicity information maintained on the U.S. EPA Regional Screening Level website: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm. As toxicity data are updated periodically for different types of contaminants, the WDNR RCL spreadsheet is similarly updated. The soil laboratory analytical tables included with this report have been updated to reflect the recently updated December 2018 RCLs.

As part of the revisions to NR720, WDNR adopted use of Background Threshold Values (BTVs) for select metals in soil whose occurrence may be attributable in whole or in part to natural occurrence in Wisconsin soil. BTVs are "non-outlier trace element maximum levels in Wisconsin surface soils" as determined through a state-wide study (USGS, 2011). BTVs were established for 16 metals including aluminum, arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, lead, manganese, nickel, strontium, vanadium, and zinc. Probably the most significant BTV is the value of 8.0 milligrams per kilogram established for arsenic. This value is significant because the RCLs calculated for the direct contact and groundwater pathways are significantly lower than this value, which in the past resulted in sites with relatively low levels of naturally occurring arsenic significantly exceeding the cleanup levels. If measured levels of arsenic or the 15 other metals for which BTVs have been established are below the BTVs, these levels can be attributed to natural occurrence without the need to perform a WDNR-approved site-specific study to determine background levels. RCL values calculated for the non-industrial direct contact and groundwater protection pathways are included on Tables 2a to 2c. BTVs are included on Table 2a.

Public health-related groundwater quality standards are set forth by NR140. Standards are listed for substances of public health concern (defined as substances having carcinogenic, mutagenic, or teratogenic properties or interactive effects) and substances of public welfare concern (defined as having a negative aesthetic value, but with little threat to human health). Two levels of standards are listed, the PAL and the ES. The ES represents a concentration above which action generally must be taken to improve the quality of groundwater. The PAL represents a lower concentration (usually 10 to 20 percent of the ES) above which groundwater quality should be monitored. PAL and ES concentrations are summarized in Tables 3a, 3b, and 3c.

The term "vapor intrusion pathway" generally refers to subsurface contamination that can move through the air-filled pores of vadose zone soils and enter the breathing space of buildings. WDNR notes that due to their high volatility and health risk, VOCs, particularly chlorinated VOCs and petroleum, are the contaminants that most commonly trigger assessment of the vapor intrusion pathway. Soil vapor results were compared to the U.S. EPA Regional screening levels for residential sites established using the U.S. EPA Vapor Intrusion Screening Level Calculator (VISL) and VISL User Guide as recommended in the WDNR's Guidance for *Addressing Vapor Intrusion at Remediation and Redevelopment Sites in Wisconsin Technical Guidance* dated January 2018.)

5.0 Site Investigation Findings

5.1 SITE HYDROGEOLOGIC CONDITIONS

Subsurface strata encountered in the borings generally consisted of approximately three inches of asphalt or 1.5 to 2 feet of topsoil underlain by 0.5 to 2 feet of fine black sand and gravel underlain by 5 to 6 feet of silty clay. A geologic cross-section of the Site is shown on Figures 8 and 9.

Measured depth to the water table in the five wells installed at the Property ranged from 3.86 feet bgs in TW10 to 6.14 feet bgs in TW15. Due to the moderate to low saturated hydraulic conductivity of the silty clay soil, wells on the Property were able to be purged dry using a peristaltic pump. Based on water levels collected from the wells in August 2019 and April 2020, the local shallow groundwater flow is predominantly to the south away from the Fox River. A summary of the water table elevation data is included in Table 5. Groundwater flow direction is shown on Figure 5.

5.2 NATURE AND EXTENT OF SOIL IMPACTS

All soil samples collected by Stantec as part of the SI, with the exception of HA-1 through HA-14, were field screened for the presence of VOCs using a PID. PID readings ranged across the Site from 0.8 instrument units as isobutylene (iu) to greater than 300 iu. Petroleum odors were noted in several of the borings at the time of field screening. The PID data is summarized on Table 1 as well as included on the soil boring logs presented in Appendix A.

Laboratory analysis of shallow soil samples (0-4 feet bgs) collected from the Site detected multiple RCRA metals, and PAHs exceeding the NR720 RCLs for groundwater protection and/or non-industrial direct contact. Benzo(a)pyrene, arsenic, lead and mercury were also detected in soil above the industrial direct contact RCL. Based on the sampling results, it appears detected contaminants are likely related to historic urban fill on the Property since contaminant concentrations generally decrease when native soils are encountered.

In addition, during soil investigation activities, VOCs did not appear to be prevalent in soil at the Site, as no exceedances were detected in soil samples collected with the exception of benzene above the RCL for groundwater protection in soil borings SB6, HA-4, HA-5, and HA-8 and trimethylbenzenes in SB15 and SB17. Methylene chloride was also detected in several soil samples above the RCL for groundwater protection but is considered to be a laboratory contaminant. Dichlorodifluoromethane was not detected within any of the soil samples collected at the Site.

Soil laboratory analytical reports, chain-of-custody forms and laboratory quality assurance/quality control data are presented in Appendix D. Soil laboratory analytical results from the SI fieldwork and previous Phase II ESA are summarized in Tables 2a through 2c.

Based on sampling data provided by this SI, the extent of contamination in soil has been sufficiently defined. PAH and RCRA metal impacted clay and sand/gravel fill appears to extend sitewide and is associated with the presence of historic urban fill. Based on the historic use of the Site and neighboring properties as a railyard, it is assumed that this historic urban fill extends off-site and throughout a large portion of the surrounding area. Therefore, further investigation was not completed beyond the property lines.

In addition, petroleum impacted soils appear to extend sporadically between the apartment buildings north of Bicentennial Court and along landscaped areas adjacent to Bicentennial Court and Fox Shores Drive. The estimated extent of soil containing contamination in excess of RCLs for groundwater protection and direct contact is shown on Figure 6.

5.3 NATURE AND EXTENT OF GROUNDWATER IMPACTS

Three rounds of groundwater sampling were completed at the Site between the initial Phase II ESA and the site investigation. Groundwater analysis of water samples collected at the Property detected arsenic in three of the five temporary monitoring wells exceeding their respective NR 140 PALs. Benzo(a)pyrene, benzo(b)fluoranthene, and/or chrysene were also identified within three temporary monitoring wells above the PAL with benzo(a)pyrene and benzo(b)fluoranthene above the ES during the most recent round of sampling at TW17. PAH contamination in groundwater likely appears to be a product of fine sediment resulting from silty clay and sandy soils found at the Site along with the limitations of temporary monitoring wells. This is what likely can be seen at TW17 where no exceedances existed within the initial sampling by Stantec and no detections being found while sampling temporary well B1-GW directly adjacent to it. No VOCs were detected in groundwater samples collected exceeding either the PAL or ES.

The results of the SI indicate that the extent of groundwater impacts is sufficiently defined. Based on sampling results, it does not appear that contaminants in soil are significantly affecting groundwater quality at the Property. Arsenic remains above the PAL within three of the temporary monitoring wells on-site. Additionally, benzo(a)pyrene and benzo(b)fluoranthene also remain just above the ES in temporary monitoring well TW17. However, the PAH contamination in groundwater likely appears to be a product of fine sediment resulting from silty clay and sandy soils found at the Site along with the limitations of temporary monitoring wells. A map depicting the estimated extent of groundwater contamination is included as Figure 7. Groundwater results for the SI are presented on Tables 3a through 3c. Laboratory analytical reports for groundwater samples are presented in Appendix E.

5.4 MIGRATION PATHWAYS AND POTENTIAL RECEPTORS

As part of the SI, Stantec evaluated potential contaminant migration pathways at the Site and the findings are summarized below.

5.4.1 Groundwater/Surface Water Impacts

Groundwater impacts at the Site appear to be minimal with soil contaminants not significantly affecting groundwater quality. Due to the low concentrations detected in the groundwater, it does not appear surface water or sediment is likely to be impacted as the result of this release. Further, water for the Site is provided by the City of Kaukauna's municipal water system which receives its supply from five municipal wells throughout the city. The closest municipal well to the Site is north of the Fox River and in excess of 1,600 feet to the Site.

5.4.2 Utilities

During the SI a limited number of underground utilities were identified at the Site. Buried electric lines run across the Site from transformers to each of the apartment buildings. It is not anticipated that buried electric lines would serve as a conduit for contaminant migration since these lines are typically backfilled with the same material which was removed from the utility trench or horizontally bored. In addition, water, storm, and sanitary sewer lines were also noted along Fox Shores Drive and Bicentennial Court. Given the fact that soil contaminants on-site do not appear to be affecting groundwater quality, it does not appear likely that contamination is migrating along utilities to or from the site.

5.4.3 Vapor Intrusion

The term "vapor intrusion pathway" generally refers to subsurface contamination that can move through the air-filled pores of vadose zone soils and enter the breathing space of buildings. WDNR notes that due to their high volatility and health risk, VOCs, particularly chlorinated VOCs and petroleum, are the contaminants that most commonly trigger assessment of the vapor intrusion pathway.

On December 3, 2018 Stantec notified the WDNR of soil and groundwater contamination at the Site and possible vapor intrusion of dichlorodifluoromethane into Site buildings. On January 7, 2019, the WDNR opened BRRTS case #02-45-582746 for the Site and requested additional investigation to further characterize and define the extent of contamination at the Site and complete remedial actions needed for Site closure. Due to the potential health threat of vapor intrusion, the WDNR requested that immediate actions be taken to investigate potential vapor intrusion impacts within the apartments at the Site.

On February 25, 2019 Stantec conducted ambient air sampling within three apartment units. On February 26, 2019, Stantec personnel installed three sub-slab vapor points (VP-4, VP-5, and VP-6) within the same three apartment units where the ambient air samples were collected. An additional vapor point was also installed immediately adjacent to original vapor point (VP-2) from the November 2018 Phase II ESA completed by Partner. Sub-slab vapor point locations can be found on the attached Figure 3. Vapor samples were analyzed for dichlorodifluoromethane using U.S. EPA method TO-15. Based on results from the air sampling, dichlorodifluoromethane exceeded the target residential sub-slab vapor concentration limit in two of the vapor points (VP-6 and VP-2R). However, dichlorodifluoromethane was not detected above target residential indoor air concentration limits. While dichlorodifluoromethane vapors were determined to be present at the Site, their presence did not affect ambient air quality within the apartments in which sampling was conducted.

On August 13, 2019 Stantec conducted additional sub-slab vapor sampling at vapor points VP-4, VP-5, and VP-6 within three apartment units at the Site. Samples were collected within the cooling months of summer to contrast earlier samples collected during the heating months of winter. Vapor samples were again sampled for dichlorodifluoromethane using EPA method TO-15.

Based on results from the additional air sampling, dichlorodifluoromethane exceeded the target residential sub-slab vapor concentration limit in vapor points VP4, VP-5, and VP-6. Results indicated an increase in sub-slab vapor concentrations at each of the sampling points over results of previous samples collected during the heating months of winter. Air quality results for the SI are presented on Tables 4. Laboratory analytical reports for air samples are presented in Appendix F.

With elevated dichlorodifluoromethane sub-slab concentrations at the Site, a source for the contamination was investigated. Due to the lack of dichlorodifluoromethane in soil samples collected at the Site, Stantec and the property owner continued to search for potential alternative options as to a source for the vapor intrusion issues. A release from the air conditioning was ruled out as a source since each apartment is supplied with its own window mounted unit. Any potential release of dichlorodifluoromethane from these units would readily off gas to the atmosphere.

Upon further investigation, it was discovered that extruded polystyrene foam board was used as insulation on the interior foundation walls of the apartment buildings. It was further determined that dichlorodifluoromethane is a component that makes up the extruded polystyrene foam insulation. Therefore, the insulation would be the active source for the dichlorodifluoromethane seen within the sub-slab vapor samples collected. In addition, it was noted that the building design shows the placement of a 4 mil. polyethylene vapor barrier beneath the concrete floor of the buildings. This is likely the reason that dichlorodifluoromethane concentrations did not exceed regulatory limits on ambient air samples collected from the apartments while sub-slab vapor concentrations were detected well in excess of sub-slab vapor limits. Schematics for the apartment buildings along with a materials safety data sheet for the polystyrene foam board insulation are included in Appendix H.

After determining that the extruded polystyrene foam board used on the apartment building's foundation walls was the likely source of the vapor intrusion issues at the Site, discussions were conducted with the DNR. During those discussions, it was determined that construction/building materials are unregulated and that a subsequent release from these materials would not warrant further vapor assessment or require remedial action to be conducted.

6.0 Conclusions, Recommendations, and Limitations

6.1 CONCLUSIONS AND RECOMMENDATIONS

The results of the Phase II ESA and Site Investigation indicate that widespread historic urban fill consisting of clay and sand/gravel is present across the Property at depths of up to 3 feet bgs. The sand and gravel fill are underlain by native silty clay. Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select VOCs exceeding Chapter NR 720 Wisconsin Administrative Code RCLs for protection of groundwater. Various RCRA metals and PAHs were also detected in some samples above their respective industrial and non-industrial direct contact RCLs. Based on sampling data provided by this SI, the extent of contamination in soil has been sufficiently defined.

Overall, three rounds of groundwater sampling were completed at the Site. Groundwater analysis of water samples collected at the Property detected arsenic in three of the five temporary monitoring wells exceeding their respective NR 140 PALs. Benzo(a)pyrene, benzo(b)fluoranthene, and/or chrysene were also identified within three temporary monitoring wells above the PAL with benzo(a)pyrene and benzo(b)fluoranthene above the ES during the most recent round of sampling at TW17. PAH contamination in groundwater likely appears to be a product of fine sediment resulting from silty clay and sandy soils found at the Site along with the limitations of temporary monitoring wells. This is what likely can be seen at TW17 where no exceedances existed within the initial sampling by Stantec and no detections being found while sampling temporary well B1-GW directly adjacent to it. No VOCs were detected in groundwater samples collected exceeding either the PAL or ES. Based on sampling results, it does not appear that contaminants in soil are significantly affecting groundwater quality at the Property. Therefore, no further groundwater monitoring appears to be necessary.

Dichlorodifluoromethane was detected above WDNR residential sub-slab vapor risk screening levels during the Phase II investigation completed by Partner in November 2018. Further site investigation activities to locate a source of the vapor intrusion issue concluded that no dichlorodifluoromethane was detected within any of the soil samples collected at the Site. After determining that the extruded polystyrene foam board used on the apartment building's foundation walls was the likely source of the vapor intrusion issues at the Site, no further investigation was warranted since construction/building materials are unregulated, would not warrant further vapor assessment, and their presence would not require remedial action.

On behalf of Fox Investments LLC (Tom Vandeyacht), Stantec is requesting WDNRs concurrence that the site investigation is complete and that the WDNR agrees with the proposed next step which includes remedial action activities to address remaining soil impacts.

6.2 LIMITATIONS

The SI was performed in accordance with generally accepted practices for the environmental consulting profession, undertaking similar studies at the same time and in the same geographical area as the work conducted by Stantec. Stantec observed the degree of care and skill that are generally exercised by the profession under similar circumstances and conditions. No other warranty is expressed or implied.

Stantec's observations, findings, and opinions should not be considered as scientific certainties, but only as opinion based on our professional judgment concerning the significance of the data gathered during this investigation. Specifically, Stantec cannot represent that the Site does not contain any hazardous or toxic materials or other latent conditions beyond that observed by Stantec during the investigation. Additionally, due to limitations of this investigation process and the necessary use of data furnished by others, Stantec and its subcontractors cannot assume liability if actual conditions differ from the information presented in this report.

7.0 References

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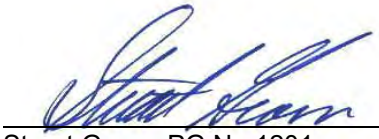
8.0 Certification

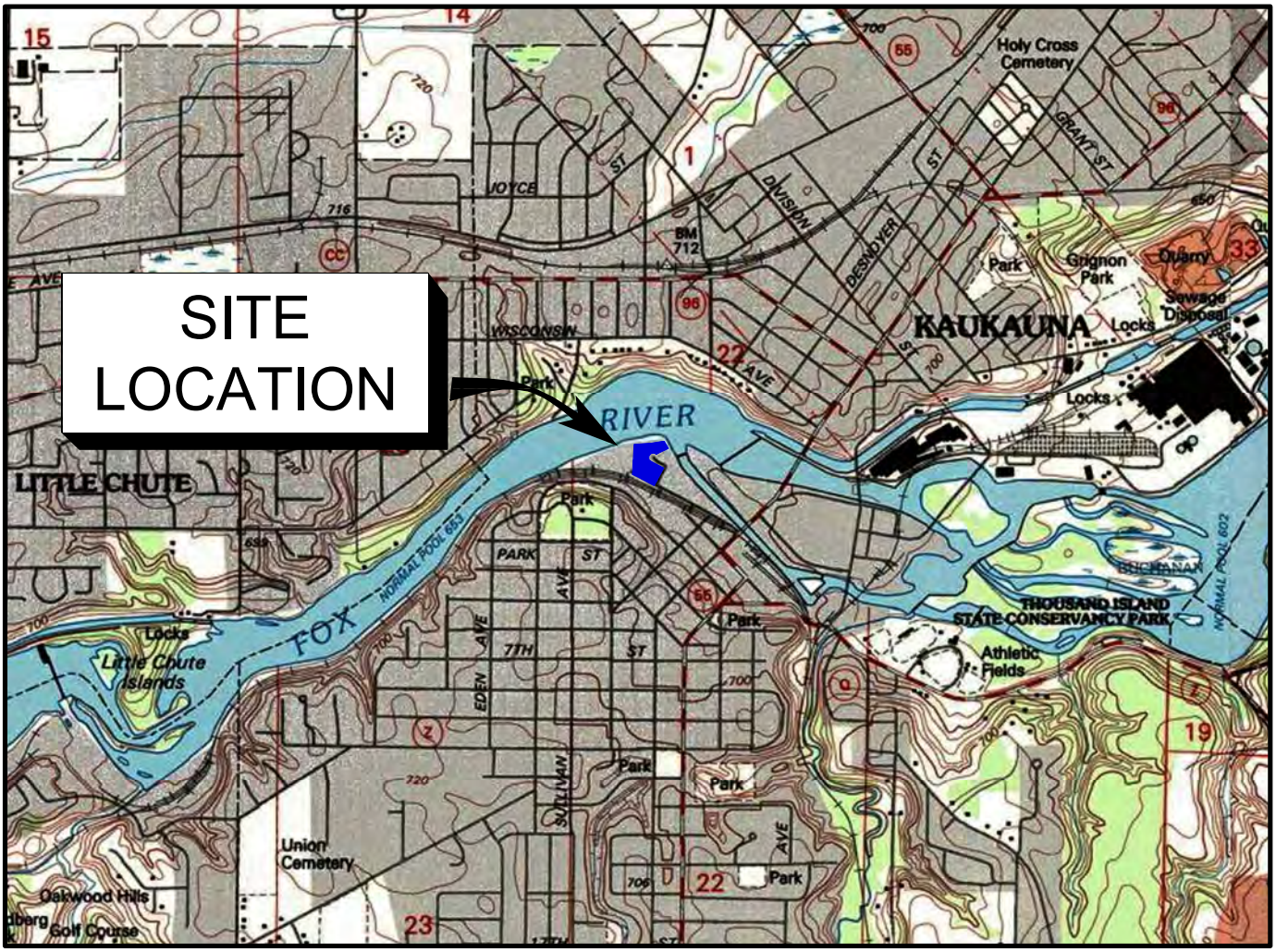
I, Stuart Gross, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wiis. Adm. Code, and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.



Stuart Gross, PG No.1201

June 9, 2020
Date

FIGURES



SCALE IN FEET

1" = 2000'

0 1000 2000 3000 4000 5000 6000 7000 8000

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929



QUADRANGLE LOCATION

BASE MAP SOURCE: USGS 7.5 MINUTE QUADRANGLE, KAUKAUNA, WISCONSIN, 1982 (NATIONAL GEOGRAPHIC HOLDINGS, INC.)

Stantec

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SITE LOCATION AND LOCAL TOPOGRAPHY

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 04/02/19	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE 1



N

SCALE IN FEET

30 0 30 60

LEGEND

APPROXIMATE PROPERTY LINE

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SITE LAYOUT

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 04/01/19	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE 2



N

SCALE IN FEET

30 0 30 60

LEGEND

B1	PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
SB6	STANTEC SOIL BORING LOCATION
HA–1	STANTEC HAND AUGER SOIL BORING LOCATION
VP–4	PARTNER ENGINEERING AND SCIENCE INC. SOIL GAS SAMPLE LOCATION (SAMPLE LOCATIONS ADJUSTED BASED ON FIELD OBSERVATIONS OF LOCATIONS)
VP–4	STANTEC AMBIENT AIR AND SOIL GAS SAMPLE LOCATION
	APPROXIMATE PROPERTY LINE

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SITE LAYOUT WITH SOIL BORING AND SOIL GAS SAMPLE LOCATIONS

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
04/24/20	JRB	JRB	193706620	3



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10 TEMPORARY MONITORING WELL LOCATION

B1–GW PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION

APPROXIMATE PROPERTY LINE

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SITE LAYOUT WITH TEMPORARY MONITORING WELL LOCATIONS

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 08/22/19	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE 4



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10 94.57 — TEMPORARY MONITORING WELL LOCATION AND GROUNDWATER ELEVATION ON 08/28/19

—93.60— — GROUNDWATER CONTOUR LINE: DASHED WHERE INFERRED CONTOUR LINE INTERVAL = 0.1 FEET

GROUNDWATER FLOW DIRECTION

APPROXIMATE PROPERTY LINE

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GROUNDWATER CONTOUR MAP (08/28/19)

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 09/10/19	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE 5



N

SCALE IN FEET

30 0 30 60

LEGEND

- B1 — PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
- SB6 — STANTEC SOIL BORING LOCATION
- HA–1 — STANTEC HAND AUGER SOIL BORING LOCATION
- APPROXIMATE PROPERTY LINE
- ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION (ASSUMED TO BE SITEWIDE)

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ESTIMATED EXTENT OF SOIL CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
04/24/20	JRB	JRB	193706620	6



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10	TEMPORARY MONITORING WELL LOCATION
B1–GW	PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION
	APPROXIMATE PROPERTY LINE
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES

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ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
05/22/20	JRB	JRB	193706620	7



LEGEND

B1	PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
SB6	STANTEC SOIL BORING LOCATION
HA–1	STANTEC HAND AUGER SOIL BORING LOCATION
VP–4	PARTNER ENGINEERING AND SCIENCE INC. SOIL GAS SAMPLE LOCATION (SAMPLE LOCATIONS ADJUSTED BASED ON FIELD OBSERVATIONS OF LOCATIONS)
VP–4	STANTEC AMBIENT AIR AND SOIL GAS SAMPLE LOCATION
	APPROXIMATE PROPERTY LINE

N

SCALE IN FEET

30 0 30 60

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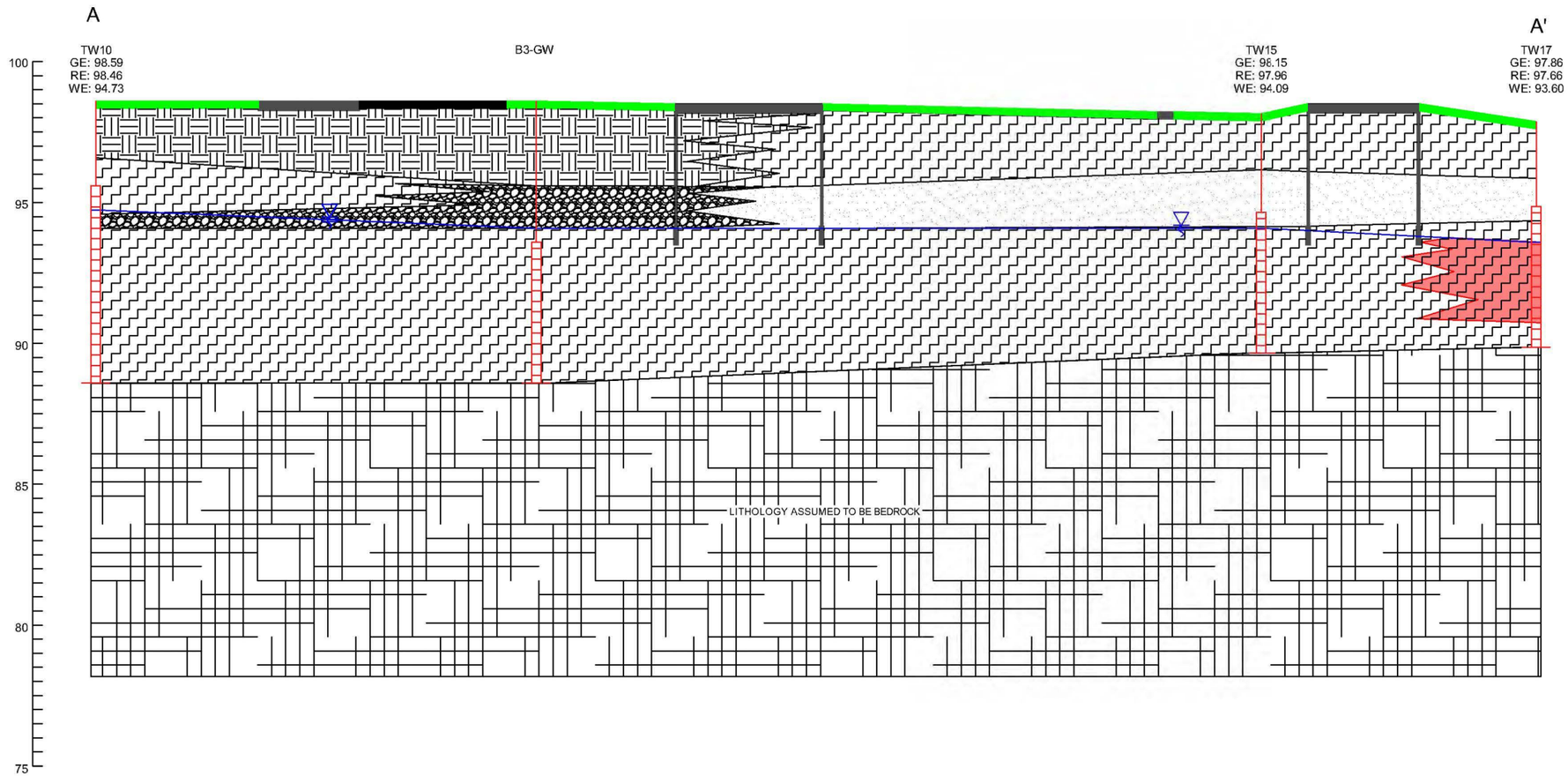
CROSS-SECTION A-A'

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
05/22/20	JRB	JRB	193706620	8

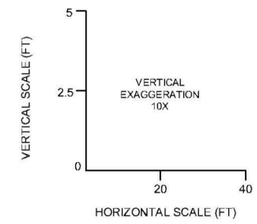


LEGEND

- ESTIMATED GROUNDWATER CONTAMINATION >ES
- TOPSOIL / GRASS
- ASPHALT
- CONCRETE
- CLAY
- BEDROCK
- SAND
- SILTY CLAY
- SAND AND GRAVEL
- = SOIL BORING/ GEOPROBE LOCATION
- = MONITORING WELL SCREEN LOCATION
- = GROUNDWATER TABLE 04-16-20

MW = MONITORING WELL
GE = GROUND ELEVATION (FEET)
RE= RISER ELEVATION (FEET)
WE= WATER ELEVATION (FEET)

NOTE: ENTIRE SITE ASSUMED TO BE IMPACTED WITH SOIL CONTAMINATION EXCEEDING RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION



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GEOLOGIC CROSS SECTION
FIGURE A - A'

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	TASK NUMBER:	PROJECT NUMBER:	FIGURE
05/26/20	JRB	600	193706620	9

TABLES

Table 1 - Soil Field Screening Results, Fox Shores Apartments, Kaukauna, Wisconsin

Boring Number	Sample Number	Sample Depth (fbg)	Sample Odor	Sample Description	Date Collected	PID Headspace Analysis	
						Time Collected/Analyzed	PID Response (IUI)
B1	*B1 (0.5-1)	0.5-1	None	Topsoil	10/3/2018	---	---
	*B1 (6-7)	6-7	None	Clay	10/3/2018	---	---
B2	*B2 (0.5-1)	0.5-1	None	Topsoil	10/3/2018	---	---
	*B2 (7-8)	7-8	None	Clay	10/3/2018	---	0.1
B3	*B3 (0.5-1)	0.5-1	None	Topsoil	10/3/2018	---	---
	*B3 (3-4)	3-4	None	Clay	10/3/2018	---	0.0
B4	*B4 (0.5-1)	0.5-1	None	Topsoil	10/3/2018	---	---
	*B4 (6-7)	6-7	None	Clay	10/3/2018	---	---
B5	*B5 (0.5-1)	0.5-1	None	Topsoil	10/3/2018	---	---
	*B5 (3.5-4.5)	3.5-4.5	None	Clay	10/3/2018	---	---
SB6	*SB6 (0-1)	0-1	None	Topsoil	5/14/2019	920/940	1.2
	*SB6 (1-2)	1-2	None	Black Fill	5/14/2019	925/940	1.3
	SB6 (2-3)	2-3	None	Black Fill	5/14/2019	930/947	1.6
SB7	*SB7 (0-1)	0-1	None	Topsoil	5/14/2019	1100/1115	0.9
	*SB7 (1-2)	1-2	None	Clay	5/14/2019	1110/1130	3.7
SB8	*SB8 (0-2)	0-2	None	Topsoil	5/14/2019	1210/1225	0.8
SB9	*SB9 (0-1)	0-1	None	Topsoil	5/14/2019	1235/1250	0.9
	*SB9 (1-2)	1-2	None	Black Fill	5/14/2019	1245/1300	1.0
	SB9 (2-3)	2-3	None	Gavel	5/14/2019	1250/1305	1.3
SB10-1	*SB10-1 (0-1)	0-1	None	Black Fill	5/14/2019	1350 / 1410	1.2
	*SB10-1 (1-2)	1-2	None	Black Fill	5/14/2019	1355 / 1410	1.2
	SB10-1 (2-3)	2-3	None	Black Fill	5/14/2019	1357 / 1415	1.1
	SB10-1 (3-4)	3-4	None	Black Fill	5/14/2019	1359 / 1415	0.9
	*SB10-1 (4-5)	4-5	None	Silty Sand	5/14/2019	1402 / 1417	1.2
SB10-2	SB10-2 (0-2)	0-2	None	Clay	8/21/2019	933 / 948	2.6
	*SB10-2 (2-4)	2-4	None	Black Fill	8/21/2019	933 / 948	2.0
	SB10-2 (4-6)	4-6	None	Silty Clay	8/21/2019	935 / 950	1.4
	SB10-2 (6-8)	6-8	None	Silty Clay	8/21/2019	935 / 950	2.4
	SB10-2 (8-10)	8-10	None	Silty Clay	8/21/2019	938 / 955	2.8

Boring Number	Sample Number	Sample Depth (fbg)	Sample Odor	Sample Description	Date Collected	PID Headspace Analysis	
						Time Collected/Analyzed	PID Response (IUI)
SB11	SB11 (0-2)	0-2	None	Silty Clay	8/21/2019	1035 / 1050	2.5
	*SB11 (2-4)	2-4	None	Black Fill	8/21/2019	1035 / 1050	4.3
	SB11 (4-6)	4-6	None	Sand and Gravel Fill	8/21/2019	1038 / 1053	2.4
	SB11 (6-8)	6-8	None	Sandy Silt	8/21/2019	1038 / 1053	3.8
	SB11 (8-10)	8-10	None	Sand and Gravel	8/21/2019	1041 / 1056	4.8
SB12	SB12 (0-2)	0-2	None	Silty Clay	8/21/2019	958 / 1013	5.9
	*SB12 (2-4)	2-4	None	Black Fill	8/21/2019	958 / 1013	5.9
	SB12 (4-6)	4-6	None	Silty Clay	8/21/2019	1000 / 1015	6.0
	SB12 (6-8)	6-8	None	Silty Sand	8/21/2019	1000 / 1015	5.3
	SB12 (8-10)	8-10	None	Sand and Gravel	8/21/2019	1005 / 1020	4.8
SB13	SB13 (0-2)	0-2	None	Silty Clay	8/21/2019	1106 / 1121	2.6
	*SB13 (2-4)	2-4	None	Black Fill	8/21/2019	1106 / 1121	2.7
	SB13 (4-6)	4-6	None	Silty Clay	8/21/2019	1110 / 1125	3.5
	SB13 (6-8)	6-8	None	Silty Clay	8/21/2019	1110 / 1125	4.0
	SB13 (8-10)	8-10	None	Silty Clay	8/21/2019	1115 / 1130	4.2
SB14	*SB14 (0-2)	0-2	None	Silty Clay	8/21/2019	1150 / 1205	1.5
SB15	SB15 (0-2)	0-2	None	Silty Clay	8/21/2019	1211 / 1226	2.5
	*SB15 (2-4)	2-4	None	Black Fill	8/21/2019	1211 / 1226	25.0
	*SB15 (4-6)	4-6	None	Silty Clay	8/21/2019	1214 / 1230	>300
	SB15 (6-8)	6-8	None	Silty Clay	8/21/2019	1214 / 1230	208
SB16	SB16 (0-2)	0-2	None	Silty Clay	8/21/2019	1255 / 1310	2.9
	*SB16 (2-4)	2-4	None	Black Fill	8/21/2019	1255 / 1310	3.5
	SB16 (4-6)	4-6	None	Silty Clay	8/21/2019	1258 / 1313	4.0
	SB16 (6-8)	6-8	None	Silty Clay	8/21/2019	1258 / 1313	4.1
	SB16 (8-10)	8-10	None	Silty Clay	8/21/2019	1301 / 1316	4.1
SB17	SB17 (0-2)	0-2	None	Silty Clay	8/21/2019	1326 / 1341	2.2
	*SB17 (2-4)	2-4	None	Black Fill	8/21/2019	1326 / 1341	2.2
	SB17 (4-6)	4-6	None	Silty Clay	8/21/2019	1329 / 1345	3.5
	SB17 (6-8)	6-8	None	Silty Clay	8/21/2019	1329 / 1345	3.5
HA-1	HA-1	0-1	None	Silty Clay	4/15/2020	845/---	---
		1-2	None	Silty Clay	4/15/2020	845/---	---
HA-2	HA-2	0-1	None	Sand	4/15/2020	910/---	---
		1-2	None	Silty Clay	4/15/2020	910/---	---
HA-3	HA-3	0-1	None	Silty Clay	4/15/2020	925/---	---
		1-2	None	Sand/Silty Clay	4/15/2020	925/---	---
HA-4	HA-4	0-1	None	Silty Clay	4/15/2020	950/---	---
		1-2	None	Sand/Silty Clay	4/15/2020	950/---	---

Boring Number	Sample Number	Sample Depth (fbg)	Sample Odor	Sample Description	Date Collected	PID Headspace Analysis	
						Time Collected/Analyzed	PID Response (IUI)
HA-5	HA-5	0-1	None	Silty Clay	4/15/2020	1005/---	---
		1-2	None	Sand	4/15/2020	1005/---	---
HA-6	HA-6	0-1	None	Silty Sand	4/15/2020	1025/---	---
		1-2	None	Sand	4/15/2020	1025/---	---
HA-7	HA-7	0-1	Petro	Silty Clay	4/15/2020	1040/---	---
		1-2	Petro	Sand	4/15/2020	1040/---	---
HA-8	HA-8	0-1	None	Silty Clay	4/15/2020	1055/---	---
		1-2	None	Sand	4/15/2020	1055/---	---
HA-9	HA-9	0-1	None	Silty Sand	4/15/2020	1115/---	---
		1-2	None	Sand	4/15/2020	1115/---	---
HA-10	HA-10	0-1	None	Silty Clay	4/15/2020	1130/---	---
		1-2	None	Sand	4/15/2020	1130/---	---
HA-11	HA-11	0-1	None	Silty Clay	4/15/2020	1150/---	---
		1-2	None	Sand	4/15/2020	1150/---	---
HA-12	HA-12	0-1	None	Silty Sand	4/15/2020	1210/---	---
		1-2	None	Silty Sand	4/15/2020	1210/---	---
HA-13	HA-13	0-1	None	Silty Clay	4/15/2020	1225/---	---
		1-2	None	Silty Clay	4/15/2020	1225/---	---
HA-14	HA-14	0-1	None	Silty Clay	4/15/2020	1235/---	---
		1-2	None	Silty Clay	4/15/2020	1235/---	---

Key:

PID = Photoionization Detector

IUI = Instruments units as isobutylene

= Boring completed by Partner Engineering and Science, Inc.

Table 2a Soil Sample RCRA Metals Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample					Laboratory Result (mg/kg)							
					RCRA Metals							
Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	Arsenic (total)	Barium	Cadmium	Chromium	Lead (total)	Mercury	Selenium	Silver
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	8* [0.677]	15,300	71.1	NE	400	3.13	391	391
				Industrial	8* [3.00]	100,000	985	NE	800	3.13	5,840	5,840
WDNR RCL for Protection of Groundwater					8* [0.584]	364* [164.8]	1* [0.752]	360,000	52* [27]	0.208	0.52	0.849
Background Threshold Value (BTV)					8	364	1	44	52	NE	NE	NE
B1	B1 (0.5-1)	0.5-1	Topsoil	10/3/2018	17.7	81.8	2.8	22.6	940	0.492	2.58	<0.616
B2	B2 (0.5-1)	0.5-1	Topsoil	10/3/2018	0.732 J	42.4	<0.230	15.7	5.1	0.0466	<2.30	<0.575
B3	B3 (0.5-1)	0.5-1	Topsoil	10/3/2018	3.07	76.1	0.335	17.9	209	0.0259	<2.28	<0.569
B4	B4 (0.5-1)	0.5-1	Topsoil	10/3/2018	116	58.9	2.01	14	272	0.0467	0.932 J	<0.645
B5	B5 (0.5-1)	0.5-1	Topsoil	10/3/2018	7.55	49.3	0.753	11.5	205	0.11	0.873 J	<0.550
SB10-1	SB10-1 (0-2)	0-2	Silty Sand	5/14/2019	2.8	19	0.35	7.1	48	0.066	0.91 J	1.0
	SB10-1 (4-5)	4-5	Silty Sand	5/14/2019	1.5	17	0.21 J	7.3	3.4	0.013 J	<0.64	1.5
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	08/21/19	41	55	1.7 B	14	390	0.23	0.84 J	1.6
SB11	SB11 (2-4)	2-4	Sand	08/21/19	9.3	54	1.2 B	14	440	0.41	1.5	1.5
SB12	SB12 (2-4)	2-4	Fill / Silty Clay	08/21/19	11	64	1.6 B	16	480	0.54	2.0	1.8
SB13	SB13 (2-4)	2-4	Sand	08/21/19	34	60	1.7 B	18	570	0.60	1.5	1.7
SB14	SB14 (0-2)	0-2	Silty Clay	08/21/19	2.7	45	0.13 JB	15	25	0.067	0.73 J	2.5
SB15	SB15 (2-4)	2-4	Sand	08/21/19	240	49	25 B	13	97,000	12	4.4	7.4
SB16	SB16 (2-4)	2-4	Silty Clay	08/21/19	11	40	0.44 B	16	84	0.10	0.75 J	1.5
SB17	SB17 (2-4)	2-4	Sand	08/21/19	15	79	1.7 B	14	560	0.45	2.2	1.6
HA-1	HA-1	0-2	Fill / Silty Clay	04/15/20	3.5	79	0.24	26	73	0.070	<0.67	0.45 J
HA-2	HA-2	0-2	Fill / Silty Clay	04/15/20	11	61	2.6	15	470	0.19	1.0 J	0.97
HA-3	HA-3	0-2	Fill / Silty Clay	04/15/20	11	56	0.92	16	220	0.32	0.74 J	0.56 J
HA-4	HA-4	0-2	Fill / Silty Clay	04/15/20	6.7	59	1.1	13	140	0.12	1.1	0.78
HA-5	HA-5	0-2	Fill / Silty Clay	04/15/20	8.1	55	0.64	16	160	0.15	<0.64	0.45 J
HA-6	HA-6	0-2	Fill / Silty Sand	04/15/20	6.8	37	0.36	12	91	0.053	<0.61	0.27 J

Table 2a Soil Sample RCRA Metals Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample					Laboratory Result (mg/kg)							
					RCRA Metals							
Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	Arsenic (total)	Barium	Cadmium	Chromium	Lead (total)	Mercury	Selenium	Silver
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	8* [0.677]	15,300	71.1	NE	400	3.13	391	391
				Industrial	8* [3.00]	100,000	985	NE	800	3.13	5,840	5,840
WDNR RCL for Protection of Groundwater					8* [0.584]	364* [164.8]	1* [0.752]	360,000	52* [27]	0.208	0.52	0.849
Background Threshold Value (BTV)					8	364	1	44	52	NE	NE	NE
HA-7	HA-7	0-2	Fill / Silty Clay	04/15/20	5.0	44	0.43	16	86	0.041	<0.64	0.53 J
HA-8	HA-8	0-2	Fill / Silty Clay	04/15/20	6.2	54	0.58	16	150	0.080	<0.64	0.51 J
HA-9	HA-9	0-2	Fill / Silty Sand	04/15/20	3.0	37	0.18 J	13	53	0.16	<0.65	0.23 J
HA-10	HA-10	0-2	Fill / Silty Clay	04/15/20	5.0	41	0.44	16	190	0.22	<0.64	0.36 J
HA-11	HA-11	0-2	Fill / Silty Clay	04/15/20	7.9	70	0.83	19	250	0.19	1.1	0.82
HA-12	HA-12	0-2	Fill / Silty Sand	04/15/20	2.0	31	0.040 J	14	7.2	0.0083 J	<0.57	0.13 J

Key:

RCRA = Resource Conservation and Recovery Act

<x = compound not detected to a detection limit of x

XXX = exceeds WDNR Non-Industrial RCL for direct contact risk

XXX = exceeds WDNR Industrial RCL for direct contact risk

XXX = exceeds WDNR RCL for protection of groundwater

mg/kg = milligram per kilogram

NE = not established by WAC (Wis. Adm. Code) or WDNR Soil RCL Summary Table

"J" = analyte detected between the limit of detection and limit of quantification

RCL = residual contaminant level

fbg = feet below ground

= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

For the purpose of this evaluation under ch. NR 700, background threshold values are being considered as representative of background conditions.

However, constituent concentrations less than background threshold values may represent a potential health risk if concentrations are greater than health-based standards.

Table 2b Soil Sample Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	PAH Compound Laboratory Result (µg/kg)																	
					Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthrancene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	3,590,000	NE	17,900,000	1,140	115	1,150	NE	11,500	115,000	115	2,290,000	2,390,000	1,150	17,600	239,000	5,520	NE	1,790,000
				Industrial	45,200,000	NE	100,000,000	20,800	2,110	21,100	NE	211,000	2,110,000	2,110	30,100,000	30,100,000	21,100	72,700	3,010,000	24,100	NE	22,600,000
WDNR RCL for Protection of Groundwater					NE	NE	196,900	NE	470	478	NE	NE	144	NE	88,877	14,829	NE	NE	NE	658	NE	54,545
B1	B1 (6-7)	6-7	Clay	10/3/2018	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	0.821 J	6.89	<6.89	<23.0	<23.0	<23.0	0.704 J	<6.89
B2	B2(7-8)	7-8	Clay	10/3/2018	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<22.3	<22.3	<22.3	<6.68	<6.89
B3	B3 (3-4)	3-4	Clay	10/3/2018	2.31 J	<7.02	4.25 J	18	20	26.5	15.8	10.2	26.8	3.1 J	52.1	2.53 J	12.5	5.81 J	7.86 J	7.23 J	35.1	34.9
B4	B4 (6-7)	6-7	Clay	10/3/2018	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	0.857 J	<7.06	<7.06	<23.5	<23.5	<23.5	<7.06	<7.06
B5	B5 (3.5-4.5)	3.5-4.5	Clay	10/3/2018	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<24.6	<24.6	<24.6	<7.39	<7.39
SB6	SB6 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	32 J	39	160	410	480	940	210	<11	580	58	660	29 J	190	180	250	150	610	800
SB7	SB7 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	9.8 J	31 J	39	180	220	300	140	150	240	52	210	7.1 J	120	52 J	86	47	210	280
SB8	SB8 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	<7.0	<5.1	<6.5	23 J	25 J	37 J	23 J	13 J	30 J	<7.5	38	<5.4	18 J	<9.5	15 J	6.4 J	28 J	34 J
SB9	SB9 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	1,200	1,900	3,500	9,100	14,000	16,000	2,800	10,000	11,000	2,100	19,000	1,600	4,700	870	770 J	1,000	22,000	32,000
SB10-1	SB10 (0-2)	0-2	Silty Sand	5/14/2019	7.2 J	6.5 J	22 J	100	120	180	100	38	170	38	130	<4.9	85	29 J	38 J	29 J	150	170
	SB10 (4-5)	4-5	Silty Sand	5/14/2019	<7.2	<5.3	<6.7	<5.4	<7.8	<8.7	<13	<12	<11	<7.8	<7.5	<5.7	<10	<9.8	<7.4	<6.2	<5.6	<8.0
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	8/21/2019	22 J	28 J	84	290	280	480	210	160	390	52	480	21 J	150	220	260	200	450	470
SB11	SB11 (2-4)	2-4	Sand	8/21/2019	810	240	2,000	5,200	5,200	6,900	1,700	2,800	5,900	440	15,000	650	1,500	400	510	520	11,000	13,000
SB12	SB12 (2-4)	2-4	Fill / Silty Clay	8/21/2019	47 J	65 J	120 J	650	630	990	300	300	920	92 J	1,100	59 J	240	260 J	310 J	200	950	1,300
SB13	SB13 (2-4)	2-4	Sand	8/21/2019	85	29 J	260	790	840	1,300	320	520	1,000	79	2,100	68	270	150	200	130	1,300	1,600
SB14	SB14 (0-2)	0-2	Silty Clay	8/21/2019	<6.4	<4.7	6.4 J	33 J	35	52	40	23 J	61	8.2 J	65	<5.0	26 J	<8.7	11 J	8.5 J	46	60
SB15	SB15 (2-4)	2-4	Sand	8/21/2019	26 J	22 J	95	310	310	660	220	180	850	62	600	40	160	180	410	240	1,000	580
SB16	SB16 (2-4)	2-4	Silty Clay	8/21/2019	1,700	420	4,000	11,000	9,000	11,000	2,500	3,700	13,000	890	25,000	1,500	2,100	1,100	830	600	28,000	32,000
SB17	SB17 (2-4)	2-4	Sand	8/21/2019	1,100	550	2,300	5,900	5,800	8,600	2,000	3,800	6,800	520	16,000	930	1,800	940	1,100	1,100	13,000	14,000
HA-1	HA-1	0-2	Fill / Silty Clay	04/15/20	<7.2	9.5 J	18 J	92	110	150	74	65	130	<7.8	190	<5.6	63	24 J	30 J	17 J	100	190
HA-2	HA-2	0-2	Fill / Silty Clay	04/15/20	52 J	<26	160 J	950	1,200	1,800	460	730	1,300	120 J	2,300	55 J	420	390 J	410	240	1,400	2,000
HA-3	HA-3	0-2	Fill / Silty Clay	04/15/20	56 J	41 J	180 J	1,200	1,400	2,000	820	780	1,600	140 J	2,500	61 J	710	340 J	410	260	1,500	2,300
HA-4	HA-4	0-2	Fill / Silty Clay	04/15/20	190 J	150 J	540	2,400	2,700	3,600	890	1,200	2,800	250	4,800	160 J	870	420	460	410	3,100	4,900
HA-5	HA-5	0-2	Fill / Silty Clay	04/15/20	80 J	64 J	200	1,100	1,400	2,200	510	730	1,400	180 J	2,100	51 J	480	220 J	300 J	290	1,200	2,100
HA-6	HA-6	0-2	Fill / Silty Sand	04/15/20	190	39 J	400	1,300	1,400	1,900	440	570	1,300	100 J	2,400	160 J	320	120 J	120 J	150 J	1,900	2,300
HA-7	HA-7	0-2	Fill / Silty Clay	04/15/20	49	41	100	440	450	580	180	260	480	41	760	43	170	86	100	81	630	800
HA-8	HA-8	0-2	Fill / Silty Clay	04/15/20	100	140	310	1,100	1,200	1,600	340	630	1,200	100	2,300	96	330	100	140	160	1,600	2,600
HA-9	HA-9	0-2	Fill / Silty Sand	04/15/20	14 J	14 J	48	180	170	210	100	55	190	24 J	300	12 J	93	21 J	35 J	25 J	240	300
HA-10	HA-10	0-2	Fill / Silty Clay	04/15/20	40 J	44 J	150 J	530	620	1,000	150 J	250	720	<36	980	35 J	220	120 J	160 J	150 J	600	970
HA-11	HA-11	0-2	Fill / Silty Clay	04/15/20	<36	33 J	140 J	350	370	350	<65	120 J	460	<39	530	59 J	<52	230 J	390 J	130 J	650	690
HA-12	HA-12	0-2	Fill / Silty Sand	04/15/20	<6.7	<4.9	<6.2	36 J	37	46	22 J	18 J	43	<7.2	57	<5.2	23 J	<9.1	<6.9	<5.7	17 J	59

Table 2b Soil Sample Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	PAH Compound Laboratory Result (µg/kg)																	
					Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthrancene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	3,590,000	NE	17,900,000	1,140	115	1,150	NE	11,500	115,000	115	2,290,000	2,390,000	1,150	17,600	239,000	5,520	NE	1,790,000
				Industrial	45,200,000	NE	100,000,000	20,800	2,110	21,100	NE	211,000	2,110,000	2,110	30,100,000	30,100,000	21,100	72,700	3,010,000	24,100	NE	22,600,000
WDNR RCL for Protection of Groundwater					NE	NE	196,900	NE	470	478	NE	NE	144	NE	88,877	14,829	NE	NE	NE	658	NE	54,545

Key:

<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
µg/kg = milligram per kilogram
NE = not established by WAC (Wis. Adm. Code) or WDNR Soil RCL Summary Table
"J" = analyte detected between the limit of detection and limit of quantification
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

Table 2c Soil Sample Volatile Organic Compound Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample						VOC Compound Laboratory Result (µg/kg)															
Boring Number	Sample Number	Depth (fbg)	Description	PID Response (iui)	Date Collected	Acetone	1,2,4-Trimethyl benzene	1,3,5-Trimethyl benzene	1,2,3-Trimethyl benzene	Benzene	2-Butanone	Ethylbenzene	Isopropylbenzene	Methylene Chloride	Naphthalene	Total Xylenes	n-Butylbenzene	n-Propylbenzene	p-Isopropyltoluene	sec-Butylbenzene	Toluene
WDNR NR 720 Direct Contact RCL					Non-Industrial	63,400,000	219,000	182,000	293000	1,600	28,400,000	8,020	NE	61,800	5,520	260,000	108,000	NE	162,000	145,000	818,000
					Industrial	100,000,000	219,000	182,000	293,000	7,070	28,400,000	35,400	NE	1,150,000	24,100	260,000	108,000	NE	162,000	145,000	818,000
WDNR NR 720 Groundwater Protection RCL						3,676.6	1378.7 combined		NE	5.1	1,666.1	1,570	NE	2.6	658.2	3,960	NE	NE	NE	NE	1,107.2
B1	B1 (6-7)	6-7	Clay	0	10/3/2018	<28.7	<5.74	<5.74	<5.74	<1.15	19.3 J	<2.87	<2.87	---	<14.4	<7.46	<14.4	<5.74	---	---	<5.74
B2	B2 (7-8)	7-8	Clay	0.1	10/3/2018	<27.8	<5.57	<5.57	<5.57	<1.11	28	<2.78	<2.78	---	<13.9	<7.24	<13.9	<5.57	---	---	1.49 J
B3	B3 (3-4)	3-4	Clay	0	10/3/2018	<29.3	<5.85	<5.85	<5.85	<1.17	29.7	<2.93	<2.93	---	<14.6	<7.61	<14.6	<5.85	---	---	1.54 J
B4	B4 (6-7)	6-7	Clay	0.1	10/3/2018	36.3	2.42 J	<5.88	1.62 J	0.791 J	27.4 J	0.998 J	<2.94	---	4.48 J	<7.64	<14.7	<5.88	---	---	5.69 J
B5	B5 (3.5-4.5)	3.5-4.5	Clay	0	10/3/2018	39.4	<6.16	<6.16	<6.16	<1.23	34.9	<3.08	<3.08	---	<15.4	<8.00	<15.4	<6.16	---	---	<6.16
SB6	SB6 (0-2)	0-2	Topsoil/Silty Clay	1.3	5/14/2019	---	66 J	<26	---	22	---	<13	<26	<110	---	170	<27	<29	<25	<27	110
SB7	SB7 (0-2)	0-2	Topsoil/Silty Clay	3.7	5/14/2019	---	<23	<24	---	<9.3	---	<12	<25	<100	---	<14	<25	<26	<23	<25	<9.4
SB8	SB8 (0-2)	0-2	Topsoil/Silty Clay	0.8	5/14/2019	---	<24	<26	---	<9.8	---	<12	<26	<110	---	<15	<26	<28	<24	<27	<9.9
SB9	SB9 (0-2)	0-2	Topsoil/Silty Clay	1.0	5/14/2019	---	<25	<27	---	<10	---	<13	<27	<110	---	<15	<27	<29	<25	<28	41
SB10-1	SB10-1 (0-2)	0-2	Silty Sand	1.2	5/14/2019	---	<21	<22	---	<8.4	---	<11	<22	<94	---	<13	<22	<24	<21	<23	<8.4
	SB10-1 (4-5)	4-5	Silty Sand	1.2	5/14/2019	---	<25	<27	---	<10	---	<13	<27	<120	---	<16	<27	<29	<26	<28	<10
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	2.0	08/21/19	---	<25	<27	---	<10	---	<13	<27	<110	---	<15	<27	<29	<25	<28	<10
SB11	SB11 (2-4)	2-4	Sand	4.3	08/21/19	---	<25	<26	---	<10	---	<13	<26	110 J	---	<15	<27	<28	<25	<27	43
SB12	SB12 (2-4)	2-4	Fill/Silty Clay	5.9	08/21/19	---	<25	<28	---	<11	---	<13	<28	<120	---	<16	<28	<30	<27	<29	<11
SB13	SB13 (2-4)	2-4	Sand	2.7	08/21/19	---	<25	<26	---	<10	---	<13	<27	120 J	---	<15	<27	<29	<25	<28	<10
SB14	SB14 (0-2)	0-2	Silty Clay	1.5	08/21/19	---	<21	<23	---	<8.7	---	<11	<23	110 J	---	<13	<23	<25	<22	<24	<8.7
SB15	SB15 (4-6)	4-6	Silty Clay	>300	08/21/19	---	1900	540	---	<10	---	<13	98	130 J	---	72	<27	200	510	200	<8.7
SB16	SB16 (2-4)	2-4	Silty Clay	3.5	08/21/19	---	150	62 J	---	<9.9	---	<12	<26	<110	---	68	<26	<28	<25	<27	41
SB17	SB17 (2-4)	2-4	Sand	2.2	08/21/19	---	2700	1200	---	<9.1	---	<11	<24	110 J	---	320	<24	370	170	250	<9.2
HA-1	HA-1	0-2	Fill / Silty Clay	---	04/15/20	---	<26	<28	---	<11	---	<13	<28	<120	---	<16	<28	<30	<26	<29	<11
HA-2	HA-2	0-2	Fill / Silty Clay	---	04/15/20	---	<26	<28	---	<11	---	<13	<28	<120	---	64	<28	<30	<27	<29	28
HA-3	HA-3	0-2	Fill / Silty Clay	---	04/15/20	---	42 J	<26	---	<10	---	24	<27	<110	---	130	<27	<29	<25	<28	74
HA-4	HA-4	0-2	Fill / Silty Clay	---	04/15/20	---	56 J	<25	---	18	---	26	<25	<110	---	160	<25	<27	<24	<26	77
HA-5	HA-5	0-2	Fill / Silty Clay	---	04/15/20	---	77	<26	---	140	---	49	<26	<110	---	270	<27	<28	<25	<27	260
HA-6	HA-6	0-2	Fill / Silty Sand	---	04/15/20	---	<24	<25	---	<9.7	---	<12	<26	<110	---	25 J	<26	<28	<24	<26	13 J
HA-7	HA-7	0-2	Fill / Silty Clay	---	04/15/20	---	<24	<25	---	<9.8	---	<12	<26	<110	---	53	<26	<28	<24	<27	<9.8
HA-8	HA-8	0-2	Fill / Silty Clay	---	04/15/20	---	23 J	<25	---	19	---	18	<25	<110	---	67	<25	<27	<23	<26	49
HA-9	HA-9	0-2	Fill / Silty Sand	---	04/15/20	---	<23	<24	---	<9.3	---	<12	<24	<100	---	<14	<25	<26	<23	<25	<9.4
HA-10	HA-10	0-2	Fill / Silty Clay	---	04/15/20	---	<23	<25	---	<9.6	---	<12	<25	<110	---	46	<26	<27	<24	<26	23
HA-11	HA-11	0-2	Fill / Silty Clay	---	04/15/20	---	<25	<27	---	<11	---	<13	<28	<120	---	<16	<28	<30	<26	<29	<11
HA-12	HA-12	0-2	Fill / Silty Sand	---	04/15/20	---	<22	<25	---	<9.4	---	<12	<25	<110	---	<14	<25	<27	<23	<26	<9.5

Key:

<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
µg/kg = microgram per kilogram
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

Table 3a Groundwater Sample RCRA Metals Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Well Number	Date Collected	Laboratory Results (µg/L)							
		RCRA Metals							
		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
NR 140 Preventive Action Limit		1	400	0.5	10	1.5	0.2	10	10
NR 140 Enforcement Standard		10	2000	5	100	15	2	50	50
TW10	8/28/2019	0.49 J	45	<0.17	<1.1	<0.19	<0.098	1.3 J	<0.12
	4/16/2020	0.56 J	29	<0.17	<1.1	<0.19	<0.098	1.3 J	<0.12
TW11	8/28/2019	*8.5*	*420*	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
	4/16/2020	*5.2*	330	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
TW13	8/28/2019	0.82 J	190	<0.17	<1.1	<0.19	<0.098	1.1 J	<0.12
	4/16/2020	0.77 J	91	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
TW15	8/28/2019	17	240	<0.17	1.3 J	0.31 J	<0.098	1.8 J	<0.12
	4/16/2020	*2.0*	47	<0.17	<1.1	<0.19	<0.098	7.9	<0.12
TW17	8/28/2019	*1.6*	100	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
	4/16/2020	*1.3*	67	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12

Key:

RCRA	= Resource Conservation and Recovery Act
<X	= analyte not detected above method detection limit
"J"	= Analyte detected between Limit of Detection and Limit of Quantitation
µg/L	= microgram per liter
X	= concentration detected above Chapter NR 140, Wisconsin Administrative Code(NR 140, Wis. Adm. Code) preventive action limit (PAL)
X	= concentration detected above NR 140, Wis. Adm. Code enforcement standard (ES)

Table 3b Groundwater Sample Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Well Number	Date Collected	Polynuclear Aromatic Hydrocarbons (µg/L)																	
		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g, h, i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a, h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
NR 140 Preventive Action Limit		NE	NE	600	NE	0.02	0.02	NE	NE	0.02	NE	80	80	NE	NE	NE	10	NE	50
NR 140 Enforcement Standard		NE	NE	3,000	NE	0.2	0.2	NE	NE	0.2	NE	400	400	NE	NE	NE	100	NE	250
B1-GW	10/3/2018	<0.0590	<0.0590	0.16	0.0151 J	<0.0590	0.0099 J	0.00654 J	<0.0590	<0.0590	<0.0590	0.0353 J	<0.0590	<0.0590	0.0257 J	0.0250 J	0.0557 J	0.0293 J	0.0175 J
B2-GW	10/3/2018	<0.0715	<0.0715	<0.0715	0.00715 J	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	0.0180 J	0.0185 J	0.0566 J	<0.0715	<0.0715
B3-GW	10/3/2018	0.107 J	<0.500	0.67	0.341 J	0.225 J	0.156 J	0.326 J	<0.500	0.454 J	<0.500	0.243 J	<0.500	<0.500	<2.50	<2.50	0.243 J	0.33	2.22
B4-GW	10/3/2018	<0.0525	<0.0525	<0.0525	0.00583 J	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	0.0152 J	0.0156 J	0.0338 J	<0.0525	<0.0525
B5-GW	10/3/2018	0.0155 J	<0.0590	0.0292 J	0.0698	0.0766	0.116 J	0.0991	0.0328 J	0.118 J	0.0143 J	0.203	<0.0590	0.0610 J	0.0335 J	0.0418 J	0.0452 J	0.205	0.152
TW10	8/28/2019	<0.23	<0.20	<0.25	<0.043	<0.075	<0.061	<0.29	<0.049	<0.052	<0.039	<0.35	<0.19	<0.057	<0.23	<0.050	<0.23	<0.23	<0.32
	4/16/2020	<0.26	<0.22	<0.28	<0.047	<0.083	<0.067	<0.31	<0.054	<0.057	<0.042	<0.38	<0.20	<0.063	<0.25	<0.054	<0.26	<0.25	<0.36
TW11	8/28/2019	<0.25	<0.22	<0.27	<0.047	<0.081	<0.066	<0.31	<0.053	<0.056	<0.042	<0.37	<0.20	<0.062	<0.25	<0.054	<0.25	<0.25	<0.35
	4/16/2020	<0.27	<0.24	<0.30	<0.050	<0.088	<0.072	<0.33	<0.057	<0.061	<0.045	<0.40	<0.22	<0.067	<0.27	<0.058	<0.27	<0.27	<0.38
TW13	8/28/2019	<0.25	<0.22	<0.27	<0.047	<0.081	<0.066	<0.31	<0.053	<0.056	<0.042	<0.37	<0.20	<0.061	<0.25	<0.054	<0.25	<0.25	<0.35
	4/16/2020	<0.27	<0.23	<0.29	<0.050	<0.087	<0.071	<0.33	<0.056	<0.060	<0.044	<0.40	<0.21	<0.065	<0.26	<0.057	<0.27	<0.26	<0.37
TW15	8/28/2019	<2.4	<2.1	<2.6	<0.45	<0.78	<0.64	<3.0	<0.51	*1.5 J*	<0.40	<3.6	<1.9	<0.59	4.0 J	<0.52	<2.4	2.8 J	<3.4
	4/16/2020	<0.27	<0.23	<0.29	<0.049	<0.086	<0.070	<0.33	<0.056	<0.059	<0.044	<0.39	<0.21	<0.065	<0.26	<0.057	<0.27	<0.26	<0.37
TW17	8/28/2019	<0.24	<0.21	<0.26	<0.045	<0.078	<0.064	<0.30	<0.051	<0.054	<0.040	<0.36	<0.19	<0.059	<0.24	<0.052	<0.24	<0.24	<0.34
	4/16/2020	<0.27	<0.24	<0.29	0.21	*0.36*	*0.29*	<0.33	0.23	0.17 J	<0.045	<0.40	<0.21	0.23	<0.27	<0.057	<0.27	0.29 J	<0.38

Key:

<X = analyte not detected above method detection limit
"J" = Analyte detected between Limit of Detection and Limit of Quantitation
µg/L = micrograms per liter
NE = not established
X = Concentration detected above Chapter NR 140, Wisconsin Administrative Code (NR 140, Wis. Adm. Code) preventive action limit (PAL)
X = Concentration detected above NR 140, Wis. Adm. Code enforcement standard (ES)
= Sample collected by Partner Engineering and Science Inc.

Table 3c Groundwater Sample Volatile Organic Compound Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Well Number	Date Collected	Volatile Organic Compounds (µg/L)																					
		Benzene	Chloroform	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene	Methylene Chloride	MTBE	Naphthalene	n-Butylbenzene	N-Propylbenzene	sec-Butylbenzene	Tetrachloroethene (PCE)	Toluene	1,1,1-Trichloroethane (1,1,1-TCA)	Trichloroethene (TCE)	Total Trimethylbenzene	Vinyl Chloride	Total Xylenes
NR 140 Preventive Action Limit		0.5	0.6	0.5	85	7	20	140	NE	NE	0.5	12	10	NE	NE	NE	0.5	160	40	0.5	96	0.02	400
NR 140 Enforcement Standard		5	6	5	850	70	100	700	NE	NE	5	60	100	NE	NE	NE	5	800	200	5	480	0.2	2,000
B1-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.56	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
B2-GW	10/3/2018	<5.00	<25.0	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<25.0	<5.00	<25.0	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<10.0	<5.00	<15.0
B3-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
B4-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
B5-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
TW10	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
TW11	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
TW13	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
TW15	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	1.6	1.1	<1.6	<0.39	0.76 J	<0.39	2.0	0.63 J	<0.37	<0.15	<0.38	<0.16	3.5	<0.20	1.3
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	0.21 J	2.9	2.1	<1.6	<0.39	---	9.2	4.6	3.6	<0.37	<0.15	<0.38	<0.16	6.3	<0.20	1.6
TW17	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22

Key:

"J" = Analyte detected between Limit of Detection and Limit of Quantitation
µg/L = microgram per liter
NE = not established
X = Concentration detected above Chapter NR 140, Wisconsin Administrative Code (NR 140, Wis. Adm. Code) preventive action limit (PAL)
X = Concentration detected above NR 140, Wis. Adm. Code enforcement standard (ES)
= Sample collected by Partner Engineering and Science Inc.

Table 4: Air Quality Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample Location Building Address	Sample Point	Date Sampled	Date Analyzed	Sample Location	Sample Duration	Detected Volatile Organic Compounds (micrograms per cubic meter)
						Dichlorodifluoro-methane
Target Indoor Air Concentration (micrograms per cubic meter) *				Residential		100
				Small Commercial		440
Target Sub-Slab Air Concentration (micrograms per cubic meter)				Residential		3,300
				Small Commercial		15,000
400 Fox Shores Drive	VP-1	10/03/18	10/05/18	Water softner room sub-slab	30 Minutes	7,060
400 Fox Shores Drive	VP-2	10/03/18	10/06/18	Water softner room sub-slab	30 Minutes	126,000
400 Fox Shores Drive	VP-3	10/03/18	10/06/18	Water softner room sub-slab	30 Minutes	79,000
400 Fox Shores Drive	VP-4 Ambient	02/25/19	03/01/19	Apartment indoor air	24 Hour	19
400 Fox Shores Drive	VP-5 Ambient	02/25/29	03/01/19	Apartment indoor air	24 Hour	6.0
400 Fox Shores Drive	VP-6 Ambient	02/25/19	03/01/19	Apartment indoor air	24 Hour	5.3
400 Fox Shores Drive	VP-4	02/26/19	03/01/19	Apartment sub-slab	30 Minutes	1,800
		08/13/19	08/16/19	Apartment sub-slab	30 Minutes	9,100
400 Fox Shores Drive	VP-5	02/26/19	03/01/19	Apartment sub-slab	30 Minutes	2,700
		08/13/19	08/21/19	Apartment sub-slab	30 Minutes	11,000
400 Fox Shores Drive	VP-6	02/26/19	03/02/19	Apartment sub-slab	30 Minutes	4,700
		08/13/19	08/21/19	Apartment sub-slab	30 Minutes	5,100
400 Fox Shores Drive	VP-2R	02/26/19	03/02/19	Water softner room sub-slab	30 Minutes	35,000

Note:

NSL = no screening level assigned from EPA Region 3 Screening Level Table - Residential Air, November 2017

* = screening levels from USEPA Region 3 Screening Level Table - November 2017 and, if applicable, representing 1 in 100,000 cancer risk

x = analyte exceeds applicable target air concentration

= Sample collected by Partner Engineering and Science Inc.

Table 5 - Water Level Elevations, Fox Shores Apartments, 400 Fox Shores Drive, Kaukauna, Wisconsin

Well I.D.	Ground Surface Elevation (site datum)	Reference Point Elevation (site datum)	Top / Bottom Well Screen Elevation (fbg)	Date	Depth to Water (feet)		Water Table Elevation (feet)
					Below Grade	Below Riser	
TW10	98.59	98.46	3-10	8/21/2019	4.20	4.07	94.39
				8/28/2019	4.02	3.89	94.57
				4/16/2020	3.86	3.73	94.73
TW11	98.61	98.44	4-9	8/21/2019	4.79	4.62	93.82
				8/28/2019	4.72	4.55	93.89
				4/16/2020	4.50	4.33	94.11
TW13	97.93	97.74	3.5-8.5	8/21/2019	5.55	5.36	92.38
				8/28/2019	5.12	4.93	92.81
				4/16/2020	4.87	4.68	93.06
TW15	98.15	97.96	3.5-8.5	8/21/2019	6.14	5.95	92.01
				8/28/2019	4.88	4.69	93.27
				4/16/2020	4.06	3.87	94.09
TW17	97.86	97.66	3-8	8/21/2019	4.90	4.70	92.96
				8/28/2019	4.73	4.53	93.13
				4/16/2020	4.26	4.06	93.60

Key:

fbg = Feet Below Grade

--- = Not Collected

APPENDICES

Appendix A

Soil Boring Logs

Boring Number:	B1				Page 1 of 5
Location:	Southeastern portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	7' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B1 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.0		Black clay with some sand and gravel, medium-soft, moist	
3					
4		0.0			
5					
6		0.0	CL		5/5 recovery
7	B1 (6-7)			Brown clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
8		0.0			
9				Brown clay with some sand and gravel, medium-soft, moist	
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B1-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B2				Page 2 of 5
Location:	Southwestern portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	8' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B2 (0.5-1)		--	Organic topsoil	4/5 recovery (sample volume collected for metals analysis)
2		0.1		Black clay with some sand and gravel, medium-soft, moist	
3				Brown clay with some sand and gravel, medium-soft, moist	
4		0.0			
5					
6		0.1	CL		4/5 recovery
7					
8	B2 (7-8)	0.1		Brown clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
9				Gray clay with some sand and gravel, medium-soft, moist	
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B2-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B3				Page 3 of 5
Location:	West central portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	4.5' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B3 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.1		Tan clay with some sand and gravel, medium-soft, moist	
3				Brown clay with some sand and gravel, medium-soft, moist	
4	B3 (3-4)	0.0			(sample volume collected for VOCs and PAHs analysis)
5				Brown clay with some sand and gravel, medium-soft, wet	
6		0.0	CL		2/5 recovery
7					
8		0.1			
9					
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B3-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B4				Page 4 of 5
Location:	Northwestern portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	7' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B4 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.0		Brown clay with some sand and gravel, medium-soft, moist	
3					
4		0.1			
5					
6		0.1	CL		5/5 recovery
7	B4 (6-7)			Brown clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
8		0.1		Brown clay with some sand and gravel, medium-soft, moist	
9					
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B4-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B5				Page 5 of 5
Location:	North central portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	4.5' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B5 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.0		Black clay with some sand and gravel, medium-soft, moist	
3					
4		0.0	CL		
5	B5 (3.5-4.5)			Black/tan clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
6		0.0			2/5 recovery
7					
8				Borehole termintated at 7 feet bgs due to refusal. Temporary 3/4 inch groundwater monitoring well installed to 7 feet, screend 2 to 7 feet. Groundwater sample B5-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
9					
10					
11					
12					
13					
14					
15					
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17					
18					
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20					
21					
22					
23					
24					
25					

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB6

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	5/14/2019	5/14/2019	hollow auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S / C / N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB6(0-1) HAND AUGER	12 12			TOPSOIL				1.2						
SB6(1-2) HAND AUGER	12 12		1	SILTY CLAY, medium plasticity, trace slag and gravel, brown (7.5YR 4/2) from 0 to 1 foot, black (7.5YR 2.5/1) from 1 to 2.3 feet, moist, no odor.	CL-ML			1.3						
SB6(2-3) HAND AUGER	12 4		2	REFUSAL - END OF BORING AT 2.3 FEET.				1.6						

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB7

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	5/14/2019	5/14/2019	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB7(0-1) HAND AUGER	12 12			TOPSOIL				0.9						
SB7(1-2) HAND AUGER	12 12		1	SILTY CLAY, medium plasticity, hard, trace large gravel, brown (7.5YR 4/2), moist, no odor.	CL-ML			3.7						
SB7(2-3) HAND AUGER	12 2		2	REFUSAL - END OF BORING AT 2.2 FEET.				---						

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB8

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	5/14/2019	5/14/2019	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB8(0-1) HAND AUGER	12 12			TOPSOIL				0.8						
			1	SILTY CLAY, medium plasticity, brown (7.5YR 4/2), moist, no odor.	CL-ML			---						
SB8(1-2) HAND AUGER	12 4			REFUSAL - END OF BORING AT 1.3 FEET.										

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB9

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	5/14/2019	5/14/2019	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB9(0-1) HAND AUGER	12 12			TOPSOIL				0.9						
			1	SILTY CLAY, large gravel, some root material, black (7.5YR2.5/1), moist, no odor.	CL-ML									
SB9(1-2) HAND AUGER	12 12							1.0						
			2	SAND AND GRAVEL FILL, some slag, large gravel, and root material, black (7.5YR 2.5/1), moist, no odor.										
SB9(2-3) HAND AUGER	12 5							1.3						
				REFUSAL - END OF BORING AT 2.4 FEET.										

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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB10-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	5/14/2019	5/14/2019	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E
Lat 44° 16' 51.5"
Long -88° 16' 31.0"
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB10-1(0-1) HAND AUGER	12 12		0	CONCRETE				1.2						
SB10-1(1-2) HAND AUGER	12 12		1	SILTY SAND, fine grained, poorly-graded, thin clay lense at 2.5 feet, brown (7.5YR 4/1), saturated at 4 feet, no odor.	SM			1.2						
SB10-1(2-3) HAND AUGER	12 12		2					1.1						
SB10-1(3-4) HAND AUGER	12 12		3					0.9						
SB10-1(4-5) HAND AUGER	12 12		4					1.2						
			5	END OF BORING AT 5 FEET.										

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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB10-2

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TW10	Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB10-2(0-2) GEOPROBE	24 15		1	CLAY, medium plasticity, dark brown (7.5YR 3/3), moist, no odor.	CH			2.6						
SB10-2(2-4) GEOPROBE	24 15		2 3	SILTY CLAY, some fine gravel and slag, black (7.5YR 2.5/1), moist, no odor.	CL-ML			2.0						
SB10-2(4-6) GEOPROBE	24 16		4	SAND AND GRAVEL FILL, light brown (7.5YR 6/3), moist, no odor.				1.4						
			5	SILTY CLAY, medium to low plasticity, fine gravel from 4.5 to 6 feet, large gravel from 8 to 10 feet, brown (7.5YR 4/2), saturated at 5 feet, no odor.										
SB10-2(6-8) GEOPROBE	24 16		6 7		CL-ML			2.4						
SB10-2(8-10) GEOPROBE	24 18		8 9					2.8						
			10	END OF BORING AT 10 FEET.										

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Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB11

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TW11	Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB11(0-2) GEOPROBE	24 18		0	ASPHALT				2.5						
				SAND AND GRAVEL FILL										
			1	SILTY CLAY, medium plasticity, some medium gravel, brown (7.5YR 4/3), moist, no odor.	CL-ML									
					SP									
SB11(2-4) GEOPROBE	24 18		2	SAND, fine grained, poorly-graded, some medium gravel, trace slag, black (7.5YR 2.5/1), moist, no odor.	CL-ML			4.3						
			3	SILTY CLAY, hard, low plasticity, some medium gravel, brown (7.5YR 4/3), moist, no odor.										
SB11(4-6) GEOPROBE	24 13		4	SAND AND GRAVEL FILL, some silty clay, black (7.5YR 2.5/1), saturated at 6 feet, no odor.				2.4						
			5											
SB11(6-8) GEOPROBE	24 13		6	SANDY SILT, black (7.5YR 2.5/1), saturated, no odor.	ML			3.8						
			7	SILTY CLAY, hard, low plasticity, some medium gravel, brown (7.5YR 4/2), saturated, no odor.	CL-ML									
SB11(8-10) GEOPROBE	24 12		8	SAND AND GRAVEL FILL, some clay, brown (7.5YR 4/3), saturated, no odor.				4.8						
			9	REFUSAL - END OF BORING AT 9 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	Tel:
Jeffrey R. Brown	Stantec	Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB12

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
Feet ☐ N ☐ E
Feet ☐ S ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB12(0-2) GEOPROBE	24 18		0	ASPHALT				5.9						
			1	SAND AND GRAVEL FILL, brown (7.5YR 5/3), no odor, moist.										
				SILTY CLAY, some medium gravel, very dark grey (7.5YR 3/1), moist, burnt odor.	CL-ML									
SB12(2-4) GEOPROBE	24 18		2	SAND AND GRAVEL FILL, black (7.5YR 2.5/1), moist, burnt odor.				5.9						
			3	SILTY CLAY, some medium gravel, black (7.5YR 2.5/1) from 2.75 to 4 feet, brown (7.5YR 4/3) from 4 to 6 feet, moist, burnt odor.										
SB12(4-6) GEOPROBE	24 19		4		CL-ML			6.0						
			5											
SB12(6-8) GEOPROBE	24 19		6	SILTY SAND, fine grained, poorly-graded, some medium to large gravel and clay, brown (7.5YR 4/4), saturated at 7 feet, no odor.				5.3						
			7		SM									
SB12(8-10) GEOPROBE	24 10		8	SAND AND GRAVEL FILL, well-graded, brown (7.5YR 4/2), saturated, no odor.				4.8						
			9											
			10	END OF BORING AT 10 FEET.										

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Jeffrey R. Brown	Stantec	Fax:

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Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB13

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TW13	Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
Feet ☐ N ☐ E
Feet ☐ S ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB13(0-2) GEOPROBE	24 20		1	SILTY CLAY, some silt, brown (7.5YR 5/4), moist, no odor.	CL-ML			2.6						
SB13(2-4) GEOPROBE	24 20		2 3	SAND, fine grained, poorly-graded, some fine gravel, black (7.5YR 2.5/1), moist, no odor.	SP			2.7						
SB13(4-6) GEOPROBE	24 21		4 5	SILTY CLAY, hard, low plasticity, trace medium gravel, brown (7.5YR 4/4) from 2.5 to 7.5 feet, strong brown (7.5YR 4/6) from 7.5 to 8.5 feet, saturated at 5 feet, no odor.	CL-ML			3.5						
SB13(6-8) GEOPROBE	24 21		6 7					4.0						
SB13(8-10) GEOPROBE	24 12		8					4.2						
				REFUSAL - END OF BORING AT 8.5 FEET.										

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SOIL BORING LOG INFORMATION
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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB14

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB14(0-2) GEOPROBE	24 18		1	SILTY CLAY, trace fine gravel, brown (7.5YR 4/4), dry, no odor.	CL-ML			1.5						
				REFUSAL - END OF BORING AT 1.5 FEET.										

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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB15

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TW15	Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB15(0-2) GEOPROBE	24 14		1	SILTY CLAY, some fine gravel, some slag and coal from 1 to 2 feet, brown (7.5YR 4/4) from 0 to 0.7 feet, black (7.5YR 2.5/1) from 0.7 to 2 feet, moist, no odor.	CL-ML			2.5						
SB15(2-4) GEOPROBE	24 14		2 3	SAND, fine grained, poorly-graded, trace fine gravel, some slag and coal from 2.5 to 4 feet, light grey (7.5YR 7/2) from 2 to 2.5 feet, black (7.5YR 2.5/1) from 2.5 to 4 feet, moist, no odor.	SP			25						
SB15(4-6) GEOPROBE	24 15		4 5	SILTY CLAY, high to low plasticity, some large gravel, very dark grey (7.5YR 3/1) from 4 to 6 feet, brown (7.5YR 5/2) from 6 to 8.5 feet, saturated at 6 feet, very strong petroleum odor.	CL-ML			>300						
SB15(6-8) GEOPROBE	24 15		6 7 8					208						
				REFUSAL - END OF BORING AT 8.5 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB16

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
Feet ☐ N ☐ E
Feet ☐ S ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB16(0-2) GEOPROBE	24 14		0	SILTY CLAY, trace fine gravel, brown (7.5YR 4/2) from 0 to 0.6 feet, very dark grey (7.5YR 3/1) from 0.6 to 2 feet, brown (7.5YR 5/4) from 2 to 3.5 feet, moist, no odor.	CL-ML			2.9						
SB16(2-4) GEOPROBE	24 14		2					3.5						
			3											
SB16(4-6) GEOPROBE	24 17		4	SAND, fine grained, poorly-graded, some coal, black (7.5YR 2.5/1), moist, no odor.	SP			4.0						
			5	SILTY CLAY, high to low plasticity, trace fine gravel, reddish brown (7.5YR 5/3) from 4 to 6 feet, very dark grey (7.5YR 3/1) from 6 to 8 feet, brown (7.5YR 4/4) from 8 to 9 feet, saturated at 6 feet, no odor.										
SB16(6-8) GEOPROBE	24 17		6		CL-ML			4.1						
			7											
SB16(8-10) GEOPROBE	24 12		8					4.1						
			9	REFUSAL - END OF BORING AT 9 FEET.										

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Jeffrey R. Brown	Stantec	Fax:

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Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	SB17

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Darrin Prentice Geiss Soil and Samples, LLC	8/21/2019	8/21/2019	geoprobe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TW17	Feet Site	Feet Site	2.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
SB17(0-2) GEOPROBE	24 20		1	SILTY CLAY, low plasticity, trace fine gravel, dark brown (7.5YR 3/3), dry, no odor.	CL-ML			2.2						
SB17(2-4) GEOPROBE	24 20		2 3	SAND, fine grained, poorly-graded, some coal, slag, and brick, black (7.5YR 2.5/1), moist, no odor.	SP			2.2						
SB17(4-6) GEOPROBE	24 21		4 5	SILTY CLAY, medium to low plasticity, some large gravel from 3.5 to 4 feet, strong brown (7.5YR 4/6) from 3.5 to 4 feet, reddish brown (7.5YR 4/4) from 4 to 5.5 feet, very dark grey (7.5YR 3/1) from 5.5 to 6 feet, dark brown (7.5YR 3/2) from 6 to 8 feet, saturated at 6 feet, no odor.	CL-ML			3.5						
SB17(6-8) GEOPROBE	24 21		6 7 8					3.5						
				REFUSAL - END OF BORING AT 8 FEET.										

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SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-1 HAND AUGER	24 18		1	SILTY CLAY, dark brown (7.5YR 3/2) from 0 to 1 foot, black (7.5YR 2.5/1) from 1 to 1.5 feet, moist, no odor.	CL-ML									
				REFUSAL - END OF BORING AT 1.5 FEET.										

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-2

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-2 HAND AUGER	24 20		1	SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor.	SP									
				SILTY CLAY, some medium to large gravel, moist, no odor.	CL-ML									
				REFUSAL - END OF BORING AT 1.7 FEET.										

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Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-3

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-3 HAND AUGER	24 24		1	SILTY CLAY, some medium gravel, moist, no odor.	CL-ML									
			2	SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor.	SP									
				SILTY CLAY, some medium gravel, moist, no odor.	CL-ML									
				END OF BORING AT 2 FEET.										

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SOIL BORING LOG INFORMATION

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-4

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-4 HAND AUGER	24 24		1 2	SILTY CLAY, some medium gravel, moist, no odor. SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor. SILTY CLAY, some medium gravel, moist, no odor. END OF BORING AT 2 FEET.	CL-ML SP CL-ML									

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SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-5

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-5 HAND AUGER	24 24		1	SILTY CLAY, some medium gravel, moist, no odor.	CL-ML									
			2	SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor.	SP									
				END OF BORING AT 2 FEET.										

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SOIL BORING LOG INFORMATION
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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-6

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-6 HAND AUGER	24 18		1	SILTY SAND, fine grained, poorly-graded, moist, no odor.	SM									
				SAND, fine grained, poorly-graded, some large gravel, black (7.5YR 2.5/1), moist, no odor.	SP									
				REFUSAL - END OF BORING AT 1.5 FEET.										

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SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-7

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-7 HAND AUGER	24 20		1	SILTY CLAY, moist, petroleum odor.	CL-ML									
				SAND, fine grained, poorly-graded, some large gravel, black (7.5YR 2.5/1), moist, petroleum odor.	SP									
				REFUSAL - END OF BORING AT 1.7 FEET.										

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Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-8

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-8 HAND AUGER	24 24		1	SILTY CLAY, moist, no odor.	CL-ML									
			2	SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor.	SP									
				END OF BORING AT 2 FEET.										

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-9

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-9 HAND AUGER	24 20		1	SILTY SAND, fine grained, poorly-graded, moist, no odor.	SM									
				SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor.	SP									
				REFUSAL - END OF BORING AT 1.7 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-10

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-10 HAND AUGER	24 24		1	SILTY CLAY, moist, no odor.	CL-ML									
			2	SAND, fine grained, poorly-graded, black (7.5YR 2.5/1), moist, no odor.	SP									
				END OF BORING AT 2 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-11

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-11 HAND AUGER	24 20		1	SILTY CLAY, moist, no odor.	CL-ML									
				SAND, fine grained, poorly-graded, some medium gravel, black (7.5YR 2.5/1), moist, no odor.	SP									
				REFUSAL - END OF BORING AT 1.7 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-12

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-12 HAND AUGER	24 18		1	SILTY SAND, fine grained, poorly-graded, some medium gravel, moist, no odor.	SM									
				REFUSAL - END OF BORING AT 1.5 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Braun Firm Stantec Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-13

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-13 HAND AUGER	24 20		1	SILTY CLAY, some fine grained sand and slag, black (7.5YR 2.5/1), moist, no odor.	CL-ML									
				REFUSAL - END OF BORING AT 1.7 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Fox Shores Apartments	193706620	HA-14

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Tyler Hischke Stantec Consulting Services Inc.	4/15/2020	4/15/2020	hand auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet Site	Feet Site	3.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane N, E S/C/N
SE 1/4 of NE 1/4 of Section 23, T 21 N, R 18 E

Lat 44° 16' 51.5"
Long -88° 16' 31.0"

Local Grid Location
☐ N ☐ E
Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
HA-14 HAND AUGER	24 18		1	SILTY CLAY, some fine grained sand, black (7.5YR 2.5/1), moist, no odor.	CL-ML									
				REFUSAL - END OF BORING AT 1.5 FEET.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jeffrey R. Brown Firm Stantec Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Appendix B

Soil Boring Abandonment Forms

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB6

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other:

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie		

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼/¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 05/14/2019

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2.3	0.11 Ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		05/14/2019

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5/15/20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB7

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions): 44.2809813 N, -88.2752825 W — Format Code: ☐ DD ☐ DDM — Method Code: ☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town: Kaukauna — Well ZIP Code: 54130

Subdivision Name — Lot #

Reason for Removal from Service: Complete Soil Sampling — WI Unique Well # of Replacement Well: _ _ _ _ _ _

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS)

License/Permit/Monitoring #

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner: Appleton — State: WI — ZIP Code: 54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 05/14/2019

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—
Lower Drillhole Diameter (in.)	**Casing Depth (ft.)**
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2.2	0.11 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		05/14/2019

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8490

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke — Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** S88

Route to DNR Bureau: ☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Waste Management ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 05/14/2019

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.3	0.06 ft^3	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		05/14/2019

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB9

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range
SE	NE	23	21 N	☒ E ☐ W

or Gov't Lot #

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 05/14/2019

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Augs

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2-4	0.11 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		05/14/2019

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke — Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB10-1

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N -88.2752825 W	☐ DD ☐ DDM	☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range
SE	NE	23	21 N	18 ☒ E ☐ W

or Gov't Lot #

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 05/14/2019

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Concrete	Surface	0.25	0.01 ft³	
Bentonite	0.25	5	0.23 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		05/14/2019

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8430

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB12

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other:

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie		

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N -88.2752825 W	☐ DD ☐ DDM	☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LLC

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 08/21/2019

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Geoprobe

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
2	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☐ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Asphalt Patch	Surface	0.3	0.01 ft³	
Bentonite	0.3	10	0.21 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Geiss Soil & Samples		08/21/2019

Street or Route	Telephone Number
W4490 Pope Road	(715) 539-3928

City	State	ZIP Code	Signature of Person Doing Work	Date Signed
Merrill	WI	54452	for Geiss	08/21/2019

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB14

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other:

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range
SE	NE	23	21 N	☒ E ☐ W
or Gov't Lot #				

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 08/21/2019

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Geopcobe

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
2	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LLC

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☐ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.5	0.03 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Geiss Soil 3 Samples		08/21/2019

Street or Route	Telephone Number
W4490 Pope Road	(715) 539-3928

City	State	ZIP Code	Signature of Person Doing Work	Date Signed
Merrill	WI	54452	for Geiss	08/21/2019

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** SB16

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N -88.2752825 W	☐ DD ☐ DDM	☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range
SE	NE	23	21 N	18 ☒ E ☐ W

or Gov't Lot #

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _ _

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 08/21/2019

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Geoprobe

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
2	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☐ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	9	0.20ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Geiss Soil & Samples		08/21/2019

Street or Route	Telephone Number
W4490 Pope Road	(715) 539-3928

City	State	ZIP Code	Signature of Person Doing Work	Date Signed
Merrill	WI	54452	for Geiss	08/21/2019

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

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☐ **Verification Only of Fill and Seal** HA-1

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.5	0.07 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal**

HA - 2

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other:

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie		

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼/¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 05/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Hand Augers

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.7	0.07 Ft³

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-3

Route to DNR Bureau: ☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Waste Management ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼/¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _ _

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2	0.09 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Schewing Rd	(920) 592-8400

City	State	ZIP Code
DePere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-4

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions): 44.2809813 N, -88.2752825 W — Format Code: ☐ DD ☐ DDM — Method Code: ☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range	or Gov't Lot #
SE	NE	23	21 N	18 ☒ E ☐ W	

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town: Kaukauna — Well ZIP Code: 54130

Subdivision Name: — Lot #:

Reason for Removal from Service: Complete Soil Sampling — WI Unique Well # of Replacement Well: _ _ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lyndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2	0.09 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke — Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-5

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼/¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lyndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2	0.09 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-6

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range	
SE	NE	23	21 N	18	☒ E ☐ W
or Gov't Lot #					

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Hand Augs

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.5	0.07 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8497

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hschke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

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☐ **Verification Only of Fill and Seal** HA-7

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other:

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼/¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.7	0.07 ft3	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hadtke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-8

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N -88.2752825 W	☐ DD ☐ DDM	☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range
SE	NE	23	21 N	☒ E ☐ W

or Gov't Lot #

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Augs

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2	0.09 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hachka

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-9

Route to DNR Bureau:
☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment
☐ Waste Management ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lyndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.7	0.07 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-10

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions): 44.2809813 N, -88.2752825 W — Format Code: ☐ DD ☐ DDM — Method Code: ☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range	
SE	NE	23	21 N	18	☒ E ☐ W

or Gov't Lot #

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town: Kaukauna — Well ZIP Code: 54130

Subdivision Name — Lot #

Reason for Removal from Service: Complete Soil Sampling — WI Unique Well # of Replacement Well: _ _ _ _ _

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS)

License/Permit/Monitoring #

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner: Appleton — State: WI — ZIP Code: 54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—
Lower Drillhole Diameter (in.)	**Casing Depth (ft.)**
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)? — Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	2	0.09 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hoschke — Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-11

Route to DNR Bureau: ☐ Drinking Water ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Waste Management ☐ Other:

1. Well Location Information

County: Outagamie
WI Unique Well # of Removed Well:
Hicap #:
Latitude / Longitude (see instructions): 44.2809813 N, -88.2752825 W
Format Code: ☐ DD ☐ DDM
Method Code: ☐ GPS008 ☐ SCR002 ☐ OTH001
¼ / ¼ SE ¼ NE or Gov't Lot #:
Section: 23
Township: 21 N
Range: 18 ☒ E ☐ W
Well Street Address: 410 Fox Shores Drive, 380 400 Bicentenial Ct
Well City, Village or Town: Kaukauna
Well ZIP Code: 54130
Subdivision Name:
Lot #:
Reason for Removal from Service: Complete Soil Sampling
WI Unique Well # of Replacement Well:

2. Facility / Owner Information

Facility Name: Fox Shores Apartments
Facility ID (FID or PWS):
License/Permit/Monitoring #:
Original Well Owner: Tom Vandeyacht - Fox Investments LL
Present Well Owner: SAME
Mailing Address of Present Owner: 2220 N Lynndale Drive
City of Present Owner: Appleton
State: WI
ZIP Code: 54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole
Original Construction Date (mm/dd/yyyy): 04/15/2020
If a Well Construction Report is available, please attach.
Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger
Formation Type: ☒ Unconsolidated Formation ☐ Bedrock
Total Well Depth From Ground Surface (ft.): —
Casing Diameter (in.): —
Lower Drillhole Diameter (in.):
Casing Depth (ft.): —
Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

	Yes	No	N/A
Pump and piping removed?	☐	☐	☒
Liner(s) removed?	☐	☐	☒
Liner(s) perforated?	☐	☐	☒
Screen removed?	☐	☐	☒
Casing left in place?	☐	☐	☒
Was casing cut off below surface?	☐	☐	☒
Did sealing material rise to surface?	☒	☐	☐
Did material settle after 24 hours?	☐	☒	☐
If yes, was hole retopped?	☐	☐	☒
If bentonite chips were used, were they hydrated with water from a known safe source?	☐	☐	☒

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.7	0.07 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing: Stantec
License #:
Date of Filling & Sealing or Verification (mm/dd/yyyy): 04/15/2020
Street or Route: 1165 Scheuring Rd
Telephone Number: (920) 592-8400
City: DePere
State: WI
ZIP Code: 54115
Signature of Person Doing Work: [signature] for Tyler Hischke
Date Signed: 5-15-20

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-12

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☐ Other: ☒ Remediation/Redevelopment

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie		

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼/¼ SE	¼ NE	Section	Township	Range
or Gov't Lot #		23	21 N	☒ E ☐ W 18

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete
☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.5	0.07 yd3	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code
De Pere	WI	54115

Signature of Person Doing Work: for Tyler Hischke

Date Signed: 5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-13

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Other: _____

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie	_ _ _ _ _	

Latitude / Longitude (see instructions)	Format Code	Method Code
44.2809813 N	☐ DD	☐ GPS008
-88.2752825 W	☐ DDM	☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range
SE	NE	23	21 N	☒ E ☐ W

or Gov't Lot #

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town	Well ZIP Code
Kaukauna	54130

Subdivision Name	Lot #

Reason for Removal from Service	WI Unique Well # of Replacement Well
Complete Soil Sampling	_ _ _ _ _

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—

Lower Drillhole Diameter (in.)	Casing Depth (ft.)
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS):

License/Permit/Monitoring #:

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lynndale Drive

City of Present Owner	State	ZIP Code
Appleton	WI	54914

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials
☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.7	0.07 ft3	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Scheuring Rd	(920) 592-8400

City	State	ZIP Code	Signature of Person Doing Work	Date Signed
De Pere	WI	54115	for Tyler Hischke	5-15-20

DNR Use Only

Date Received	Noted By

Comments:

State of Wis., Dept. of Natural Resources
dnr.wi.gov

Well / Drillhole / Borehole Filling & Sealing Report

Form 3300-005 (R 4/2015)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and chs. NR 141 and 812, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

☐ **Verification Only of Fill and Seal** HA-14

Route to DNR Bureau: ☐ Drinking Water ☐ Waste Management ☐ Watershed/Wastewater ☒ Remediation/Redevelopment ☐ Other:

1. Well Location Information

County	WI Unique Well # of Removed Well	Hicap #
Outagamie		

Latitude / Longitude (see instructions): 44.2809813 N, -88.2752825 W — Format Code: ☐ DD ☐ DDM — Method Code: ☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼	¼	Section	Township	Range	or Gov't Lot #
SE	NE	23	21 N	18 ☒ E ☐ W	

Well Street Address: 410 Fox Shores Drive, 380 Bicentenial Ct 400

Well City, Village or Town: Kaukauna — Well ZIP Code: 54130

Subdivision Name — Lot #

Reason for Removal from Service: Complete Soil Sampling — WI Unique Well # of Replacement Well

2. Facility / Owner Information

Facility Name: Fox Shores Apartments

Facility ID (FID or PWS)

License/Permit/Monitoring #

Original Well Owner: Tom Vandeyacht - Fox Investments LL

Present Well Owner: SAME

Mailing Address of Present Owner: 2220 N Lyndale Drive

City of Present Owner: Appleton — State: WI — ZIP Code: 54914

3. Filled & Sealed Well / Drillhole / Borehole Information

☐ Monitoring Well ☐ Water Well ☒ Borehole / Drillhole

Original Construction Date (mm/dd/yyyy): 04/15/2020

If a Well Construction Report is available, please attach.

Construction Type: ☐ Drilled ☐ Driven (Sandpoint) ☐ Dug ☒ Other (specify): Hand Auger

Formation Type: ☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Ground Surface (ft.)	Casing Diameter (in.)
—	—
Lower Drillhole Diameter (in.)	**Casing Depth (ft.)**
3	—

Was well annular space grouted? ☐ Yes ☐ No ☐ Unknown

If yes, to what depth (feet)?	Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☒ N/A
Liner(s) removed?	☐ Yes	☐ No	☒ N/A
Liner(s) perforated?	☐ Yes	☐ No	☒ N/A
Screen removed?	☐ Yes	☐ No	☒ N/A
Casing left in place?	☐ Yes	☐ No	☒ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☒ N/A
Did sealing material rise to surface?	☒ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☒ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☒ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☒ N/A

Required Method of Placing Sealing Material: ☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped ☐ Screened & Poured (Bentonite Chips) ☒ Other (Explain): Gravity

Sealing Materials: ☐ Neat Cement Grout ☐ Concrete ☐ Sand-Cement (Concrete) Grout ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only: ☐ Bentonite Chips ☐ Bentonite - Cement Grout ☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used to Fill Well / Drillhole

	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite	Surface	1.5	0.07 ft³	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Filling & Sealing	License #	Date of Filling & Sealing or Verification (mm/dd/yyyy)
Stantec		04/15/2020

Street or Route	Telephone Number
1165 Schreiber Rd	(920) 592-8400

City	State	ZIP Code	Signature of Person Doing Work	Date Signed
De Pere	WI	54115	for Tyler Hischke	5-15-20

DNR Use Only

Date Received	Noted By

Comments

Appendix C

Monitoring Well Construction and Development Forms

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Fox Shores Apartments	Local Grid Location of Well ☐ ft. ☐N. ☐S. ☐ ft. ☐E. ☐W.	Well Name: TW 10
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. 44.280983 Long. -88.275825 or	Wis. Unique Well No. / DNR Well ID No.
Facility ID	St. Plane ft. N, ft. E. S/C/N	Date Well Installed: 08/21/2019 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: SE 1/4 of NE 1/4 of Sec. 23, T. 21 N, R. 18 ☒E ☐W	Well Installed By: Name (first, last) and Firm: Geiss Soil & Samples LLC; Dassin Prentice
Distance from Waste/Source ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☐ 41
Geoprobe Other ☒

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe —

17. Source of water (attach analysis, if required):
—

E. Bentonite seal, top _____ ft. MSL or 0.5 ft.

F. Fine sand, top _____ ft. MSL or 1.5 ft.

G. Filter pack, top _____ ft. MSL or 2 ft.

H. Screen joint, top _____ ft. MSL or 3 ft.

I. Well bottom _____ ft. MSL or 10 ft.

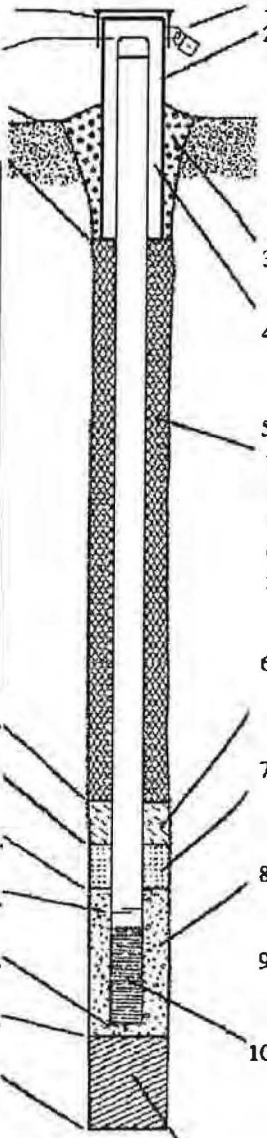
J. Filter pack, bottom _____ ft. MSL or 10 ft.

K. Borehole, bottom _____ ft. MSL or 10 ft.

L. Borehole, diameter 2 in.

M. O.D. well casing 1.3 in.

N. I.D. well casing 1.03 in.



1. Cap and lock? ☐ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4 in.
b. Length: 1 ft.
c. Material: Steel ☐ 04 Other ☒
d. Additional protection? ☐ Yes ☒ No
If yes, describe: —

3. Surface seal: Bentonite ☒ 30 Concrete ☐ 01 Other ☐

4. Material between well casing and protective pipe: Bentonite ☒ 30 Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. #20 Red Flint
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #40 Red Flint
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 Flush threaded PVC schedule 80 ☐ 24 Other ☐

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☐ 01 Other ☐
b. Manufacturer Johnson
c. Slot size: 0.01 in.
d. Slotted length: ____ ft.

11. Backfill material (below filter pack): None ☒ 14 Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Bru | Firm: Stantec Consulting Services Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Fox Shores Apartments	Local Grid Location of Well: _____ ft. ☐N. ☐S. _____ ft. ☐E. ☐W.	Well Name: TW 11
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. 44.280 9813 " Long. -88.27 52825 " or	Wis. Unique Well No. _____ DNR Well ID No. _____
Facility ID _____	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 08/21/2019 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: SE 1/4 of NE 1/4 of Sec. 23, T. 21 N, R. 18 ☒E ☐W	Well Installed By: Name (first, last) and Firm: Geiss Soil & Samples LLC; Darcin Prentice
Distance from Waste/Source _____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number _____

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or __0__ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☐ 41 / Other ☒ Geoprobe

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe —

17. Source of water (attach analysis, if required):
—

E. Bentonite seal, top _____ ft. MSL or __0.5__ ft.

F. Fine sand, top _____ ft. MSL or __2.5__ ft.

G. Filter pack, top _____ ft. MSL or __3__ ft.

H. Screen joint, top _____ ft. MSL or __4__ ft.

I. Well bottom _____ ft. MSL or __9__ ft.

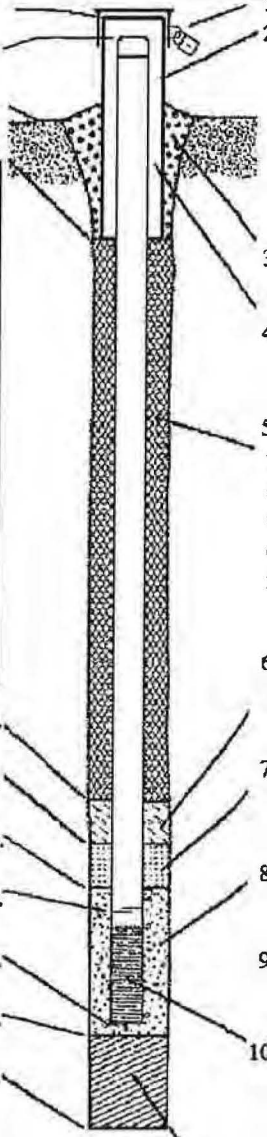
J. Filter pack, bottom _____ ft. MSL or __9__ ft.

K. Borehole, bottom _____ ft. MSL or __9__ ft.

L. Borehole, diameter __2__ in.

M. O.D. well casing __1.3__ in.

N. I.D. well casing __1.03__ in.



1. Cap and lock? ☐ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: __4__ in.
b. Length: __1__ ft.
c. Material: Steel ☐ 04 / Other ☒ ____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☒ 30 / Concrete ☒ 01 / Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 32
c. _____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. #20 Red Flint
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #40 Red Flint
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ____

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ____
b. Manufacturer Johnson
c. Slot size: 0.01 in.
d. Slotted length: ____ ft.

11. Backfill material (below filter pack): None ☒ 14 / Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature _____ Firm: Stantec Consulting Services Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Fox Shores Apartments	Local Grid Location of Well ☐ft. ☐N. ☐S. ☐ft. ☐E. ☐W.	Well Name: TW13
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. 44.280 9813 " Long. -88.27 52825 " or	Wis. Unique Well No. _____ DNR Well ID No. _____
Facility ID _____	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed 08/21/2019 (m m d d y y y y)
Type of Well Well Code 11 / MW	Section Location of Waste/Source SE 1/4 of NE 1/4 of Sec. 23, T. 21 N, R. 18 ☒E ☐W	Well Installed By: Name (first, last) and Firm Geiss Soil & Samples LLC Darcin Prentice
Distance from Waste/Source _____ ft. Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number _____

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☐ 41
Geoprobe Other ☒

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe —

17. Source of water (attach analysis, if required):
—

E. Bentonite seal, top _____ ft. MSL or 0.5 ft.

F. Fine sand, top _____ ft. MSL or 1.5 ft.

G. Filter pack, top _____ ft. MSL or 2.0 ft.

H. Screen joint, top _____ ft. MSL or 3.5 ft.

I. Well bottom _____ ft. MSL or 8.5 ft.

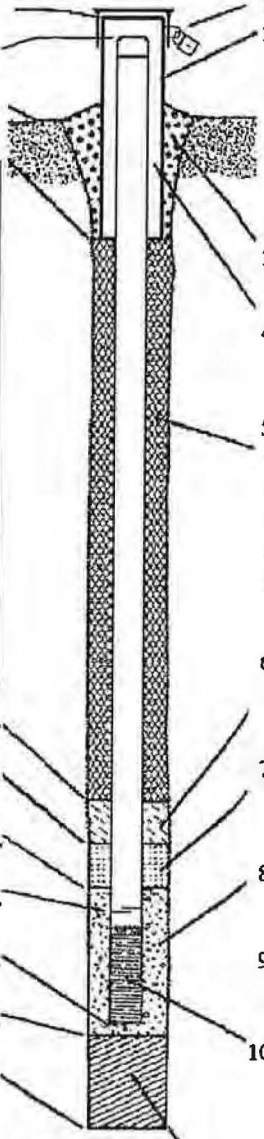
J. Filter pack, bottom _____ ft. MSL or 8.5 ft.

K. Borehole, bottom _____ ft. MSL or 8.5 ft.

L. Borehole, diameter 2 in.

M. O.D. well casing 1.3 in.

N. I.D. well casing 1.03 in.



1. Cap and lock? ☐ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4 in.
b. Length: 1 ft.
c. Material: Steel ☐ 04
Other ☒
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☒ 30
Concrete ☐ 01
Other ☐
_____

4. Material between well casing and protective pipe:
Bentonite ☒ 30
Other ☐
_____

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01
Tremie pumped ☐ 02
Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. #20 Red Flint
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #40 Red Flint
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
Other ☐
_____

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11
Continuous slot ☐ 01
Other ☐
_____
b. Manufacturer Johnson
c. Slot size: 0.01 in.
d. Slotted length: ____ ft.

11. Backfill material (below filter pack): None ☒ 14
Other ☐
_____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature _____ Firm Stantec Consulting Services Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☒ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Fox Shores Apartments	Local Grid Location of Well: _____ ft. ☐ N. ☐ S. _____ ft. ☐ E. ☐ W.	Well Name: TW 15
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. 44.2809813 " Long. -88.2752825 " or	Wis. Unique Well No. _____ DNR Well ID No. _____
Facility ID _____	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 08/21/2019 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: SE 1/4 of NE 1/4 of Sec. 23, T. 21 N, R. 18 ☒ E ☐ W	Well Installed By: Name (first, last) and Firm: Geiss Soil & Samples LLC, Darrin Prentice
Distance from Waste/Source _____ ft. Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known; Gov. Lot Number _____	

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☒ Geoprobe

15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe —

17. Source of water (attach analysis, if required): —

E. Bentonite seal, top _____ ft. MSL or 0.5 ft.

F. Fine sand, top _____ ft. MSL or 1.5 ft.

G. Filter pack, top _____ ft. MSL or 2 ft.

H. Screen joint, top _____ ft. MSL or 3.5 ft.

I. Well bottom _____ ft. MSL or 8.5 ft.

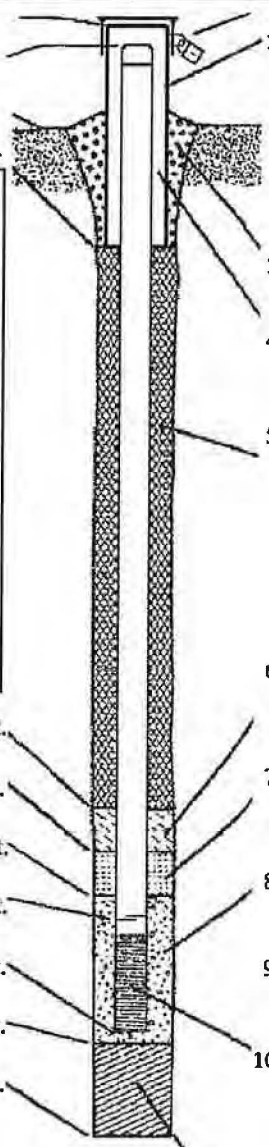
J. Filter pack, bottom _____ ft. MSL or 8.5 ft.

K. Borehole, bottom _____ ft. MSL or 8.5 ft.

L. Borehole, diameter 2 in.

M. O.D. well casing 1.3 in.

N. I.D. well casing 1.03 in.



1. Cap and lock? ☐ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 4 in.
   b. Length: 1 ft.
   c. Material: Steel ☐ 04; Other ☒
   d. Additional protection? ☐ Yes ☒ No
   If yes, describe: _____
3. Surface seal: Bentonite ☒ 30; Concrete ☐ 01; Other ☐
4. Material between well casing and protective pipe: Bentonite ☒ 30; Other ☐
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
   b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
   c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
   d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
   e. _____ Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
   b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 32
   c. _____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. #20 Red Flint
   b. Volume added _____ ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. #40 Red Flint
   b. Volume added _____ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23; Flush threaded PVC schedule 80 ☐ 24; Other ☐
10. Screen material: PVC
    a. Screen type: Factory cut ☒ 11; Continuous slot ☐ 01; Other ☐
    b. Manufacturer Johnson
    c. Slot size: 0.01 in.
    d. Slotted length: ____ ft.
11. Backfill material (below filter pack): None ☒ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Jeff Bu[illegible]	Stantec Consulting Services Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Fox Shores Apartments	Local Grid Location of Well: _____ ft. ☐N. ☐S. _____ ft. ☐E. ☐W.	Well Name: TW 17
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. 44.280 9813 " Long. -88.27 52825 " or	Wis. Unique Well No. _____ DNR Well ID No. _____
Facility ID _____	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 08/21/2019 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: SE 1/4 of NE 1/4 of Sec. 23, T. 21 N, R. 18 ☒E ☐W	Well Installed By: Name (first, last) and Firm: Geiss Soil & Samples LLC; Darcin Prentice
Distance from Waste/Source _____ ft. Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number _____

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or 0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☒ Geoprobe

15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe —

17. Source of water (attach analysis, if required):
—

E. Bentonite seal, top _____ ft. MSL or 0.5 ft.

F. Fine sand, top _____ ft. MSL or 1.5 ft.

G. Filter pack, top _____ ft. MSL or 2 ft.

H. Screen joint, top _____ ft. MSL or 3 ft.

I. Well bottom _____ ft. MSL or 8 ft.

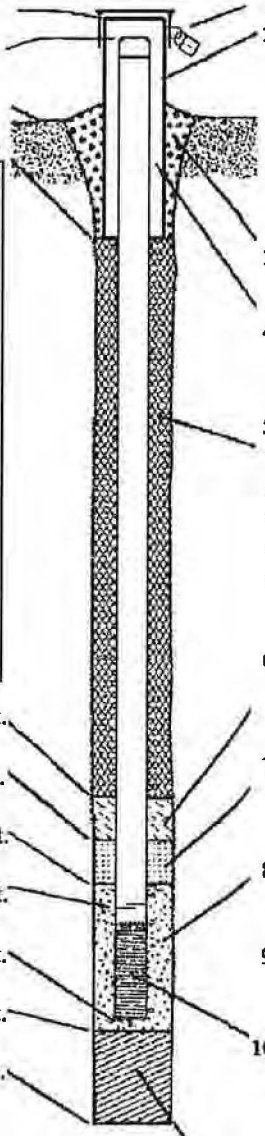
J. Filter pack, bottom _____ ft. MSL or 8 ft.

K. Borehole, bottom _____ ft. MSL or 8 ft.

L. Borehole, diameter 2 in.

M. O.D. well casing 1.3 in.

N. I.D. well casing 1.03 in.



1. Cap and lock? ☐ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4 in.
b. Length: 1 ft.
c. Material: Steel ☐ 04; Other ☒ —
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☒ 30; Concrete ☐ 01; Other ☐ —

4. Material between well casing and protective pipe: Bentonite ☒ 30; Other ☐ —

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 32
c. _____ Other ☐ —

7. Fine sand material: Manufacturer, product name & mesh size
a. #20 Red Flint —
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #40 Red Flint —
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23; Flush threaded PVC schedule 80 ☐ 24; Other ☐ —

10. Screen material: PVC —
a. Screen type: Factory cut ☒ 11; Continuous slot ☐ 01; Other ☐ —
b. Manufacturer Johnson
c. Slot size: 0.01 in.
d. Slotted length: _____ ft.

11. Backfill material (below filter pack): None ☒ 14; Other ☐ —

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature _____ Firm Stantec Consulting Services Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	County	Well Name
Fox Shores Apartments	Outagamie	TW 10
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number** / **DNR Well Number**
	45	

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method:

surged with bailer and bailed	☐	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed, and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☒	51
pumped slowly	☐	50
other _____	☐	__

3. Time spent developing well 45 min.

4. Depth of well (from top of well casing) 10 ft.

5. Inside diameter of well 1.0 in.

6. Volume of water in filter pack and well casing 0.08 gal.

7. Volume of water removed from well 1.0 gal.

8. Volume of water added (if any) — gal.

9. Source of water added —

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results) NA

	Before Development	After Development
11. Depth to Water (from top of well casing) a.	4.07 ft.	3.89 ft.
Date b.	08/21/2019	08/28/2019
Time c.	15:57 ☐ a.m. ☒ p.m.	11:12 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	— inches	— inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) muddy	Clear ☐ 20 Turbid ☒ 25 (Describe) slightly turbid

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jeff Brand - Stantec Consulting Services Inc

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name: Tom Vandeyacht
Firm: Fox Investments LLC
Street: 2220 N Lynndale Drive
City/State/Zip: Appleton, WI 54914

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Jeff Brand
Print Name: Jeff Brand
Firm: Stantec Consulting Services Inc.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	County	Well Name
Fox Shores Apartments	Outagamie	TW 11
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number** / **DNR Well Number**
	45	

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method:

surged with bailer and bailed	☐	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed, and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☒	51
pumped slowly	☐	50
other _____	☐	--

3. Time spent developing well: 45 min.

4. Depth of well (from top of well casing): 9 ft.

5. Inside diameter of well: 1.0 in.

6. Volume of water in filter pack and well casing: 0.06 gal.

7. Volume of water removed from well: 1.0 gal.

8. Volume of water added (if any): — gal.

9. Source of water added: —

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results) NA

	Before Development	After Development
11. Depth to Water (from top of well casing) a.	4.62 ft.	4.55 ft.
Date b.	08/21/2019	08/29/2019
Time c.	15:37 ☐ a.m. ☒ p.m.	11:50 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	— inches	— inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) muddy	Clear ☐ 20 Turbid ☒ 25 (Describe) slightly turbid

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jeff Brand - Stantec Consulting Services Inc

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name: Tom Vandeyacht
Firm: Fox Investments LLC
Street: 2220 N Lynndale Drive
City/State/Zip: Appleton, WI 54914

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: [signature]
Print Name: Jeff Brand
Firm: Stantec Consulting Services Inc.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	County	Well Name
Fox Shores Apartments	Outagamie	TW 13
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well Number**
	45		

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method:

surged with bailer and bailed	☐	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed, and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☒	51
pumped slowly	☐	50
other _____	☐	__

3. Time spent developing well 45 min.

4. Depth of well (from top of well casing) 8.5 ft.

5. Inside diameter of well 1.0 in.

6. Volume of water in filter pack and well casing 0.05 gal.

7. Volume of water removed from well 1.0 gal.

8. Volume of water added (if any) — gal.

9. Source of water added —

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)
NA

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 5.36 ft.	4.93 ft.
Date	b. 08/21/2019	08/28/2019
Time	c. 15:25 ☐ a.m. ☒ p.m.	10:27 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	— inches	— inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) muddy	Clear ☐ 20 Turbid ☒ 25 (Describe) slightly turbid

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jeff Brand - Stantec Consulting Services Inc

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name: Tom Vandeyacht
Firm: Fox Investments LLC
Street: 2220 N Lynndale Drive
City/State/Zip: Appleton, WI 54914

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature:
Print Name: Jeff Brand
Firm: Stantec Consulting Services Inc.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	County	Well Name
Fox Shores Apartments	Outagamie	TW 15
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number** / **DNR Well Number**
	45	

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method:

surged with bailer and bailed	☐	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed, and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☒	51
pumped slowly	☐	50
other _____	☐	__

3. Time spent developing well: 45 min.

4. Depth of well (from top of well casing): 8.5 ft.

5. Inside diameter of well: 1.0 in.

6. Volume of water in filter pack and well casing: 0.05 gal.

7. Volume of water removed from well: 1.0 gal.

8. Volume of water added (if any): — gal.

9. Source of water added: —

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)
NA

	Before Development	After Development
11. Depth to Water (from top of well casing) a.	5.95 ft.	4.69 ft.
Date b.	08/21/2019	08/28/2019
Time c.	14:25 ☐ a.m. ☒ p.m.	9:48 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	— inches	— inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) muddy	Clear ☐ 20 Turbid ☒ 25 (Describe) slightly turbid

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jeff Brand - Stantec Consulting Services Inc

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name: Tom Vandeyacht
Firm: Fox Investments LLC
Street: 2220 N Lyndale Drive
City/State/Zip: Appleton, WI 54914

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Jeff Brand
Print Name: Jeff Brand
Firm: Stantec Consulting Services Inc.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	County	Well Name
Fox Shores Apartments	Outagamie	TW 17
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well Number**
	45		

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method:

surged with bailer and bailed	☐	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed, and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☒	51
pumped slowly	☐	50
other _____	☐	

3. Time spent developing well 45 min.

4. Depth of well (from top of well casing) 8.0 ft.

5. Inside diameter of well 1.0 in.

6. Volume of water in filter pack and well casing 0.05 gal.

7. Volume of water removed from well 1.0 gal.

8. Volume of water added (if any) — gal.

9. Source of water added —

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results) NA

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 4.70 ft.	4.53 ft.
Date	b. 08/21/2019	08/28/2019
Time	c. 14:05 ☐ a.m. ☒ p.m.	9:13 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	— inches	— inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) muddy	Clear ☐ 20 Turbid ☒ 25 (Describe) slightly turbid

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Person's Name and Firm
Jeff Brand - Stantec Consulting Services Inc.

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name: Tom Vandeyacht
Firm: Fox Investments LLC
Street: 2220 N Lynndale Drive
City/State/Zip: Appleton, WI 54914

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Jeff Brand
Print Name: Jeff Brand
Firm: Stantec Consulting Services Inc.

Appendix D

Soil Laboratory Analytical Reports and Chain-of-Custody Forms

eurofins | Environment Testing TestAmerica



ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-163346-1
Client Project/Site: Fox Shores - 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Mr. Jeff Brand

Authorized for release by:
5/28/2019 4:32:22 PM
Eric Lang, Manager of Project Management
(708)534-5200
eric.lang@testamericainc.com

Designee for

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Detection Summary 4
Method Summary 7
Sample Summary 8
Client Sample Results 9
Definitions 23
QC Association 24
Surrogate Summary 27
QC Sample Results 28
Chronicle 40
Certification Summary 43
Chain of Custody 44
Receipt Checklists 45

Job ID: 500-163346-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-163346-1

Comments
No additional comments.

Receipt
The samples were received on 5/15/2019 9:10 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 2.9º C.

GC/MS VOA
Method(s) 8260B: The method blank for 487277 contained Naphthalene above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore,re-analysis of samples was not performed.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method(s) 8270D: The following sample was diluted due to the nature of the sample matrix: SB9 0-2 (500-163346-4). Elevated reporting limits (RLs) are provided.

Method(s) 8270D: The following sample required a dilution due to the nature of the sample matrix: SB9 0-2 (500-163346-4). Because of this dilution, the surrogate spike concentration in the sample was reduced to a level where the recovery calculation does not provide useful information.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB6 0-2 — Lab Sample ID: 500-163346-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	66	J	69	25	ug/Kg	50	☼	8260B	Total/NA
Benzene	22		17	10	ug/Kg	50	☼	8260B	Total/NA
Toluene	110		17	10	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	170		34	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	180		76	9.3	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	250		76	7.0	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	32	J	38	6.8	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	39		38	5.0	ug/Kg	1	☼	8270D	Total/NA
Anthracene	160		38	6.3	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	410		38	5.1	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	480		38	7.3	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	940		38	8.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	210	F1	38	12	ug/Kg	1	☼	8270D	Total/NA
Chrysene	580		38	10	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	58		38	7.3	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	660	F1 F2	38	7.0	ug/Kg	1	☼	8270D	Total/NA
Fluorene	29	J	38	5.3	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	190	F1	38	9.8	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	150		38	5.8	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	610	F2	38	5.3	ug/Kg	1	☼	8270D	Total/NA
Pyrene	800	F1 F2	38	7.5	ug/Kg	1	☼	8270D	Total/NA

Client Sample ID: SB7 0-2 — Lab Sample ID: 500-163346-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	52	J	75	9.1	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	86		75	6.8	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	9.8	J	37	6.7	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	31	J	37	4.9	ug/Kg	1	☼	8270D	Total/NA
Anthracene	39		37	6.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	180		37	5.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	220		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	300		37	8.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	140		37	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	150		37	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	240		37	10	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	52		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	210		37	6.9	ug/Kg	1	☼	8270D	Total/NA
Fluorene	7.1	J	37	5.2	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	120		37	9.6	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	47		37	5.7	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	210		37	5.2	ug/Kg	1	☼	8270D	Total/NA
Pyrene	280		37	7.4	ug/Kg	1	☼	8270D	Total/NA

Client Sample ID: SB8 0-2 — Lab Sample ID: 500-163346-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
2-Methylnaphthalene	15	J	78	7.1	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	23	J	38	5.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	25	J	38	7.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	37	J	38	8.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	23	J	38	12	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Eurofins TestAmerica, Chicago

Client Sample ID: SB8 0-2 (Continued)

Lab Sample ID: 500-163346-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[k]fluoranthene	13	J	38	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	30	J	38	11	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	38		38	7.2	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	18	J	38	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	6.4	J	38	6.0	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	28	J	38	5.4	ug/Kg	1	☼	8270D	Total/NA
Pyrene	34	J	38	7.7	ug/Kg	1	☼	8270D	Total/NA

Client Sample ID: SB9 0-2

Lab Sample ID: 500-163346-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	41		18	10	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	870		810	98	ug/Kg	10	☼	8270D	Total/NA
2-Methylnaphthalene	770	J	810	74	ug/Kg	10	☼	8270D	Total/NA
Acenaphthene	1200		400	72	ug/Kg	10	☼	8270D	Total/NA
Acenaphthylene	1900		400	53	ug/Kg	10	☼	8270D	Total/NA
Anthracene	3500		400	67	ug/Kg	10	☼	8270D	Total/NA
Benzo[a]anthracene	9100		400	54	ug/Kg	10	☼	8270D	Total/NA
Chrysene	11000		400	110	ug/Kg	10	☼	8270D	Total/NA
Fluoranthene	19000		400	74	ug/Kg	10	☼	8270D	Total/NA
Fluorene	1600		400	56	ug/Kg	10	☼	8270D	Total/NA
Naphthalene	1000		400	62	ug/Kg	10	☼	8270D	Total/NA
Phenanthrene	22000		400	56	ug/Kg	10	☼	8270D	Total/NA
Benzo[a]pyrene - DL	14000		2000	390	ug/Kg	50	☼	8270D	Total/NA
Benzo[b]fluoranthene - DL	16000		2000	430	ug/Kg	50	☼	8270D	Total/NA
Benzo[g,h,i]perylene - DL	2800		2000	650	ug/Kg	50	☼	8270D	Total/NA
Benzo[k]fluoranthene - DL	10000		2000	590	ug/Kg	50	☼	8270D	Total/NA
Dibenz(a,h)anthracene - DL	2100		2000	390	ug/Kg	50	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene - DL	4700		2000	520	ug/Kg	50	☼	8270D	Total/NA
Pyrene - DL	32000		2000	400	ug/Kg	50	☼	8270D	Total/NA

Client Sample ID: SB10 0-2

Lab Sample ID: 500-163346-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	29	J	70	8.5	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	38	J	70	6.4	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	7.2	J	35	6.3	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	6.5	J	35	4.6	ug/Kg	1	☼	8270D	Total/NA
Anthracene	22	J	35	5.8	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	100		35	4.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	120		35	6.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	180		35	7.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	100		35	11	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	38		35	10	ug/Kg	1	☼	8270D	Total/NA
Chrysene	170		35	9.5	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	38		35	6.7	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	130		35	6.5	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	85		35	9.0	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	29	J	35	5.4	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	150		35	4.9	ug/Kg	1	☼	8270D	Total/NA
Pyrene	170		35	6.9	ug/Kg	1	☼	8270D	Total/NA
Arsenic	2.8		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: SB10 0-2 (Continued)

Lab Sample ID: 500-163346-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	19		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.35	B	0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	7.1		1.1	0.53	mg/Kg	1	☼	6010C	Total/NA
Lead	48		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Selenium	0.91	J	1.1	0.63	mg/Kg	1	☼	6010C	Total/NA
Silver	1.0		0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.066		0.017	0.0058	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB10 4-5

Lab Sample ID: 500-163346-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	1.5		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	17		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.21	J B	0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	7.3		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	3.4		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	1.5		0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.013	J	0.018	0.0059	mg/Kg	1	☼	7471B	Total/NA

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL CHI
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL CHI
6010C	Metals (ICP)	SW846	TAL CHI
7471B	Mercury (CVAA)	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
3541	Automated Soxhlet Extraction	SW846	TAL CHI
5035	Closed System Purge and Trap	SW846	TAL CHI
7471B	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
500-163346-1	SB6 0-2	Solid	05/14/19 09:45	05/15/19 09:10	
500-163346-2	SB7 0-2	Solid	05/14/19 11:35	05/15/19 09:10	
500-163346-3	SB8 0-2	Solid	05/14/19 12:30	05/15/19 09:10	
500-163346-4	SB9 0-2	Solid	05/14/19 13:05	05/15/19 09:10	
500-163346-5	SB10 0-2	Solid	05/14/19 14:15	05/15/19 09:10	
500-163346-6	SB10 4-5	Solid	05/14/19 14:25	05/15/19 09:10	

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB6 0-2
Date Collected: 05/14/19 09:45
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-1
Matrix: Solid
Percent Solids: 86.6

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		69	32	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,1,1-Trichloroethane	<26		69	26	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,1,2,2-Tetrachloroethane	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,1,2-Trichloroethane	<24		69	24	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,1-Dichloroethane	<28		69	28	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,1-Dichloroethene	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,1-Dichloropropene	<21		69	21	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2,3-Trichlorobenzene	<32		69	32	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2,4-Trichlorobenzene	<24		69	24	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2,4-Trimethylbenzene	**66**	**J**	69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2-Dibromo-3-Chloropropane	<140		340	140	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2-Dibromoethane	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2-Dichlorobenzene	<23		69	23	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2-Dichloroethane	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,2-Dichloropropane	<29		69	29	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,3,5-Trimethylbenzene	<26		69	26	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,3-Dichlorobenzene	<28		69	28	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,3-Dichloropropane	<25		69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
1,4-Dichlorobenzene	<25		69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
2,2-Dichloropropane	<31		69	31	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
2-Chlorotoluene	<22		69	22	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
4-Chlorotoluene	<24		69	24	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Benzene	**22**		17	10	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Bromobenzene	<25		69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Bromochloromethane	<29		69	29	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Bromodichloromethane	<26		69	26	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Bromoform	<33		69	33	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Bromomethane	<55		210	55	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Carbon tetrachloride	<26		69	26	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Chlorobenzene	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Chloroethane	<35		69	35	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Chloroform	<25		140	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Chloromethane	<22		69	22	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
cis-1,2-Dichloroethene	<28		69	28	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
cis-1,3-Dichloropropene	<29		69	29	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Dibromochloromethane	<34		69	34	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Dibromomethane	<19		69	19	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Dichlorodifluoromethane	<46		210	46	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Ethylbenzene	<13		17	13	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Hexachlorobutadiene	<31		69	31	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Isopropyl ether	<19		69	19	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Isopropylbenzene	<26		69	26	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Methyl tert-butyl ether	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Methylene Chloride	<110		340	110	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
n-Butylbenzene	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
N-Propylbenzene	<29		69	29	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
p-Isopropyltoluene	<25		69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
sec-Butylbenzene	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50

Client Sample ID: SB6 0-2

Date Collected: 05/14/19 09:45
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-1

Matrix: Solid
Percent Solids: 86.6

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
tert-Butylbenzene	<27		69	27	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Tetrachloroethene	<25		69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Toluene	**110**		17	10	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
trans-1,2-Dichloroethene	<24		69	24	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
trans-1,3-Dichloropropene	<25		69	25	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Trichloroethene	<11		34	11	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Trichlorofluoromethane	<29		69	29	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Vinyl chloride	<18		69	18	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50
Xylenes, Total	**170**		34	15	ug/Kg	☼	05/14/19 09:45	05/27/19 11:28	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*	*05/14/19 09:45*	*05/27/19 11:28*	*50*
4-Bromofluorobenzene (Surr)	*91*		*72 - 124*	*05/14/19 09:45*	*05/27/19 11:28*	*50*
Dibromofluoromethane	*104*		*75 - 120*	*05/14/19 09:45*	*05/27/19 11:28*	*50*
Toluene-d8 (Surr)	*94*		*75 - 120*	*05/14/19 09:45*	*05/27/19 11:28*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**180**		76	9.3	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
2-Methylnaphthalene	**250**		76	7.0	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Acenaphthene	**32**	**J**	38	6.8	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Acenaphthylene	**39**		38	5.0	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Anthracene	**160**		38	6.3	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Benzo[a]anthracene	**410**		38	5.1	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Benzo[a]pyrene	**480**		38	7.3	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Benzo[b]fluoranthene	**940**		38	8.2	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Benzo[g,h,i]perylene	**210**	**F1**	38	12	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Benzo[k]fluoranthene	<11		38	11	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Chrysene	**580**		38	10	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Dibenz(a,h)anthracene	**58**		38	7.3	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Fluoranthene	**660**	**F1 F2**	38	7.0	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Fluorene	**29**	**J**	38	5.3	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Indeno[1,2,3-cd]pyrene	**190**	**F1**	38	9.8	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Naphthalene	**150**		38	5.8	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Phenanthrene	**610**	**F2**	38	5.3	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1
Pyrene	**800**	**F1 F2**	38	7.5	ug/Kg	☼	05/23/19 07:26	05/24/19 18:20	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*76*		*43 - 145*	*05/23/19 07:26*	*05/24/19 18:20*	*1*
Nitrobenzene-d5 (Surr)	*50*		*37 - 147*	*05/23/19 07:26*	*05/24/19 18:20*	*1*
Terphenyl-d14 (Surr)	*104*		*42 - 157*	*05/23/19 07:26*	*05/24/19 18:20*	*1*

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB7 0-2
Date Collected: 05/14/19 11:35
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-2
Matrix: Solid
Percent Solids: 87.0

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		64	30	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,1,1-Trichloroethane	<24		64	24	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,1,2,2-Tetrachloroethane	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,1,2-Trichloroethane	<22		64	22	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,1-Dichloroethane	<26		64	26	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,1-Dichloroethene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,1-Dichloropropene	<19		64	19	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2,3-Trichlorobenzene	<29		64	29	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2,3-Trichloropropane	<26		130	26	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2,4-Trichlorobenzene	<22		64	22	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2,4-Trimethylbenzene	<23		64	23	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2-Dibromoethane	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2-Dichlorobenzene	<21		64	21	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2-Dichloroethane	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,2-Dichloropropane	<27		64	27	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,3,5-Trimethylbenzene	<24		64	24	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,3-Dichlorobenzene	<26		64	26	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,3-Dichloropropane	<23		64	23	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
1,4-Dichlorobenzene	<23		64	23	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
2,2-Dichloropropane	<28		64	28	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
2-Chlorotoluene	<20		64	20	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
4-Chlorotoluene	<22		64	22	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Benzene	<9.3		16	9.3	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Bromobenzene	<23		64	23	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Bromochloromethane	<27		64	27	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Bromodichloromethane	<24		64	24	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Bromoform	<31		64	31	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Bromomethane	<51		190	51	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Carbon tetrachloride	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Chlorobenzene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Chloroethane	<32		64	32	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Chloroform	<24		130	24	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Chloromethane	<20		64	20	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
cis-1,2-Dichloroethene	<26		64	26	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
cis-1,3-Dichloropropene	<27		64	27	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Dibromochloromethane	<31		64	31	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Dibromomethane	<17		64	17	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Dichlorodifluoromethane	<43		190	43	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Ethylbenzene	<12		16	12	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Hexachlorobutadiene	<28		64	28	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Isopropyl ether	<18		64	18	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Isopropylbenzene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Methyl tert-butyl ether	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Methylene Chloride	<100		320	100	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
n-Butylbenzene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
N-Propylbenzene	<26		64	26	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
p-Isopropyltoluene	<23		64	23	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
sec-Butylbenzene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50

Client Sample ID: SB7 0-2

Date Collected: 05/14/19 11:35
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-2

Matrix: Solid
Percent Solids: 87.0

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
tert-Butylbenzene	<25		64	25	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Tetrachloroethene	<24		64	24	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Toluene	<9.4		16	9.4	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
trans-1,2-Dichloroethene	<22		64	22	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
trans-1,3-Dichloropropene	<23		64	23	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Trichloroethene	<10		32	10	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Trichlorofluoromethane	<27		64	27	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Vinyl chloride	<17		64	17	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50
Xylenes, Total	<14		32	14	ug/Kg	☼	05/14/19 11:35	05/27/19 11:54	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*	*05/14/19 11:35*	*05/27/19 11:54*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*05/14/19 11:35*	*05/27/19 11:54*	*50*
Dibromofluoromethane	*105*		*75 - 120*	*05/14/19 11:35*	*05/27/19 11:54*	*50*
Toluene-d8 (Surr)	*94*		*75 - 120*	*05/14/19 11:35*	*05/27/19 11:54*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**52**	**J**	75	9.1	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
2-Methylnaphthalene	**86**		75	6.8	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Acenaphthene	**9.8**	**J**	37	6.7	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Acenaphthylene	**31**	**J**	37	4.9	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Anthracene	**39**		37	6.2	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Benzo[a]anthracene	**180**		37	5.0	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Benzo[a]pyrene	**220**		37	7.2	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Benzo[b]fluoranthene	**300**		37	8.0	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Benzo[g,h,i]perylene	**140**		37	12	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Benzo[k]fluoranthene	**150**		37	11	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Chrysene	**240**		37	10	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Dibenz(a,h)anthracene	**52**		37	7.2	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Fluoranthene	**210**		37	6.9	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Fluorene	**7.1**	**J**	37	5.2	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Indeno[1,2,3-cd]pyrene	**120**		37	9.6	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Naphthalene	**47**		37	5.7	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Phenanthrene	**210**		37	5.2	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1
Pyrene	**280**		37	7.4	ug/Kg	☼	05/23/19 07:26	05/24/19 15:34	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*74*		*43 - 145*	*05/23/19 07:26*	*05/24/19 15:34*	*1*
Nitrobenzene-d5 (Surr)	*47*		*37 - 147*	*05/23/19 07:26*	*05/24/19 15:34*	*1*
Terphenyl-d14 (Surr)	*89*		*42 - 157*	*05/23/19 07:26*	*05/24/19 15:34*	*1*

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB8 0-2
Date Collected: 05/14/19 12:30
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-3
Matrix: Solid
Percent Solids: 84.6

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		67	31	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,1,1-Trichloroethane	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,1,2,2-Tetrachloroethane	<27		67	27	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,1,2-Trichloroethane	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,1-Dichloroethane	<28		67	28	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,1-Dichloroethene	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,1-Dichloropropene	<20		67	20	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2,3-Trichlorobenzene	<31		67	31	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2,3-Trichloropropane	<28		130	28	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2,4-Trichlorobenzene	<23		67	23	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2,4-Trimethylbenzene	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2-Dibromo-3-Chloropropane	<130		340	130	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2-Dibromoethane	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2-Dichlorobenzene	<23		67	23	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2-Dichloroethane	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,2-Dichloropropane	<29		67	29	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,3,5-Trimethylbenzene	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,3-Dichlorobenzene	<27		67	27	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,3-Dichloropropane	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
1,4-Dichlorobenzene	<25		67	25	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
2,2-Dichloropropane	<30		67	30	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
2-Chlorotoluene	<21		67	21	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
4-Chlorotoluene	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Benzene	<9.8		17	9.8	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Bromobenzene	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Bromochloromethane	<29		67	29	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Bromodichloromethane	<25		67	25	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Bromoform	<33		67	33	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Bromomethane	<54		200	54	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Carbon tetrachloride	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Chlorobenzene	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Chloroethane	<34		67	34	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Chloroform	<25		130	25	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Chloromethane	<22		67	22	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
cis-1,2-Dichloroethene	<28		67	28	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
cis-1,3-Dichloropropene	<28		67	28	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Dibromochloromethane	<33		67	33	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Dibromomethane	<18		67	18	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Ethylbenzene	<12		17	12	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Hexachlorobutadiene	<30		67	30	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Isopropyl ether	<19		67	19	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Isopropylbenzene	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Methyl tert-butyl ether	<27		67	27	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Methylene Chloride	<110		340	110	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
n-Butylbenzene	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
N-Propylbenzene	<28		67	28	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
p-Isopropyltoluene	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
sec-Butylbenzene	<27		67	27	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50

Client Sample ID: SB8 0-2

Date Collected: 05/14/19 12:30
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-3

Matrix: Solid
Percent Solids: 84.6

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		67	26	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
tert-Butylbenzene	<27		67	27	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Tetrachloroethene	<25		67	25	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Toluene	<9.9		17	9.9	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
trans-1,2-Dichloroethene	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
trans-1,3-Dichloropropene	<24		67	24	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Trichloroethene	<11		34	11	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Trichlorofluoromethane	<29		67	29	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Vinyl chloride	<18		67	18	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50
Xylenes, Total	<15		34	15	ug/Kg	☼	05/14/19 12:30	05/27/19 12:20	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*	*05/14/19 12:30*	*05/27/19 12:20*	*50*
4-Bromofluorobenzene (Surr)	*93*		*72 - 124*	*05/14/19 12:30*	*05/27/19 12:20*	*50*
Dibromofluoromethane	*105*		*75 - 120*	*05/14/19 12:30*	*05/27/19 12:20*	*50*
Toluene-d8 (Surr)	*94*		*75 - 120*	*05/14/19 12:30*	*05/27/19 12:20*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<9.5		78	9.5	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
2-Methylnaphthalene	**15**	**J**	78	7.1	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Acenaphthene	<7.0		38	7.0	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Acenaphthylene	<5.1		38	5.1	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Anthracene	<6.5		38	6.5	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Benzo[a]anthracene	**23**	**J**	38	5.2	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Benzo[a]pyrene	**25**	**J**	38	7.5	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Benzo[b]fluoranthene	**37**	**J**	38	8.4	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Benzo[g,h,i]perylene	**23**	**J**	38	12	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Benzo[k]fluoranthene	**13**	**J**	38	11	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Chrysene	**30**	**J**	38	11	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Dibenz(a,h)anthracene	<7.5		38	7.5	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Fluoranthene	**38**		38	7.2	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Fluorene	<5.4		38	5.4	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Indeno[1,2,3-cd]pyrene	**18**	**J**	38	10	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Naphthalene	**6.4**	**J**	38	6.0	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Phenanthrene	**28**	**J**	38	5.4	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1
Pyrene	**34**	**J**	38	7.7	ug/Kg	☼	05/23/19 07:26	05/24/19 12:48	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*80*		*43 - 145*	*05/23/19 07:26*	*05/24/19 12:48*	*1*
Nitrobenzene-d5 (Surr)	*59*		*37 - 147*	*05/23/19 07:26*	*05/24/19 12:48*	*1*
Terphenyl-d14 (Surr)	*95*		*42 - 157*	*05/23/19 07:26*	*05/24/19 12:48*	*1*

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB9 0-2
Date Collected: 05/14/19 13:05
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-4
Matrix: Solid
Percent Solids: 82.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		70	32	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,1,1-Trichloroethane	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,1,2,2-Tetrachloroethane	<28		70	28	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,1,2-Trichloroethane	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,1-Dichloroethane	<29		70	29	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,1-Dichloroethene	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,1-Dichloropropene	<21		70	21	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2,3-Trichlorobenzene	<32		70	32	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2,4-Trichlorobenzene	<24		70	24	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2,4-Trimethylbenzene	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2-Dibromo-3-Chloropropane	<140		350	140	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2-Dibromoethane	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2-Dichlorobenzene	<23		70	23	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2-Dichloroethane	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,2-Dichloropropane	<30		70	30	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,3,5-Trimethylbenzene	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,3-Dichlorobenzene	<28		70	28	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,3-Dichloropropane	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
1,4-Dichlorobenzene	<26		70	26	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
2,2-Dichloropropane	<31		70	31	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
2-Chlorotoluene	<22		70	22	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
4-Chlorotoluene	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Benzene	<10		18	10	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Bromobenzene	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Bromochloromethane	<30		70	30	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Bromodichloromethane	<26		70	26	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Bromoform	<34		70	34	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Bromomethane	<56		210	56	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Carbon tetrachloride	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Chlorobenzene	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Chloroethane	<35		70	35	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Chloroform	<26		140	26	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Chloromethane	<22		70	22	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
cis-1,2-Dichloroethene	<29		70	29	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
cis-1,3-Dichloropropene	<29		70	29	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Dibromochloromethane	<34		70	34	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Dibromomethane	<19		70	19	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Dichlorodifluoromethane	<47		210	47	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Ethylbenzene	<13		18	13	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Hexachlorobutadiene	<31		70	31	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Isopropyl ether	<19		70	19	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Isopropylbenzene	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Methyl tert-butyl ether	<28		70	28	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Methylene Chloride	<110		350	110	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
n-Butylbenzene	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
N-Propylbenzene	<29		70	29	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
p-Isopropyltoluene	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
sec-Butylbenzene	<28		70	28	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50

Client Sample ID: SB9 0-2
Date Collected: 05/14/19 13:05
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-4
Matrix: Solid
Percent Solids: 82.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27		70	27	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
tert-Butylbenzene	<28		70	28	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Tetrachloroethene	<26		70	26	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Toluene	**41**		18	10	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
trans-1,2-Dichloroethene	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
trans-1,3-Dichloropropene	<25		70	25	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Trichloroethene	<11		35	11	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Trichlorofluoromethane	<30		70	30	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Vinyl chloride	<18		70	18	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50
Xylenes, Total	<15		35	15	ug/Kg	☼	05/14/19 13:05	05/27/19 12:46	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*	*05/14/19 13:05*	*05/27/19 12:46*	*50*
4-Bromofluorobenzene (Surr)	*95*		*72 - 124*	*05/14/19 13:05*	*05/27/19 12:46*	*50*
Dibromofluoromethane	*104*		*75 - 120*	*05/14/19 13:05*	*05/27/19 12:46*	*50*
Toluene-d8 (Surr)	*92*		*75 - 120*	*05/14/19 13:05*	*05/27/19 12:46*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**870**		810	98	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
2-Methylnaphthalene	**770**	**J**	810	74	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Acenaphthene	**1200**		400	72	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Acenaphthylene	**1900**		400	53	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Anthracene	**3500**		400	67	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Benzo[a]anthracene	**9100**		400	54	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Chrysene	**11000**		400	110	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Fluoranthene	**19000**		400	74	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Fluorene	**1600**		400	56	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Naphthalene	**1000**		400	62	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10
Phenanthrene	**22000**		400	56	ug/Kg	☼	05/23/19 07:26	05/24/19 19:31	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*78*		*43 - 145*	*05/23/19 07:26*	*05/24/19 19:31*	*10*
Nitrobenzene-d5 (Surr)	*48*		*37 - 147*	*05/23/19 07:26*	*05/24/19 19:31*	*10*
Terphenyl-d14 (Surr)	*107*		*42 - 157*	*05/23/19 07:26*	*05/24/19 19:31*	*10*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzo[a]pyrene	**14000**		2000	390	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50
Benzo[b]fluoranthene	**16000**		2000	430	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50
Benzo[g,h,i]perylene	**2800**		2000	650	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50
Benzo[k]fluoranthene	**10000**		2000	590	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50
Dibenz(a,h)anthracene	**2100**		2000	390	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50
Indeno[1,2,3-cd]pyrene	**4700**		2000	520	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50
Pyrene	**32000**		2000	400	ug/Kg	☼	05/23/19 07:26	05/28/19 15:14	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 0-2
Date Collected: 05/14/19 14:15
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-5
Matrix: Solid
Percent Solids: 92.2

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<27		57	27	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,1,1-Trichloroethane	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,1,2,2-Tetrachloroethane	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,1,2-Trichloroethane	<20		57	20	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,1-Dichloroethane	<24		57	24	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,1-Dichloroethene	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,1-Dichloropropene	<17		57	17	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2,3-Trichlorobenzene	<26		57	26	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2,3-Trichloropropane	<24		110	24	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2,4-Trichlorobenzene	<20		57	20	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2,4-Trimethylbenzene	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2-Dibromo-3-Chloropropane	<110		290	110	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2-Dibromoethane	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2-Dichlorobenzene	<19		57	19	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2-Dichloroethane	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,2-Dichloropropane	<25		57	25	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,3,5-Trimethylbenzene	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,3-Dichlorobenzene	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,3-Dichloropropane	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
1,4-Dichlorobenzene	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
2,2-Dichloropropane	<26		57	26	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
2-Chlorotoluene	<18		57	18	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
4-Chlorotoluene	<20		57	20	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Benzene	<8.4		14	8.4	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Bromobenzene	<20		57	20	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Bromochloromethane	<25		57	25	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Bromodichloromethane	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Bromoform	<28		57	28	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Bromomethane	<46		170	46	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Carbon tetrachloride	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Chlorobenzene	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Chloroethane	<29		57	29	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Chloroform	<21		110	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Chloromethane	<18		57	18	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
cis-1,2-Dichloroethene	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
cis-1,3-Dichloropropene	<24		57	24	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Dibromochloromethane	<28		57	28	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Dibromomethane	<16		57	16	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Dichlorodifluoromethane	<39		170	39	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Ethylbenzene	<11		14	11	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Hexachlorobutadiene	<26		57	26	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Isopropyl ether	<16		57	16	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Isopropylbenzene	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Methyl tert-butyl ether	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Methylene Chloride	<94		290	94	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
n-Butylbenzene	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
N-Propylbenzene	<24		57	24	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
p-Isopropyltoluene	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
sec-Butylbenzene	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 0-2

Date Collected: 05/14/19 14:15
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-5

Matrix: Solid
Percent Solids: 92.2

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<22		57	22	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
tert-Butylbenzene	<23		57	23	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Tetrachloroethene	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Toluene	<8.4		14	8.4	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
trans-1,2-Dichloroethene	<20		57	20	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
trans-1,3-Dichloropropene	<21		57	21	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Trichloroethene	<9.4		29	9.4	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Trichlorofluoromethane	<25		57	25	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Vinyl chloride	<15		57	15	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50
Xylenes, Total	<13		29	13	ug/Kg	☼	05/14/19 14:15	05/27/19 13:12	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*	*05/14/19 14:15*	*05/27/19 13:12*	*50*
4-Bromofluorobenzene (Surr)	*91*		*72 - 124*	*05/14/19 14:15*	*05/27/19 13:12*	*50*
Dibromofluoromethane	*105*		*75 - 120*	*05/14/19 14:15*	*05/27/19 13:12*	*50*
Toluene-d8 (Surr)	*92*		*75 - 120*	*05/14/19 14:15*	*05/27/19 13:12*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**29**	**J**	70	8.5	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
2-Methylnaphthalene	**38**	**J**	70	6.4	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Acenaphthene	**7.2**	**J**	35	6.3	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Acenaphthylene	**6.5**	**J**	35	4.6	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Anthracene	**22**	**J**	35	5.8	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Benzo[a]anthracene	**100**		35	4.7	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Benzo[a]pyrene	**120**		35	6.7	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Benzo[b]fluoranthene	**180**		35	7.5	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Benzo[g,h,i]perylene	**100**		35	11	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Benzo[k]fluoranthene	**38**		35	10	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Chrysene	**170**		35	9.5	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Dibenz(a,h)anthracene	**38**		35	6.7	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Fluoranthene	**130**		35	6.5	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Fluorene	<4.9		35	4.9	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Indeno[1,2,3-cd]pyrene	**85**		35	9.0	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Naphthalene	**29**	**J**	35	5.4	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Phenanthrene	**150**		35	4.9	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1
Pyrene	**170**		35	6.9	ug/Kg	☼	05/23/19 07:26	05/24/19 13:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*73*		*43 - 145*	*05/23/19 07:26*	*05/24/19 13:35*	*1*
Nitrobenzene-d5 (Surr)	*51*		*37 - 147*	*05/23/19 07:26*	*05/24/19 13:35*	*1*
Terphenyl-d14 (Surr)	*91*		*42 - 157*	*05/23/19 07:26*	*05/24/19 13:35*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.8**		1.1	0.37	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1
Barium	**19**		1.1	0.12	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1
Cadmium	**0.35**	**B**	0.22	0.039	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1
Chromium	**7.1**		1.1	0.53	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1
Lead	**48**		0.54	0.25	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 0-2
Date Collected: 05/14/19 14:15
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-5
Matrix: Solid
Percent Solids: 92.2

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	0.91	J	1.1	0.63	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1
Silver	1.0		0.54	0.14	mg/Kg	☼	05/22/19 17:17	05/23/19 10:22	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.066		0.017	0.0058	mg/Kg	☼	05/22/19 14:50	05/23/19 09:20	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 4-5
Date Collected: 05/14/19 14:25
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-6
Matrix: Solid
Percent Solids: 82.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<33		71	33	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,1,1-Trichloroethane	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,1,2,2-Tetrachloroethane	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,1,2-Trichloroethane	<25		71	25	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,1-Dichloroethane	<29		71	29	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,1-Dichloroethene	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,1-Dichloropropene	<21		71	21	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2,3-Trichlorobenzene	<32		71	32	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2,4-Trichlorobenzene	<24		71	24	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2,4-Trimethylbenzene	<25		71	25	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2-Dibromo-3-Chloropropane	<140		350	140	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2-Dibromoethane	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2-Dichlorobenzene	<24		71	24	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2-Dichloroethane	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,2-Dichloropropane	<30		71	30	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,3,5-Trimethylbenzene	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,3-Dichlorobenzene	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,3-Dichloropropane	<26		71	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
1,4-Dichlorobenzene	<26		71	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
2,2-Dichloropropane	<31		71	31	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
2-Chlorotoluene	<22		71	22	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
4-Chlorotoluene	<25		71	25	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Benzene	<10		18	10	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Bromobenzene	<25		71	25	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Bromochloromethane	<30		71	30	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Bromodichloromethane	<26		71	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Bromoform	<34		71	34	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Bromomethane	<56		210	56	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Carbon tetrachloride	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Chlorobenzene	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Chloroethane	<36		71	36	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Chloroform	<26		140	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Chloromethane	<23		71	23	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
cis-1,2-Dichloroethene	<29		71	29	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
cis-1,3-Dichloropropene	<29		71	29	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Dibromochloromethane	<35		71	35	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Dibromomethane	<19		71	19	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Dichlorodifluoromethane	<48		210	48	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Ethylbenzene	<13		18	13	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Hexachlorobutadiene	<32		71	32	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Isopropyl ether	<20		71	20	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Isopropylbenzene	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Methyl tert-butyl ether	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Methylene Chloride	<120		350	120	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
n-Butylbenzene	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
N-Propylbenzene	<29		71	29	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
p-Isopropyltoluene	<26		71	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
sec-Butylbenzene	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 4-5

Date Collected: 05/14/19 14:25
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-6

Matrix: Solid
Percent Solids: 82.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27		71	27	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
tert-Butylbenzene	<28		71	28	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Tetrachloroethene	<26		71	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Toluene	<10		18	10	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
trans-1,2-Dichloroethene	<25		71	25	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
trans-1,3-Dichloropropene	<26		71	26	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Trichloroethene	<12		35	12	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Trichlorofluoromethane	<30		71	30	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Vinyl chloride	<19		71	19	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50
Xylenes, Total	<16		35	16	ug/Kg	☼	05/14/19 14:25	05/27/19 13:37	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*	*05/14/19 14:25*	*05/27/19 13:37*	*50*
4-Bromofluorobenzene (Surr)	*93*		*72 - 124*	*05/14/19 14:25*	*05/27/19 13:37*	*50*
Dibromofluoromethane	*105*		*75 - 120*	*05/14/19 14:25*	*05/27/19 13:37*	*50*
Toluene-d8 (Surr)	*93*		*75 - 120*	*05/14/19 14:25*	*05/27/19 13:37*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<9.8		81	9.8	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
2-Methylnaphthalene	<7.4		81	7.4	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Acenaphthene	<7.2		40	7.2	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Acenaphthylene	<5.3		40	5.3	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Anthracene	<6.7		40	6.7	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Benzo[a]anthracene	<5.4		40	5.4	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Benzo[a]pyrene	<7.8		40	7.8	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Benzo[b]fluoranthene	<8.7		40	8.7	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Benzo[g,h,i]perylene	<13		40	13	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Benzo[k]fluoranthene	<12		40	12	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Chrysene	<11		40	11	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Dibenz(a,h)anthracene	<7.8		40	7.8	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Fluoranthene	<7.5		40	7.5	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Fluorene	<5.7		40	5.7	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Indeno[1,2,3-cd]pyrene	<10		40	10	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Naphthalene	<6.2		40	6.2	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Phenanthrene	<5.6		40	5.6	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1
Pyrene	<8.0		40	8.0	ug/Kg	☼	05/23/19 07:26	05/24/19 13:12	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*76*		*43 - 145*	*05/23/19 07:26*	*05/24/19 13:12*	*1*
Nitrobenzene-d5 (Surr)	*51*		*37 - 147*	*05/23/19 07:26*	*05/24/19 13:12*	*1*
Terphenyl-d14 (Surr)	*98*		*42 - 157*	*05/23/19 07:26*	*05/24/19 13:12*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.5**		1.1	0.37	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1
Barium	**17**		1.1	0.12	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1
Cadmium	**0.21**	**J B**	0.22	0.039	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1
Chromium	**7.3**		1.1	0.54	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1
Lead	**3.4**		0.54	0.25	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 4-5
Date Collected: 05/14/19 14:25
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-6
Matrix: Solid
Percent Solids: 82.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1
Silver	**1.5**		0.54	0.14	mg/Kg	☼	05/22/19 17:17	05/23/19 10:26	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.013**	**J**	0.018	0.0059	mg/Kg	☼	05/22/19 14:50	05/23/19 09:23	1

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
E	Result exceeded calibration range.
F1	MS and/or MSD Recovery is outside acceptance limits.
F2	MS/MSD RPD exceeds control limits
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

GC/MS VOA

Prep Batch: 486035

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-1	SB6 0-2	Total/NA	Solid	5035	
500-163346-2	SB7 0-2	Total/NA	Solid	5035	
500-163346-3	SB8 0-2	Total/NA	Solid	5035	
500-163346-4	SB9 0-2	Total/NA	Solid	5035	
500-163346-5	SB10 0-2	Total/NA	Solid	5035	
500-163346-6	SB10 4-5	Total/NA	Solid	5035	
LB3 500-486035/20-A	Method Blank	Total/NA	Solid	5035	
LCS 500-486035/21-A	Lab Control Sample	Total/NA	Solid	5035	

Analysis Batch: 486642

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LB3 500-486035/20-A	Method Blank	Total/NA	Solid	8260B	486035
MB 500-486642/7	Method Blank	Total/NA	Solid	8260B	
LCS 500-486035/21-A	Lab Control Sample	Total/NA	Solid	8260B	486035
LCS 500-486642/4	Lab Control Sample	Total/NA	Solid	8260B	

Analysis Batch: 487277

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-1	SB6 0-2	Total/NA	Solid	8260B	486035
500-163346-2	SB7 0-2	Total/NA	Solid	8260B	486035
500-163346-3	SB8 0-2	Total/NA	Solid	8260B	486035
500-163346-4	SB9 0-2	Total/NA	Solid	8260B	486035
500-163346-5	SB10 0-2	Total/NA	Solid	8260B	486035
500-163346-6	SB10 4-5	Total/NA	Solid	8260B	486035
MB 500-487277/6	Method Blank	Total/NA	Solid	8260B	
LCS 500-487277/7	Lab Control Sample	Total/NA	Solid	8260B	

GC/MS Semi VOA

Prep Batch: 486696

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-1	SB6 0-2	Total/NA	Solid	3541	
500-163346-2	SB7 0-2	Total/NA	Solid	3541	
500-163346-3	SB8 0-2	Total/NA	Solid	3541	
500-163346-4 - DL	SB9 0-2	Total/NA	Solid	3541	
500-163346-4	SB9 0-2	Total/NA	Solid	3541	
500-163346-5	SB10 0-2	Total/NA	Solid	3541	
500-163346-6	SB10 4-5	Total/NA	Solid	3541	
MB 500-486696/1-A	Method Blank	Total/NA	Solid	3541	
LCS 500-486696/2-A	Lab Control Sample	Total/NA	Solid	3541	
500-163346-1 MS	SB6 0-2	Total/NA	Solid	3541	
500-163346-1 MSD	SB6 0-2	Total/NA	Solid	3541	

Analysis Batch: 486966

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-486696/1-A	Method Blank	Total/NA	Solid	8270D	486696
LCS 500-486696/2-A	Lab Control Sample	Total/NA	Solid	8270D	486696

Analysis Batch: 486999

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-1	SB6 0-2	Total/NA	Solid	8270D	486696

GC/MS Semi VOA (Continued)

Analysis Batch: 486999 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-2	SB7 0-2	Total/NA	Solid	8270D	486696
500-163346-3	SB8 0-2	Total/NA	Solid	8270D	486696
500-163346-4	SB9 0-2	Total/NA	Solid	8270D	486696
500-163346-5	SB10 0-2	Total/NA	Solid	8270D	486696
500-163346-6	SB10 4-5	Total/NA	Solid	8270D	486696
500-163346-1 MS	SB6 0-2	Total/NA	Solid	8270D	486696
500-163346-1 MSD	SB6 0-2	Total/NA	Solid	8270D	486696

Analysis Batch: 487348

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-4 - DL	SB9 0-2	Total/NA	Solid	8270D	486696

Metals

Prep Batch: 486602

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-5	SB10 0-2	Total/NA	Solid	7471B	
500-163346-6	SB10 4-5	Total/NA	Solid	7471B	
MB 500-486602/12-A	Method Blank	Total/NA	Solid	7471B	
LCS 500-486602/13-A	Lab Control Sample	Total/NA	Solid	7471B	

Prep Batch: 486654

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-5	SB10 0-2	Total/NA	Solid	3050B	
500-163346-6	SB10 4-5	Total/NA	Solid	3050B	
MB 500-486654/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-486654/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Analysis Batch: 486829

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-5	SB10 0-2	Total/NA	Solid	7471B	486602
500-163346-6	SB10 4-5	Total/NA	Solid	7471B	486602
MB 500-486602/12-A	Method Blank	Total/NA	Solid	7471B	486602
LCS 500-486602/13-A	Lab Control Sample	Total/NA	Solid	7471B	486602

Analysis Batch: 486838

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-5	SB10 0-2	Total/NA	Solid	6010C	486654
500-163346-6	SB10 4-5	Total/NA	Solid	6010C	486654
MB 500-486654/1-A	Method Blank	Total/NA	Solid	6010C	486654
LCS 500-486654/2-A	Lab Control Sample	Total/NA	Solid	6010C	486654

General Chemistry

Analysis Batch: 486519

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-1	SB6 0-2	Total/NA	Solid	Moisture	
500-163346-2	SB7 0-2	Total/NA	Solid	Moisture	
500-163346-3	SB8 0-2	Total/NA	Solid	Moisture	
500-163346-4	SB9 0-2	Total/NA	Solid	Moisture	
500-163346-5	SB10 0-2	Total/NA	Solid	Moisture	
500-163346-6	SB10 4-5	Total/NA	Solid	Moisture	

General Chemistry (Continued)

Analysis Batch: 486519 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-163346-3 DU	SB8 0-2	Total/NA	Solid	Moisture	

Surrogate Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Solid **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
Lab Sample ID	Client Sample ID	DCA (75-126)	BFB (72-124)	DBFM (75-120)	TOL (75-120)
500-163346-1	SB6 0-2	100	91	104	94
500-163346-2	SB7 0-2	103	90	105	94
500-163346-3	SB8 0-2	102	93	105	94
500-163346-4	SB9 0-2	105	95	104	92
500-163346-5	SB10 0-2	102	91	105	92
500-163346-6	SB10 4-5	103	93	105	93
LB3 500-486035/20-A	Method Blank	93	102	92	87
LCS 500-486035/21-A	Lab Control Sample	89	98	94	90
LCS 500-486642/4	Lab Control Sample	91	100	96	90
LCS 500-487277/7	Lab Control Sample	96	92	100	96
MB 500-486642/7	Method Blank	93	106	93	88
MB 500-487277/6	Method Blank	95	90	101	96

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane
TOL = Toluene-d8 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Solid **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	FBP (43-145)	NBZ (37-147)	TPHL (42-157)
500-163346-1	SB6 0-2	76	50	104
500-163346-1 MS	SB6 0-2	78	46	89
500-163346-1 MSD	SB6 0-2	67	44	102
500-163346-2	SB7 0-2	74	47	89
500-163346-3	SB8 0-2	80	59	95
500-163346-4	SB9 0-2	78	48	107
500-163346-4 - DL	SB9 0-2	0 D	0 D	0 D
500-163346-5	SB10 0-2	73	51	91
500-163346-6	SB10 4-5	76	51	98
LCS 500-486696/2-A	Lab Control Sample	82	75	92
MB 500-486696/1-A	Method Blank	81	68	91

Surrogate Legend

FBP = 2-Fluorobiphenyl
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: LB3 500-486035/20-A
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 486035

Analyte	LB3 Result	LB3 Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<23		50	23	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,1,1-Trichloroethane	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,1,2,2-Tetrachloroethane	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,1,2-Trichloroethane	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,1-Dichloroethane	<21		50	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,1-Dichloroethene	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,1-Dichloropropene	<15		50	15	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2,3-Trichlorobenzene	<23		50	23	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2,3-Trichloropropane	<21		100	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2,4-Trichlorobenzene	<17		50	17	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2,4-Trimethylbenzene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2-Dibromo-3-Chloropropane	<100		250	100	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2-Dibromoethane	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2-Dichlorobenzene	<17		50	17	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2-Dichloroethane	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,2-Dichloropropane	<21		50	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,3,5-Trimethylbenzene	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,3-Dichlorobenzene	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,3-Dichloropropane	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
1,4-Dichlorobenzene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
2,2-Dichloropropane	<22		50	22	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
2-Chlorotoluene	<16		50	16	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
4-Chlorotoluene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Benzene	<7.3		13	7.3	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Bromobenzene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Bromochloromethane	<21		50	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Bromodichloromethane	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Bromoform	<24		50	24	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Bromomethane	<40		150	40	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Carbon tetrachloride	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Chlorobenzene	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Chloroethane	<25		50	25	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Chloroform	<19		100	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Chloromethane	<16		50	16	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
cis-1,2-Dichloroethene	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
cis-1,3-Dichloropropene	<21		50	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Dibromochloromethane	<24		50	24	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Dibromomethane	<14		50	14	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Dichlorodifluoromethane	<34		150	34	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Ethylbenzene	<9.2		13	9.2	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Hexachlorobutadiene	<22		50	22	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Isopropyl ether	<14		50	14	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Isopropylbenzene	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Methyl tert-butyl ether	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Methylene Chloride	<82		250	82	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
n-Butylbenzene	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
N-Propylbenzene	<21		50	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
p-Isopropyltoluene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LB3 500-486035/20-A
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 486035

Analyte	LB3 Result	LB3 Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Styrene	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
tert-Butylbenzene	<20		50	20	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Tetrachloroethene	<19		50	19	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Toluene	<7.4		13	7.4	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
trans-1,2-Dichloroethene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
trans-1,3-Dichloropropene	<18		50	18	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Trichloroethene	<8.2		25	8.2	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Trichlorofluoromethane	<21		50	21	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Vinyl chloride	<13		50	13	ug/Kg		05/19/19 16:05	05/23/19 00:53	50
Xylenes, Total	<11		25	11	ug/Kg		05/19/19 16:05	05/23/19 00:53	50

Surrogate	*LB3 %Recovery*	*LB3 Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*93*		*75 - 126*	*05/19/19 16:05*	*05/23/19 00:53*	*50*
4-Bromofluorobenzene (Surr)	*102*		*72 - 124*	*05/19/19 16:05*	*05/23/19 00:53*	*50*
Dibromofluoromethane	*92*		*75 - 120*	*05/19/19 16:05*	*05/23/19 00:53*	*50*
Toluene-d8 (Surr)	*87*		*75 - 120*	*05/19/19 16:05*	*05/23/19 00:53*	*50*

Lab Sample ID: LCS 500-486035/21-A
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 486035

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	2500	2640		ug/Kg		106	70 - 125
1,1,1-Trichloroethane	2500	2710		ug/Kg		108	70 - 125
1,1,2,2-Tetrachloroethane	2500	2540		ug/Kg		102	62 - 140
1,1,2-Trichloroethane	2500	2630		ug/Kg		105	71 - 130
1,1-Dichloroethane	2500	2800		ug/Kg		112	70 - 125
1,1-Dichloroethene	2500	2490		ug/Kg		100	67 - 122
1,1-Dichloropropene	2500	2650		ug/Kg		106	70 - 121
1,2,3-Trichlorobenzene	2500	3130		ug/Kg		125	51 - 145
1,2,3-Trichloropropane	2500	2550		ug/Kg		102	50 - 133
1,2,4-Trichlorobenzene	2500	3020		ug/Kg		121	57 - 137
1,2,4-Trimethylbenzene	2500	2790		ug/Kg		112	70 - 123
1,2-Dibromo-3-Chloropropane	2500	2260		ug/Kg		91	56 - 123
1,2-Dibromoethane	2500	2620		ug/Kg		105	70 - 125
1,2-Dichlorobenzene	2500	2780		ug/Kg		111	70 - 125
1,2-Dichloroethane	2500	2450		ug/Kg		98	68 - 127
1,2-Dichloropropane	2500	2990		ug/Kg		120	67 - 130
1,3,5-Trimethylbenzene	2500	2800		ug/Kg		112	70 - 123
1,3-Dichlorobenzene	2500	2840		ug/Kg		114	70 - 125
1,3-Dichloropropane	2500	2640		ug/Kg		106	62 - 136
1,4-Dichlorobenzene	2500	2830		ug/Kg		113	70 - 120
2,2-Dichloropropane	2500	2750		ug/Kg		110	58 - 139
2-Chlorotoluene	2500	2710		ug/Kg		108	70 - 125
4-Chlorotoluene	2500	2700		ug/Kg		108	68 - 124
Benzene	2500	2630		ug/Kg		105	70 - 120
Bromobenzene	2500	2870		ug/Kg		115	70 - 122

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-486035/21-A
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 486035

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromochloromethane	2500	2830		ug/Kg		113	65 - 122
Bromodichloromethane	2500	2470		ug/Kg		99	69 - 120
Bromoform	2500	2340		ug/Kg		94	56 - 132
Bromomethane	2500	1640		ug/Kg		66	40 - 152
Carbon tetrachloride	2500	2650		ug/Kg		106	59 - 133
Chlorobenzene	2500	2750		ug/Kg		110	70 - 120
Chloroethane	2500	1440		ug/Kg		58	48 - 136
Chloroform	2500	2540		ug/Kg		102	70 - 120
Chloromethane	2500	2440		ug/Kg		98	56 - 152
cis-1,2-Dichloroethene	2500	2710		ug/Kg		108	70 - 125
cis-1,3-Dichloropropene	2500	2480		ug/Kg		99	64 - 127
Dibromochloromethane	2500	2470		ug/Kg		99	68 - 125
Dibromomethane	2500	2600		ug/Kg		104	70 - 120
Dichlorodifluoromethane	2500	1420		ug/Kg		57	40 - 159
Ethylbenzene	2500	2750		ug/Kg		110	70 - 123
Hexachlorobutadiene	2500	2600		ug/Kg		104	51 - 150
Isopropylbenzene	2500	2870		ug/Kg		115	70 - 126
Methyl tert-butyl ether	2500	2440		ug/Kg		98	55 - 123
Methylene Chloride	2500	2550		ug/Kg		102	69 - 125
Naphthalene	2500	2860		ug/Kg		114	53 - 144
n-Butylbenzene	2500	2670		ug/Kg		107	68 - 125
N-Propylbenzene	2500	2800		ug/Kg		112	69 - 127
p-Isopropyltoluene	2500	2860		ug/Kg		115	70 - 125
sec-Butylbenzene	2500	2770		ug/Kg		111	70 - 123
Styrene	2500	2880		ug/Kg		115	70 - 120
tert-Butylbenzene	2500	2890		ug/Kg		116	70 - 121
Tetrachloroethene	2500	2940		ug/Kg		118	70 - 128
Toluene	2500	2690		ug/Kg		108	70 - 125
trans-1,2-Dichloroethene	2500	2720		ug/Kg		109	70 - 125
trans-1,3-Dichloropropene	2500	2430		ug/Kg		97	62 - 128
Trichloroethene	2500	2930		ug/Kg		117	70 - 125
Trichlorofluoromethane	2500	2330		ug/Kg		93	55 - 128
Vinyl chloride	2500	2180		ug/Kg		87	64 - 126
Xylenes, Total	5000	5440		ug/Kg		109	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*89*		*75 - 126*
4-Bromofluorobenzene (Surr)	*98*		*72 - 124*
Dibromofluoromethane	*94*		*75 - 120*
Toluene-d8 (Surr)	*90*		*75 - 120*

Lab Sample ID: MB 500-486642/7
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/Kg			05/23/19 00:28	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/Kg			05/23/19 00:28	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-486642/7
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/Kg			05/23/19 00:28	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/Kg			05/23/19 00:28	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/Kg			05/23/19 00:28	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/Kg			05/23/19 00:28	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/Kg			05/23/19 00:28	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/Kg			05/23/19 00:28	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/Kg			05/23/19 00:28	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/Kg			05/23/19 00:28	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/Kg			05/23/19 00:28	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/Kg			05/23/19 00:28	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/Kg			05/23/19 00:28	1
1,3,5-Trimethylbenzene	<0.38		1.0	0.38	ug/Kg			05/23/19 00:28	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/Kg			05/23/19 00:28	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/Kg			05/23/19 00:28	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/Kg			05/23/19 00:28	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/Kg			05/23/19 00:28	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/Kg			05/23/19 00:28	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/Kg			05/23/19 00:28	1
Benzene	<0.15		0.25	0.15	ug/Kg			05/23/19 00:28	1
Bromobenzene	<0.36		1.0	0.36	ug/Kg			05/23/19 00:28	1
Bromochloromethane	<0.43		1.0	0.43	ug/Kg			05/23/19 00:28	1
Bromodichloromethane	<0.37		1.0	0.37	ug/Kg			05/23/19 00:28	1
Bromoform	<0.48		1.0	0.48	ug/Kg			05/23/19 00:28	1
Bromomethane	<0.80		3.0	0.80	ug/Kg			05/23/19 00:28	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/Kg			05/23/19 00:28	1
Chlorobenzene	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
Chloroethane	<0.50		1.0	0.50	ug/Kg			05/23/19 00:28	1
Chloroform	<0.37		2.0	0.37	ug/Kg			05/23/19 00:28	1
Chloromethane	<0.32		1.0	0.32	ug/Kg			05/23/19 00:28	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/Kg			05/23/19 00:28	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/Kg			05/23/19 00:28	1
Dibromochloromethane	<0.49		1.0	0.49	ug/Kg			05/23/19 00:28	1
Dibromomethane	<0.27		1.0	0.27	ug/Kg			05/23/19 00:28	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/Kg			05/23/19 00:28	1
Ethylbenzene	<0.18		0.25	0.18	ug/Kg			05/23/19 00:28	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/Kg			05/23/19 00:28	1
Isopropyl ether	<0.28		1.0	0.28	ug/Kg			05/23/19 00:28	1
Isopropylbenzene	<0.38		1.0	0.38	ug/Kg			05/23/19 00:28	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
Methylene Chloride	<1.6		5.0	1.6	ug/Kg			05/23/19 00:28	1
n-Butylbenzene	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
N-Propylbenzene	<0.41		1.0	0.41	ug/Kg			05/23/19 00:28	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/Kg			05/23/19 00:28	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/Kg			05/23/19 00:28	1
Styrene	<0.39		1.0	0.39	ug/Kg			05/23/19 00:28	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/Kg			05/23/19 00:28	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-486642/7
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Tetrachloroethene	<0.37		1.0	0.37	ug/Kg			05/23/19 00:28	1
Toluene	<0.15		0.25	0.15	ug/Kg			05/23/19 00:28	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/Kg			05/23/19 00:28	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/Kg			05/23/19 00:28	1
Trichloroethene	<0.16		0.50	0.16	ug/Kg			05/23/19 00:28	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/Kg			05/23/19 00:28	1
Vinyl chloride	<0.26		1.0	0.26	ug/Kg			05/23/19 00:28	1
Xylenes, Total	<0.22		0.50	0.22	ug/Kg			05/23/19 00:28	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*93*		*75 - 126*		*05/23/19 00:28*	*1*
4-Bromofluorobenzene (Surr)	*106*		*72 - 124*		*05/23/19 00:28*	*1*
Dibromofluoromethane	*93*		*75 - 120*		*05/23/19 00:28*	*1*
Toluene-d8 (Surr)	*88*		*75 - 120*		*05/23/19 00:28*	*1*

Lab Sample ID: LCS 500-486642/4
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	47.1		ug/Kg		94	70 - 125
1,1,1-Trichloroethane	50.0	47.6		ug/Kg		95	70 - 125
1,1,2,2-Tetrachloroethane	50.0	46.4		ug/Kg		93	62 - 140
1,1,2-Trichloroethane	50.0	48.1		ug/Kg		96	71 - 130
1,1-Dichloroethane	50.0	49.7		ug/Kg		99	70 - 125
1,1-Dichloroethene	50.0	45.2		ug/Kg		90	67 - 122
1,1-Dichloropropene	50.0	47.1		ug/Kg		94	70 - 121
1,2,3-Trichlorobenzene	50.0	57.2		ug/Kg		114	51 - 145
1,2,3-Trichloropropane	50.0	48.1		ug/Kg		96	50 - 133
1,2,4-Trichlorobenzene	50.0	54.3		ug/Kg		109	57 - 137
1,2,4-Trimethylbenzene	50.0	49.5		ug/Kg		99	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	42.9		ug/Kg		86	56 - 123
1,2-Dibromoethane	50.0	48.9		ug/Kg		98	70 - 125
1,2-Dichlorobenzene	50.0	50.5		ug/Kg		101	70 - 125
1,2-Dichloroethane	50.0	45.0		ug/Kg		90	68 - 127
1,2-Dichloropropane	50.0	55.3		ug/Kg		111	67 - 130
1,3,5-Trimethylbenzene	50.0	49.6		ug/Kg		99	70 - 123
1,3-Dichlorobenzene	50.0	50.8		ug/Kg		102	70 - 125
1,3-Dichloropropane	50.0	48.7		ug/Kg		97	62 - 136
1,4-Dichlorobenzene	50.0	50.8		ug/Kg		102	70 - 120
2,2-Dichloropropane	50.0	47.7		ug/Kg		95	58 - 139
2-Chlorotoluene	50.0	48.4		ug/Kg		97	70 - 125
4-Chlorotoluene	50.0	48.4		ug/Kg		97	68 - 124
Benzene	50.0	47.8		ug/Kg		96	70 - 120
Bromobenzene	50.0	51.9		ug/Kg		104	70 - 122
Bromochloromethane	50.0	51.8		ug/Kg		104	65 - 122
Bromodichloromethane	50.0	45.5		ug/Kg		91	69 - 120
Bromoform	50.0	41.7		ug/Kg		83	56 - 132

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-486642/4
Matrix: Solid
Analysis Batch: 486642

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromomethane	50.0	34.6		ug/Kg		69	40 - 152
Carbon tetrachloride	50.0	46.4		ug/Kg		93	59 - 133
Chlorobenzene	50.0	49.0		ug/Kg		98	70 - 120
Chloroethane	50.0	32.9		ug/Kg		66	48 - 136
Chloroform	50.0	46.2		ug/Kg		92	70 - 120
Chloromethane	50.0	56.1		ug/Kg		112	56 - 152
cis-1,2-Dichloroethene	50.0	49.0		ug/Kg		98	70 - 125
cis-1,3-Dichloropropene	50.0	45.3		ug/Kg		91	64 - 127
Dibromochloromethane	50.0	44.4		ug/Kg		89	68 - 125
Dibromomethane	50.0	48.5		ug/Kg		97	70 - 120
Dichlorodifluoromethane	50.0	44.6		ug/Kg		89	40 - 159
Ethylbenzene	50.0	47.9		ug/Kg		96	70 - 123
Hexachlorobutadiene	50.0	46.8		ug/Kg		94	51 - 150
Isopropylbenzene	50.0	50.5		ug/Kg		101	70 - 126
Methyl tert-butyl ether	50.0	44.2		ug/Kg		88	55 - 123
Methylene Chloride	50.0	46.9		ug/Kg		94	69 - 125
Naphthalene	50.0	52.3		ug/Kg		105	53 - 144
n-Butylbenzene	50.0	46.2		ug/Kg		92	68 - 125
N-Propylbenzene	50.0	49.0		ug/Kg		98	69 - 127
p-Isopropyltoluene	50.0	50.3		ug/Kg		101	70 - 125
sec-Butylbenzene	50.0	48.5		ug/Kg		97	70 - 123
Styrene	50.0	51.2		ug/Kg		102	70 - 120
tert-Butylbenzene	50.0	50.6		ug/Kg		101	70 - 121
Tetrachloroethene	50.0	51.7		ug/Kg		103	70 - 128
Toluene	50.0	48.1		ug/Kg		96	70 - 125
trans-1,2-Dichloroethene	50.0	48.7		ug/Kg		97	70 - 125
trans-1,3-Dichloropropene	50.0	44.5		ug/Kg		89	62 - 128
Trichloroethene	50.0	53.2		ug/Kg		106	70 - 125
Trichlorofluoromethane	50.0	44.4		ug/Kg		89	55 - 128
Vinyl chloride	50.0	45.8		ug/Kg		92	64 - 126
Xylenes, Total	100	95.5		ug/Kg		96	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*91*		*75 - 126*
4-Bromofluorobenzene (Surr)	*100*		*72 - 124*
Dibromofluoromethane	*96*		*75 - 120*
Toluene-d8 (Surr)	*90*		*75 - 120*

Lab Sample ID: MB 500-487277/6
Matrix: Solid
Analysis Batch: 487277

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/Kg			05/27/19 10:10	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/Kg			05/27/19 10:10	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/Kg			05/27/19 10:10	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/Kg			05/27/19 10:10	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/Kg			05/27/19 10:10	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-487277/6
Matrix: Solid
Analysis Batch: 487277

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1-Dichloroethene	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/Kg			05/27/19 10:10	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/Kg			05/27/19 10:10	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/Kg			05/27/19 10:10	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/Kg			05/27/19 10:10	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/Kg			05/27/19 10:10	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/Kg			05/27/19 10:10	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/Kg			05/27/19 10:10	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/Kg			05/27/19 10:10	1
1,3,5-Trimethylbenzene	<0.38		1.0	0.38	ug/Kg			05/27/19 10:10	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/Kg			05/27/19 10:10	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/Kg			05/27/19 10:10	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/Kg			05/27/19 10:10	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/Kg			05/27/19 10:10	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/Kg			05/27/19 10:10	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/Kg			05/27/19 10:10	1
Benzene	<0.15		0.25	0.15	ug/Kg			05/27/19 10:10	1
Bromobenzene	<0.36		1.0	0.36	ug/Kg			05/27/19 10:10	1
Bromochloromethane	<0.43		1.0	0.43	ug/Kg			05/27/19 10:10	1
Bromodichloromethane	<0.37		1.0	0.37	ug/Kg			05/27/19 10:10	1
Bromoform	<0.48		1.0	0.48	ug/Kg			05/27/19 10:10	1
Bromomethane	<0.80		3.0	0.80	ug/Kg			05/27/19 10:10	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/Kg			05/27/19 10:10	1
Chlorobenzene	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
Chloroethane	<0.50		1.0	0.50	ug/Kg			05/27/19 10:10	1
Chloroform	<0.37		2.0	0.37	ug/Kg			05/27/19 10:10	1
Chloromethane	<0.32		1.0	0.32	ug/Kg			05/27/19 10:10	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/Kg			05/27/19 10:10	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/Kg			05/27/19 10:10	1
Dibromochloromethane	<0.49		1.0	0.49	ug/Kg			05/27/19 10:10	1
Dibromomethane	<0.27		1.0	0.27	ug/Kg			05/27/19 10:10	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/Kg			05/27/19 10:10	1
Ethylbenzene	<0.18		0.25	0.18	ug/Kg			05/27/19 10:10	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/Kg			05/27/19 10:10	1
Isopropyl ether	<0.28		1.0	0.28	ug/Kg			05/27/19 10:10	1
Isopropylbenzene	<0.38		1.0	0.38	ug/Kg			05/27/19 10:10	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
Methylene Chloride	<1.6		5.0	1.6	ug/Kg			05/27/19 10:10	1
n-Butylbenzene	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
N-Propylbenzene	<0.41		1.0	0.41	ug/Kg			05/27/19 10:10	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/Kg			05/27/19 10:10	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/Kg			05/27/19 10:10	1
Styrene	<0.39		1.0	0.39	ug/Kg			05/27/19 10:10	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/Kg			05/27/19 10:10	1
Tetrachloroethene	<0.37		1.0	0.37	ug/Kg			05/27/19 10:10	1
Toluene	<0.15		0.25	0.15	ug/Kg			05/27/19 10:10	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/Kg			05/27/19 10:10	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-487277/6
Matrix: Solid
Analysis Batch: 487277

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/Kg			05/27/19 10:10	1
Trichloroethene	<0.16		0.50	0.16	ug/Kg			05/27/19 10:10	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/Kg			05/27/19 10:10	1
Vinyl chloride	<0.26		1.0	0.26	ug/Kg			05/27/19 10:10	1
Xylenes, Total	<0.22		0.50	0.22	ug/Kg			05/27/19 10:10	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*95*		*75 - 126*		*05/27/19 10:10*	*1*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*		*05/27/19 10:10*	*1*
Dibromofluoromethane	*101*		*75 - 120*		*05/27/19 10:10*	*1*
Toluene-d8 (Surr)	*96*		*75 - 120*		*05/27/19 10:10*	*1*

Lab Sample ID: LCS 500-487277/7
Matrix: Solid
Analysis Batch: 487277

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	52.7		ug/Kg		105	70 - 125
1,1,1-Trichloroethane	50.0	51.4		ug/Kg		103	70 - 125
1,1,2,2-Tetrachloroethane	50.0	45.6		ug/Kg		91	62 - 140
1,1,2-Trichloroethane	50.0	47.6		ug/Kg		95	71 - 130
1,1-Dichloroethane	50.0	49.7		ug/Kg		99	70 - 125
1,1-Dichloroethene	50.0	52.1		ug/Kg		104	67 - 122
1,1-Dichloropropene	50.0	49.8		ug/Kg		100	70 - 121
1,2,3-Trichlorobenzene	50.0	41.5		ug/Kg		83	51 - 145
1,2,3-Trichloropropane	50.0	46.4		ug/Kg		93	50 - 133
1,2,4-Trichlorobenzene	50.0	43.2		ug/Kg		86	57 - 137
1,2,4-Trimethylbenzene	50.0	47.1		ug/Kg		94	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	47.7		ug/Kg		95	56 - 123
1,2-Dibromoethane	50.0	46.8		ug/Kg		94	70 - 125
1,2-Dichlorobenzene	50.0	46.2		ug/Kg		92	70 - 125
1,2-Dichloroethane	50.0	47.7		ug/Kg		95	68 - 127
1,2-Dichloropropane	50.0	49.4		ug/Kg		99	67 - 130
1,3,5-Trimethylbenzene	50.0	48.7		ug/Kg		97	70 - 123
1,3-Dichlorobenzene	50.0	48.4		ug/Kg		97	70 - 125
1,3-Dichloropropane	50.0	46.2		ug/Kg		92	62 - 136
1,4-Dichlorobenzene	50.0	47.8		ug/Kg		96	70 - 120
2,2-Dichloropropane	50.0	52.6		ug/Kg		105	58 - 139
2-Chlorotoluene	50.0	48.2		ug/Kg		96	70 - 125
4-Chlorotoluene	50.0	47.4		ug/Kg		95	68 - 124
Benzene	50.0	48.6		ug/Kg		97	70 - 120
Bromobenzene	50.0	47.9		ug/Kg		96	70 - 122
Bromochloromethane	50.0	51.5		ug/Kg		103	65 - 122
Bromodichloromethane	50.0	48.9		ug/Kg		98	69 - 120
Bromoform	50.0	57.0		ug/Kg		114	56 - 132
Bromomethane	50.0	52.4		ug/Kg		105	40 - 152
Carbon tetrachloride	50.0	59.2		ug/Kg		118	59 - 133
Chlorobenzene	50.0	48.1		ug/Kg		96	70 - 120

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-487277/7
Matrix: Solid
Analysis Batch: 487277

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloroethane	50.0	50.2		ug/Kg		100	48 - 136
Chloroform	50.0	47.9		ug/Kg		96	70 - 120
Chloromethane	50.0	43.2		ug/Kg		86	56 - 152
cis-1,2-Dichloroethene	50.0	49.9		ug/Kg		100	70 - 125
cis-1,3-Dichloropropene	50.0	46.8		ug/Kg		94	64 - 127
Dibromochloromethane	50.0	52.7		ug/Kg		105	68 - 125
Dibromomethane	50.0	47.9		ug/Kg		96	70 - 120
Dichlorodifluoromethane	50.0	31.3		ug/Kg		63	40 - 159
Ethylbenzene	50.0	50.8		ug/Kg		102	70 - 123
Hexachlorobutadiene	50.0	40.5		ug/Kg		81	51 - 150
Isopropylbenzene	50.0	49.9		ug/Kg		100	70 - 126
Methyl tert-butyl ether	50.0	46.7		ug/Kg		93	55 - 123
Methylene Chloride	50.0	48.2		ug/Kg		96	69 - 125
Naphthalene	50.0	43.4		ug/Kg		87	53 - 144
n-Butylbenzene	50.0	48.1		ug/Kg		96	68 - 125
N-Propylbenzene	50.0	49.2		ug/Kg		98	69 - 127
p-Isopropyltoluene	50.0	46.9		ug/Kg		94	70 - 125
sec-Butylbenzene	50.0	48.9		ug/Kg		98	70 - 123
Styrene	50.0	49.3		ug/Kg		99	70 - 120
tert-Butylbenzene	50.0	46.9		ug/Kg		94	70 - 121
Tetrachloroethene	50.0	52.6		ug/Kg		105	70 - 128
Toluene	50.0	47.3		ug/Kg		95	70 - 125
trans-1,2-Dichloroethene	50.0	51.7		ug/Kg		103	70 - 125
trans-1,3-Dichloropropene	50.0	47.6		ug/Kg		95	62 - 128
Trichloroethene	50.0	52.9		ug/Kg		106	70 - 125
Trichlorofluoromethane	50.0	51.7		ug/Kg		103	55 - 128
Vinyl chloride	50.0	46.0		ug/Kg		92	64 - 126
Xylenes, Total	100	98.9		ug/Kg		99	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*96*		*75 - 126*
4-Bromofluorobenzene (Surr)	*92*		*72 - 124*
Dibromofluoromethane	*100*		*75 - 120*
Toluene-d8 (Surr)	*96*		*75 - 120*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-486696/1-A
Matrix: Solid
Analysis Batch: 486966

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 486696

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<8.1		67	8.1	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
2-Methylnaphthalene	<6.1		67	6.1	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Acenaphthene	<6.0		33	6.0	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Acenaphthylene	<4.4		33	4.4	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Anthracene	<5.6		33	5.6	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Benzo[a]anthracene	<4.5		33	4.5	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Benzo[a]pyrene	<6.4		33	6.4	ug/Kg		05/23/19 07:26	05/24/19 12:39	1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-486696/1-A
Matrix: Solid
Analysis Batch: 486966

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 486696

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzo[b]fluoranthene	<7.2		33	7.2	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Benzo[g,h,i]perylene	<11		33	11	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Benzo[k]fluoranthene	<9.8		33	9.8	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Chrysene	<9.1		33	9.1	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Dibenz(a,h)anthracene	<6.4		33	6.4	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Fluoranthene	<6.2		33	6.2	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Fluorene	<4.7		33	4.7	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Indeno[1,2,3-cd]pyrene	<8.6		33	8.6	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Naphthalene	<5.1		33	5.1	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Phenanthrene	<4.6		33	4.6	ug/Kg		05/23/19 07:26	05/24/19 12:39	1
Pyrene	<6.6		33	6.6	ug/Kg		05/23/19 07:26	05/24/19 12:39	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*81*		*43 - 145*	*05/23/19 07:26*	*05/24/19 12:39*	*1*
Nitrobenzene-d5 (Surr)	*68*		*37 - 147*	*05/23/19 07:26*	*05/24/19 12:39*	*1*
Terphenyl-d14 (Surr)	*91*		*42 - 157*	*05/23/19 07:26*	*05/24/19 12:39*	*1*

Lab Sample ID: LCS 500-486696/2-A
Matrix: Solid
Analysis Batch: 486966

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 486696

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	1330	1130		ug/Kg		85	68 - 111
2-Methylnaphthalene	1330	1120		ug/Kg		84	69 - 112
Acenaphthene	1330	1130		ug/Kg		85	65 - 124
Acenaphthylene	1330	1090		ug/Kg		82	68 - 120
Anthracene	1330	1180		ug/Kg		88	70 - 114
Benzo[a]anthracene	1330	1160		ug/Kg		87	67 - 122
Benzo[a]pyrene	1330	1490		ug/Kg		111	65 - 133
Benzo[b]fluoranthene	1330	1360		ug/Kg		102	69 - 129
Benzo[g,h,i]perylene	1330	1140		ug/Kg		85	72 - 131
Benzo[k]fluoranthene	1330	1370		ug/Kg		103	68 - 127
Chrysene	1330	1210		ug/Kg		90	63 - 120
Dibenz(a,h)anthracene	1330	1300		ug/Kg		98	64 - 131
Fluoranthene	1330	1210		ug/Kg		91	62 - 120
Fluorene	1330	1120		ug/Kg		84	62 - 120
Indeno[1,2,3-cd]pyrene	1330	1250		ug/Kg		94	68 - 130
Naphthalene	1330	1120		ug/Kg		84	63 - 110
Phenanthrene	1330	1160		ug/Kg		87	62 - 120
Pyrene	1330	1160		ug/Kg		87	61 - 128

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl	*82*		*43 - 145*
Nitrobenzene-d5 (Surr)	*75*		*37 - 147*
Terphenyl-d14 (Surr)	*92*		*42 - 157*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 500-163346-1 MS
Matrix: Solid
Analysis Batch: 486999

Client Sample ID: SB6 0-2
Prep Type: Total/NA
Prep Batch: 486696

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	180		1520	1300		ug/Kg	☼	73	68 - 111
2-Methylnaphthalene	250		1520	1750		ug/Kg	☼	99	69 - 112
Acenaphthene	32	J	1520	1100		ug/Kg	☼	70	65 - 124
Acenaphthylene	39		1520	1090		ug/Kg	☼	69	68 - 120
Anthracene	160		1520	1410		ug/Kg	☼	81	70 - 114
Benzo[a]anthracene	410		1520	1660		ug/Kg	☼	82	67 - 122
Benzo[a]pyrene	480		1520	2050		ug/Kg	☼	103	65 - 133
Benzo[b]fluoranthene	940		1520	2100		ug/Kg	☼	76	69 - 129
Benzo[g,h,i]perylene	210	F1	1520	945	F1	ug/Kg	☼	48	72 - 131
Benzo[k]fluoranthene	<11		1520	1410		ug/Kg	☼	93	68 - 127
Chrysene	580		1520	1710		ug/Kg	☼	74	63 - 120
Dibenz(a,h)anthracene	58		1520	1240		ug/Kg	☼	78	64 - 131
Fluoranthene	660	F1 F2	1520	1540	F1	ug/Kg	☼	58	62 - 120
Fluorene	29	J	1520	1200		ug/Kg	☼	77	62 - 120
Indeno[1,2,3-cd]pyrene	190	F1	1520	1210	F1	ug/Kg	☼	67	68 - 130
Naphthalene	150		1520	1250		ug/Kg	☼	72	63 - 110
Phenanthrene	610	F2	1520	1550		ug/Kg	☼	62	62 - 120
Pyrene	800	F1 F2	1520	1930		ug/Kg	☼	74	61 - 128

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
2-Fluorobiphenyl	*78*		*43 - 145*
Nitrobenzene-d5 (Surr)	*46*		*37 - 147*
Terphenyl-d14 (Surr)	*89*		*42 - 157*

Lab Sample ID: 500-163346-1 MSD
Matrix: Solid
Analysis Batch: 486999

Client Sample ID: SB6 0-2
Prep Type: Total/NA
Prep Batch: 486696

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1-Methylnaphthalene	180		1530	1370		ug/Kg	☼	78	68 - 111	6	30
2-Methylnaphthalene	250		1530	1890		ug/Kg	☼	108	69 - 112	8	30
Acenaphthene	32	J	1530	1120		ug/Kg	☼	71	65 - 124	2	30
Acenaphthylene	39		1530	1150		ug/Kg	☼	73	68 - 120	5	30
Anthracene	160		1530	1620		ug/Kg	☼	96	70 - 114	14	30
Benzo[a]anthracene	410		1530	1960		ug/Kg	☼	102	67 - 122	17	30
Benzo[a]pyrene	480		1530	2100		ug/Kg	☼	106	65 - 133	3	30
Benzo[b]fluoranthene	940		1530	2520		ug/Kg	☼	104	69 - 129	18	30
Benzo[g,h,i]perylene	210	F1	1530	982	F1	ug/Kg	☼	50	72 - 131	4	30
Benzo[k]fluoranthene	<11		1530	1490		ug/Kg	☼	98	68 - 127	6	30
Chrysene	580		1530	2070		ug/Kg	☼	97	63 - 120	19	30
Dibenz(a,h)anthracene	58		1530	1070		ug/Kg	☼	66	64 - 131	15	30
Fluoranthene	660	F1 F2	1530	2100	F2	ug/Kg	☼	94	62 - 120	31	30
Fluorene	29	J	1530	1250		ug/Kg	☼	80	62 - 120	4	30
Indeno[1,2,3-cd]pyrene	190	F1	1530	1110	F1	ug/Kg	☼	60	68 - 130	9	30
Naphthalene	150		1530	1330		ug/Kg	☼	78	63 - 110	7	30
Phenanthrene	610	F2	1530	2300	F2	ug/Kg	☼	111	62 - 120	39	30
Pyrene	800	F1 F2	1530	2770	E F1 F2	ug/Kg	☼	129	61 - 128	36	30

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 500-163346-1 MSD
Matrix: Solid
Analysis Batch: 486999

Client Sample ID: SB6 0-2
Prep Type: Total/NA
Prep Batch: 486696

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
2-Fluorobiphenyl	*67*		*43 - 145*
Nitrobenzene-d5 (Surr)	*44*		*37 - 147*
Terphenyl-d14 (Surr)	*102*		*42 - 157*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 500-486654/1-A
Matrix: Solid
Analysis Batch: 486838

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 486654

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.34		1.0	0.34	mg/Kg		05/22/19 17:17	05/23/19 10:06	1
Barium	<0.11		1.0	0.11	mg/Kg		05/22/19 17:17	05/23/19 10:06	1
Cadmium	0.0642	J	0.20	0.036	mg/Kg		05/22/19 17:17	05/23/19 10:06	1
Chromium	<0.50		1.0	0.50	mg/Kg		05/22/19 17:17	05/23/19 10:06	1
Lead	<0.23		0.50	0.23	mg/Kg		05/22/19 17:17	05/23/19 10:06	1
Selenium	<0.59		1.0	0.59	mg/Kg		05/22/19 17:17	05/23/19 10:06	1
Silver	<0.13		0.50	0.13	mg/Kg		05/22/19 17:17	05/23/19 10:06	1

Lab Sample ID: LCS 500-486654/2-A
Matrix: Solid
Analysis Batch: 486838

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 486654

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	10.0	9.32		mg/Kg		93	80 - 120
Barium	200	194		mg/Kg		97	80 - 120
Cadmium	5.00	4.70		mg/Kg		94	80 - 120
Chromium	20.0	19.4		mg/Kg		97	80 - 120
Lead	10.0	9.51		mg/Kg		95	80 - 120
Selenium	10.0	8.95		mg/Kg		89	80 - 120
Silver	5.00	4.54		mg/Kg		91	80 - 120

Method: 7471B - Mercury (CVAA)

Lab Sample ID: MB 500-486602/12-A
Matrix: Solid
Analysis Batch: 486829

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 486602

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.0056		0.017	0.0056	mg/Kg		05/22/19 14:50	05/23/19 09:14	1

Lab Sample ID: LCS 500-486602/13-A
Matrix: Solid
Analysis Batch: 486829

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 486602

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.167	0.169		mg/Kg		101	80 - 120

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB6 0-2
Date Collected: 05/14/19 09:45
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	486519	05/22/19 10:05	LWN	TAL CHI

Client Sample ID: SB6 0-2
Date Collected: 05/14/19 09:45
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-1
Matrix: Solid
Percent Solids: 86.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			486035	05/14/19 09:45	WRE	TAL CHI
Total/NA	Analysis	8260B		50	487277	05/27/19 11:28	PMF	TAL CHI
Total/NA	Prep	3541			486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D		1	486999	05/24/19 18:20	AJD	TAL CHI

Client Sample ID: SB7 0-2
Date Collected: 05/14/19 11:35
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	486519	05/22/19 10:05	LWN	TAL CHI

Client Sample ID: SB7 0-2
Date Collected: 05/14/19 11:35
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-2
Matrix: Solid
Percent Solids: 87.0

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			486035	05/14/19 11:35	WRE	TAL CHI
Total/NA	Analysis	8260B		50	487277	05/27/19 11:54	PMF	TAL CHI
Total/NA	Prep	3541			486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D		1	486999	05/24/19 15:34	AJD	TAL CHI

Client Sample ID: SB8 0-2
Date Collected: 05/14/19 12:30
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	486519	05/22/19 10:05	LWN	TAL CHI

Client Sample ID: SB8 0-2
Date Collected: 05/14/19 12:30
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-3
Matrix: Solid
Percent Solids: 84.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			486035	05/14/19 12:30	WRE	TAL CHI
Total/NA	Analysis	8260B		50	487277	05/27/19 12:20	PMF	TAL CHI
Total/NA	Prep	3541			486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D		1	486999	05/24/19 12:48	AJD	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB9 0-2
Date Collected: 05/14/19 13:05
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-4
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	486519	05/22/19 10:05	LWN	TAL CHI

Client Sample ID: SB9 0-2
Date Collected: 05/14/19 13:05
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-4
Matrix: Solid
Percent Solids: 82.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			486035	05/14/19 13:05	WRE	TAL CHI
Total/NA	Analysis	8260B		50	487277	05/27/19 12:46	PMF	TAL CHI
Total/NA	Prep	3541			486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D		10	486999	05/24/19 19:31	AJD	TAL CHI
Total/NA	Prep	3541	DL		486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D	DL	50	487348	05/28/19 15:14	STW	TAL CHI

Client Sample ID: SB10 0-2
Date Collected: 05/14/19 14:15
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-5
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	486519	05/22/19 10:05	LWN	TAL CHI

Client Sample ID: SB10 0-2
Date Collected: 05/14/19 14:15
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-5
Matrix: Solid
Percent Solids: 92.2

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			486035	05/14/19 14:15	WRE	TAL CHI
Total/NA	Analysis	8260B		50	487277	05/27/19 13:12	PMF	TAL CHI
Total/NA	Prep	3541			486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D		1	486999	05/24/19 13:35	AJD	TAL CHI
Total/NA	Prep	3050B			486654	05/22/19 17:17	BDE	TAL CHI
Total/NA	Analysis	6010C		1	486838	05/23/19 10:22	EEN	TAL CHI
Total/NA	Prep	7471B			486602	05/22/19 14:50	MJG	TAL CHI
Total/NA	Analysis	7471B		1	486829	05/23/19 09:20	MJG	TAL CHI

Client Sample ID: SB10 4-5
Date Collected: 05/14/19 14:25
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-6
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	486519	05/22/19 10:05	LWN	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Client Sample ID: SB10 4-5

Date Collected: 05/14/19 14:25
Date Received: 05/15/19 09:10

Lab Sample ID: 500-163346-6

Matrix: Solid
Percent Solids: 82.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			486035	05/14/19 14:25	WRE	TAL CHI
Total/NA	Analysis	8260B		50	487277	05/27/19 13:37	PMF	TAL CHI
Total/NA	Prep	3541			486696	05/23/19 07:26	DX	TAL CHI
Total/NA	Analysis	8270D		1	486999	05/24/19 13:12	AJD	TAL CHI
Total/NA	Prep	3050B			486654	05/22/19 17:17	BDE	TAL CHI
Total/NA	Analysis	6010C		1	486838	05/23/19 10:26	EEN	TAL CHI
Total/NA	Prep	7471B			486602	05/22/19 14:50	MJG	TAL CHI
Total/NA	Analysis	7471B		1	486829	05/23/19 09:23	MJG	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores - 193706620

Job ID: 500-163346-1

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Wisconsin	State Program	5	999580010	08-31-19 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

2417 Bond Street, University Park, IL 60484
Phone: 708.534.5200 Fax: 708.534.5211

Chain of Custody Record

Lab Job #: 500 - 163346

Chain of Custody Number:

Page _____ of _____

Temperature °C of Cooler: 2.9

Report To (optional)		Bill To (optional)	
Contact:	Jeff Brand	Contact:	
Company:	Stantec	Company:	
Address:		Address:	
Address:		Address:	
Phone:		Phone:	
Fax:		Fax:	
E-Mail:	jeff.brand@stantec.com	PO#/Reference#	

Client	Stantec	Client Project #	193706620
Project Name	Fox Shores		
Project Location/State	Kaukauna, WI	Lab Project #	
Sampler	Tyler Hischke	Lab PM	

500-163346 COC

Preservative Key
1. HCL, Cool to 4°
2. H2SO4, Cool to 4°
3. HNO3, Cool to 4°
4. NaOH, Cool to 4°
5. NaOH/Zn, Cool to 4°
6. NaHSO4
7. Cool to 4°
8. None
9. Other

Lab ID	MS/MSD	Sample ID	Sampling Date	Sampling Time	# of Containers	Matrix	Preservative	Parameter: VOC	PAH	RCRA						Comments
1		SB6 0-2	5/14/19	0945	3	S		X	X							
2		SB7 0-2	5/14/19	1135	3	S		X	X							
3		SB8 0-2	5/14/19	1230	3	S		X	X							
4		SB9 0-2	5/14/19	1305	3	S		X	X							
5		SB10 0-2	5/14/19	1415	4	S		X	X	X						
6		SB10 4-5	5/14/19	1425	4	S		X	X	X						

Turnaround Time Required (Business Days)

___ 1 Day ___ 2 Days ___ 5 Days ___ 7 Days X 10 Days ___ 15 Days _____ Other

Requested Due Date _____

Sample Disposal

[ ] Return to Client [X] Disposal by Lab [ ] Archive for _____ Months (A fee may be assessed if samples are retained longer than 1 month)

Relinquished By	Company	Date	Time	Received By	Company	Date	Time
Tyler Hischke	Stantec	5/14/19	1700	Paula Buckley	TACHI	5/15/19	0910
Relinquished By	Company	Date	Time	Received By	Company	Date	Time
Relinquished By	Company	Date	Time	Received By	Company	Date	Time

Lab Courier [ ]
Shipped [X]
Hand Delivered [ ]

Matrix Key

WW – Wastewater	SE – Sediment
W – Water	SO – Soil
S – Soil	L – Leachate
SL – Sludge	WI – Wipe
MS – Miscellaneous	DW – Drinking Water
OL – Oil	O – Other
A – Air	

Client Comments

Lab Comments:

Login Sample Receipt Checklist

Client: Stantec Consulting Corp.

Job Number: 500-163346-1

Login Number: 163346
List Number: 1
Creator: Buckley, Paula M

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	2.9
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

eurofins | Environment Testing TestAmerica



ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-168870-1
Client Project/Site: Fox Shores Apt, Kaukauna 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Mr. Jeff Brand

Sandie Fredrick

Authorized for release by:
9/5/2019 2:39:39 PM

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

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The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Detection Summary 4
Method Summary 10
Sample Summary 11
Client Sample Results 12
Definitions 36
QC Association 37
Surrogate Summary 40
QC Sample Results 41
Chronicle 46
Certification Summary 50
Chain of Custody 51
Receipt Checklists 53

Case Narrative

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Job ID: 500-168870-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-168870-1

Comments
No additional comments.

Receipt
The samples were received on 8/23/2019 8:45 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 2.7º C.

GC/MS VOA
Methylene chloride was detected in the following samples: SB11 (2-4) (500-168870-2), SB13 (2-4) (500-168870-4), SB14 (0-2) (500-168870-5), SB15 (2-4) (500-168870-6) and SB17 (2-4) (500-168870-9). The method blank associated with these samples was non-detect for Methylene chloride. Methylene chloride is known lab contaminant; therefore all low level detects for this compound should be suspected as lab contamination.

The extraction LCS associated with preparation batch 501507 had several analytes recoveries above control limits. The instrument LCS associated with analytical batch 501589 had all analytes within control limits; therefore re-analysis was not performed. The data have been reported and qualified. SB10 (2-4) (500-168870-1), SB11 (2-4) (500-168870-2), SB12 (2-4) (500-168870-3), SB13 (2-4) (500-168870-4), SB14 (0-2) (500-168870-5), SB15 (4-6) (500-168870-7), SB16 (2-4) (500-168870-8) and SB17 (2-4) (500-168870-9)

The method blank for 501998 contained Naphthalene above the method detection limit and below the Reporting limit (RL). This target analyte concentration were detected in the associated samples; therefore, re-analysis of samples was not performed. Naphthalene results have been flagged in the associated samples with a "B" flag denote the presence in the blank and possible lab contamination.

The laboratory control sample (LCS) for 501998 recovered outside control limits for the following analytes: Bromoform and 1,2-Dibromo-3-chloropropane. These analytes were biased high in the LCS and was not detected in the associated samples; therefore, the data have been reported.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method(s) 8270D: The following samples were diluted due to the nature of the sample matrix: SB11 (2-4) (500-168870-2), SB12 (2-4) (500-168870-3), SB16 (2-4) (500-168870-8) and SB17 (2-4) (500-168870-9). Elevated reporting limits (RLs) are provided.

Method(s) 8270D: The following sample required a dilution due to the nature of the sample matrix: SB16 (2-4) (500-168870-8). Because of this dilution, the surrogate spike concentration in the sample was reduced to a level where the recovery calculation does not provide useful information.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
Method(s) 6010C: The low-level CCV at line 69 and ICV at line 16 in 6010C batch 500-502911 was above the method acceptance limits of 70-130% recovery for Cadmium. The sample SB15 (2-4) (500-168870-6) was bracketed. The low-level standard concentration was insignificant compared with the reported sample results and the sample results were unaffected by the bias at that level. The mid-range bracketing the data were all within the 90-110% recovery limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB10 (2-4)

Lab Sample ID: 500-168870-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	220		80	9.7	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	260		80	7.3	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	22	J	40	7.2	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	28	J	40	5.3	ug/Kg	1	☼	8270D	Total/NA
Anthracene	84		40	6.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	290		40	5.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	280		40	7.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	480		40	8.6	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	210		40	13	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	160		40	12	ug/Kg	1	☼	8270D	Total/NA
Chrysene	390		40	11	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	52		40	7.7	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	480		40	7.4	ug/Kg	1	☼	8270D	Total/NA
Fluorene	21	J	40	5.6	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	150		40	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	200		40	6.1	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	450		40	5.6	ug/Kg	1	☼	8270D	Total/NA
Pyrene	470		40	7.9	ug/Kg	1	☼	8270D	Total/NA
Arsenic	41		1.2	0.40	mg/Kg	1	☼	6010C	Total/NA
Barium	55		1.2	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.7	B	0.23	0.042	mg/Kg	1	☼	6010C	Total/NA
Chromium	14		1.2	0.57	mg/Kg	1	☼	6010C	Total/NA
Lead	390		0.58	0.27	mg/Kg	1	☼	6010C	Total/NA
Selenium	0.84	J	1.2	0.68	mg/Kg	1	☼	6010C	Total/NA
Silver	1.6		0.58	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.23		0.019	0.0063	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB11 (2-4)

Lab Sample ID: 500-168870-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Methylene Chloride	110	J	340	110	ug/Kg	50	☼	8260B	Total/NA
Toluene	43		17	10	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	400		400	48	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	510		400	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	810		200	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	240		200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	2000		200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	5200		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	5200		200	38	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	6900		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	1700		200	64	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	2800		200	58	ug/Kg	5	☼	8270D	Total/NA
Chrysene	5900		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	440		200	38	ug/Kg	5	☼	8270D	Total/NA
Fluorene	650		200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	1500		200	51	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	520		200	30	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	11000		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	13000		200	39	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene - DL	15000		390	73	ug/Kg	10	☼	8270D	Total/NA
Arsenic	9.3		1.2	0.40	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Eurofins TestAmerica, Chicago

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB11 (2-4) (Continued)

Lab Sample ID: 500-168870-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	54		1.2	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.2	B	0.23	0.042	mg/Kg	1	☼	6010C	Total/NA
Chromium	14		1.2	0.57	mg/Kg	1	☼	6010C	Total/NA
Lead	440		0.58	0.27	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.5		1.2	0.68	mg/Kg	1	☼	6010C	Total/NA
Silver	1.5		0.58	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.41		0.018	0.0061	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB12 (2-4)

Lab Sample ID: 500-168870-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	260	J	400	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	310	J	400	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	47	J	200	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	65	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	120	J	200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	650		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	630		200	39	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	990		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	300		200	64	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	300		200	59	ug/Kg	5	☼	8270D	Total/NA
Chrysene	920		200	55	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	92	J	200	39	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	1100		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	59	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	240		200	52	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	200		200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	950		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	1300		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	11		1.1	0.38	mg/Kg	1	☼	6010C	Total/NA
Barium	64		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.6	B	0.22	0.040	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.55	mg/Kg	1	☼	6010C	Total/NA
Lead	480		0.55	0.25	mg/Kg	1	☼	6010C	Total/NA
Selenium	2.0		1.1	0.65	mg/Kg	1	☼	6010C	Total/NA
Silver	1.8		0.55	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.54		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB13 (2-4)

Lab Sample ID: 500-168870-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Methylene Chloride	120	J	350	110	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	150		78	9.5	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	200		78	7.1	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	85		39	7.0	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	29	J	39	5.1	ug/Kg	1	☼	8270D	Total/NA
Anthracene	260		39	6.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	790		39	5.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	840		39	7.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	1300		39	8.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	320		39	13	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	520		39	11	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: SB13 (2-4) (Continued)

Lab Sample ID: 500-168870-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Chrysene	1000		39	11	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	79		39	7.5	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	2100		39	7.2	ug/Kg	1	☼	8270D	Total/NA
Fluorene	68		39	5.5	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	270		39	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	130		39	6.0	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	1300		39	5.4	ug/Kg	1	☼	8270D	Total/NA
Pyrene	1600		39	7.7	ug/Kg	1	☼	8270D	Total/NA
Arsenic	34		1.0	0.35	mg/Kg	1	☼	6010C	Total/NA
Barium	60		1.0	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.7	B	0.20	0.037	mg/Kg	1	☼	6010C	Total/NA
Chromium	18		1.0	0.51	mg/Kg	1	☼	6010C	Total/NA
Lead	570		0.51	0.24	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.5		1.0	0.60	mg/Kg	1	☼	6010C	Total/NA
Silver	1.7		0.51	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.60		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB14 (0-2)

Lab Sample ID: 500-168870-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Methylene Chloride	110	J	300	97	ug/Kg	50	☼	8260B	Total/NA
2-Methylnaphthalene	11	J	72	6.5	ug/Kg	1	☼	8270D	Total/NA
Anthracene	6.4	J	35	5.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	33	J	35	4.8	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	35		35	6.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	52		35	7.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	40		35	11	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	23	J	35	10	ug/Kg	1	☼	8270D	Total/NA
Chrysene	61		35	9.7	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	8.2	J	35	6.9	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	65		35	6.6	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	26	J	35	9.2	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	8.5	J	35	5.5	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	46		35	5.0	ug/Kg	1	☼	8270D	Total/NA
Pyrene	60		35	7.1	ug/Kg	1	☼	8270D	Total/NA
Arsenic	2.7		0.95	0.33	mg/Kg	1	☼	6010C	Total/NA
Barium	45		0.95	0.11	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.13	J B	0.19	0.034	mg/Kg	1	☼	6010C	Total/NA
Chromium	15		0.95	0.47	mg/Kg	1	☼	6010C	Total/NA
Lead	25		0.48	0.22	mg/Kg	1	☼	6010C	Total/NA
Selenium	0.73	J	0.95	0.56	mg/Kg	1	☼	6010C	Total/NA
Silver	2.5		0.48	0.12	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.067		0.017	0.0057	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB15 (2-4)

Lab Sample ID: 500-168870-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	180		73	8.9	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	410		73	6.7	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	26	J	36	6.5	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	22	J	36	4.8	ug/Kg	1	☼	8270D	Total/NA
Anthracene	95		36	6.1	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: SB15 (2-4) (Continued)
Lab Sample ID: 500-168870-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[a]anthracene	310		36	4.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	310		36	7.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	660		36	7.8	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	220		36	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	180		36	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	850		36	9.9	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	62		36	7.0	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	600		36	6.7	ug/Kg	1	☼	8270D	Total/NA
Fluorene	40		36	5.1	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	160		36	9.4	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	240		36	5.6	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	1000		36	5.1	ug/Kg	1	☼	8270D	Total/NA
Pyrene	580		36	7.2	ug/Kg	1	☼	8270D	Total/NA
Arsenic	240		5.0	1.7	mg/Kg	5	☼	6010C	Total/NA
Barium	49		0.99	0.11	mg/Kg	1	☼	6010C	Total/NA
Cadmium	25	B ^	0.99	0.18	mg/Kg	5	☼	6010C	Total/NA
Chromium	13		0.99	0.49	mg/Kg	1	☼	6010C	Total/NA
Lead	97000		25	11	mg/Kg	50	☼	6010C	Total/NA
Selenium	4.4		0.99	0.58	mg/Kg	1	☼	6010C	Total/NA
Silver	7.4		2.5	0.64	mg/Kg	5	☼	6010C	Total/NA
Mercury	12		0.34	0.11	mg/Kg	20	☼	7471B	Total/NA

Client Sample ID: SB15 (4-6)
Lab Sample ID: 500-168870-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	1900		68	24	ug/Kg	50	☼	8260B	Total/NA
1,3,5-Trimethylbenzene	540		68	26	ug/Kg	50	☼	8260B	Total/NA
Isopropylbenzene	98		68	26	ug/Kg	50	☼	8260B	Total/NA
Methylene Chloride	130	J	340	110	ug/Kg	50	☼	8260B	Total/NA
N-Propylbenzene	200		68	28	ug/Kg	50	☼	8260B	Total/NA
p-Isopropyltoluene	510		68	25	ug/Kg	50	☼	8260B	Total/NA
sec-Butylbenzene	200		68	27	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	72		34	15	ug/Kg	50	☼	8260B	Total/NA

Client Sample ID: SB16 (2-4)
Lab Sample ID: 500-168870-8

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	150		68	24	ug/Kg	50	☼	8260B	Total/NA
1,3,5-Trimethylbenzene	62	J	68	26	ug/Kg	50	☼	8260B	Total/NA
Toluene	41		17	10	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	68		34	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	1100		760	92	ug/Kg	10	☼	8270D	Total/NA
2-Methylnaphthalene	830		760	69	ug/Kg	10	☼	8270D	Total/NA
Acenaphthene	1700		370	68	ug/Kg	10	☼	8270D	Total/NA
Acenaphthylene	420		370	50	ug/Kg	10	☼	8270D	Total/NA
Anthracene	4000		370	63	ug/Kg	10	☼	8270D	Total/NA
Benzo[a]anthracene	11000		370	51	ug/Kg	10	☼	8270D	Total/NA
Benzo[a]pyrene	9000		370	73	ug/Kg	10	☼	8270D	Total/NA
Benzo[b]fluoranthene	11000		370	81	ug/Kg	10	☼	8270D	Total/NA
Benzo[g,h,i]perylene	2500		370	120	ug/Kg	10	☼	8270D	Total/NA
Benzo[k]fluoranthene	3700		370	110	ug/Kg	10	☼	8270D	Total/NA
Chrysene	13000		370	100	ug/Kg	10	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: SB16 (2-4) (Continued)
Lab Sample ID: 500-168870-8

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dibenz(a,h)anthracene	890		370	73	ug/Kg	10	☼	8270D	Total/NA
Fluoranthene	25000		370	70	ug/Kg	10	☼	8270D	Total/NA
Fluorene	1500		370	53	ug/Kg	10	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	2100		370	98	ug/Kg	10	☼	8270D	Total/NA
Naphthalene	600		370	58	ug/Kg	10	☼	8270D	Total/NA
Phenanthrene - DL	28000		750	110	ug/Kg	20	☼	8270D	Total/NA
Pyrene - DL	32000		750	150	ug/Kg	20	☼	8270D	Total/NA
Arsenic	11		1.1	0.36	mg/Kg	1	☼	6010C	Total/NA
Barium	40		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.44	B	0.21	0.038	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.52	mg/Kg	1	☼	6010C	Total/NA
Lead	84		0.53	0.24	mg/Kg	1	☼	6010C	Total/NA
Selenium	0.75	J	1.1	0.62	mg/Kg	1	☼	6010C	Total/NA
Silver	1.5		0.53	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.10		0.018	0.0061	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SB17 (2-4)
Lab Sample ID: 500-168870-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	2700		62	22	ug/Kg	50	☼	8260B	Total/NA
1,3,5-Trimethylbenzene	1200		62	24	ug/Kg	50	☼	8260B	Total/NA
Methylene Chloride	110	J	310	100	ug/Kg	50	☼	8260B	Total/NA
N-Propylbenzene	370		62	26	ug/Kg	50	☼	8260B	Total/NA
p-Isopropyltoluene	170		62	23	ug/Kg	50	☼	8260B	Total/NA
sec-Butylbenzene	250		62	25	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	320		31	14	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	940		740	90	ug/Kg	10	☼	8270D	Total/NA
2-Methylnaphthalene	1100		740	68	ug/Kg	10	☼	8270D	Total/NA
Acenaphthene	1100		370	66	ug/Kg	10	☼	8270D	Total/NA
Acenaphthylene	550		370	48	ug/Kg	10	☼	8270D	Total/NA
Anthracene	2300		370	61	ug/Kg	10	☼	8270D	Total/NA
Benzo[a]anthracene	5900		370	49	ug/Kg	10	☼	8270D	Total/NA
Benzo[a]pyrene	5800		370	71	ug/Kg	10	☼	8270D	Total/NA
Benzo[b]fluoranthene	8600		370	79	ug/Kg	10	☼	8270D	Total/NA
Benzo[g,h,i]perylene	2000		370	120	ug/Kg	10	☼	8270D	Total/NA
Benzo[k]fluoranthene	3800		370	110	ug/Kg	10	☼	8270D	Total/NA
Chrysene	6800		370	100	ug/Kg	10	☼	8270D	Total/NA
Dibenz(a,h)anthracene	520		370	71	ug/Kg	10	☼	8270D	Total/NA
Fluoranthene	16000		370	68	ug/Kg	10	☼	8270D	Total/NA
Fluorene	930		370	52	ug/Kg	10	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	1800		370	95	ug/Kg	10	☼	8270D	Total/NA
Naphthalene	1100		370	57	ug/Kg	10	☼	8270D	Total/NA
Phenanthrene	13000		370	51	ug/Kg	10	☼	8270D	Total/NA
Pyrene	14000		370	73	ug/Kg	10	☼	8270D	Total/NA
Arsenic	15		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	79		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.7	B	0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	14		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	560		0.55	0.25	mg/Kg	1	☼	6010C	Total/NA
Selenium	2.2		1.1	0.64	mg/Kg	1	☼	6010C	Total/NA
Silver	1.6		0.55	0.14	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB17 (2-4) (Continued)

Lab Sample ID: 500-168870-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Mercury	0.45		0.017	0.0058	mg/Kg	1	☼	7471B	Total/NA

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL CHI
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL CHI
6010C	Metals (ICP)	SW846	TAL CHI
7471B	Mercury (CVAA)	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
3541	Automated Soxhlet Extraction	SW846	TAL CHI
5035	Closed System Purge and Trap	SW846	TAL CHI
7471B	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
500-168870-1	SB10 (2-4)	Solid	08/21/19 09:33	08/23/19 08:45	
500-168870-2	SB11 (2-4)	Solid	08/21/19 10:35	08/23/19 08:45	
500-168870-3	SB12 (2-4)	Solid	08/21/19 09:58	08/23/19 08:45	
500-168870-4	SB13 (2-4)	Solid	08/21/19 11:06	08/23/19 08:45	
500-168870-5	SB14 (0-2)	Solid	08/21/19 11:50	08/23/19 08:45	
500-168870-6	SB15 (2-4)	Solid	08/21/19 12:11	08/23/19 08:45	
500-168870-7	SB15 (4-6)	Solid	08/21/19 12:14	08/23/19 08:45	
500-168870-8	SB16 (2-4)	Solid	08/21/19 12:55	08/23/19 08:45	
500-168870-9	SB17 (2-4)	Solid	08/21/19 13:26	08/23/19 08:45	

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB10 (2-4)
Date Collected: 08/21/19 09:33
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-1
Matrix: Solid
Percent Solids: 83.2

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		70	32	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,1,1-Trichloroethane	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,1,2,2-Tetrachloroethane	<28		70	28	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,1,2-Trichloroethane	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,1-Dichloroethane	<29		70	29	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,1-Dichloroethene	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,1-Dichloropropene	<21		70	21	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2,3-Trichlorobenzene	<32		70	32	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2,4-Trichlorobenzene	<24		70	24	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2,4-Trimethylbenzene	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2-Dibromo-3-Chloropropane	<140	*	350	140	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2-Dibromoethane	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2-Dichlorobenzene	<23		70	23	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2-Dichloroethane	<27	*	70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,2-Dichloropropane	<30		70	30	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,3,5-Trimethylbenzene	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,3-Dichlorobenzene	<28		70	28	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,3-Dichloropropane	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
1,4-Dichlorobenzene	<26		70	26	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
2,2-Dichloropropane	<31		70	31	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
2-Chlorotoluene	<22		70	22	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
4-Chlorotoluene	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Benzene	<10	*	18	10	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Bromobenzene	<25	*	70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Bromochloromethane	<30		70	30	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Bromodichloromethane	<26	*	70	26	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Bromoform	<34	*	70	34	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Bromomethane	<56		210	56	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Carbon tetrachloride	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Chlorobenzene	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Chloroethane	<35		70	35	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Chloroform	<26	*	140	26	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Chloromethane	<22		70	22	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
cis-1,2-Dichloroethene	<29		70	29	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
cis-1,3-Dichloropropene	<29		70	29	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Dibromochloromethane	<34		70	34	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Dibromomethane	<19	*	70	19	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Dichlorodifluoromethane	<47		210	47	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Ethylbenzene	<13		18	13	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Hexachlorobutadiene	<31		70	31	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Isopropyl ether	<19		70	19	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Isopropylbenzene	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Methyl tert-butyl ether	<28		70	28	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Methylene Chloride	<110		350	110	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
n-Butylbenzene	<27		70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
N-Propylbenzene	<29		70	29	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
p-Isopropyltoluene	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
sec-Butylbenzene	<28		70	28	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50

Client Sample ID: SB10 (2-4)
Date Collected: 08/21/19 09:33
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-1
Matrix: Solid
Percent Solids: 83.2

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27	*	70	27	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
tert-Butylbenzene	<28		70	28	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Tetrachloroethene	<26		70	26	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Toluene	<10		18	10	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
trans-1,2-Dichloroethene	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
trans-1,3-Dichloropropene	<25		70	25	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Trichloroethene	<11		35	11	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Trichlorofluoromethane	<30		70	30	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Vinyl chloride	<18		70	18	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50
Xylenes, Total	<15		35	15	ug/Kg	☼	08/21/19 09:33	08/28/19 13:45	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*	*08/21/19 09:33*	*08/28/19 13:45*	*50*
4-Bromofluorobenzene (Surr)	*91*		*72 - 124*	*08/21/19 09:33*	*08/28/19 13:45*	*50*
Dibromofluoromethane	*104*		*75 - 120*	*08/21/19 09:33*	*08/28/19 13:45*	*50*
Toluene-d8 (Surr)	*98*		*75 - 120*	*08/21/19 09:33*	*08/28/19 13:45*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**220**		80	9.7	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
2-Methylnaphthalene	**260**		80	7.3	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Acenaphthene	**22**	**J**	40	7.2	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Acenaphthylene	**28**	**J**	40	5.3	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Anthracene	**84**		40	6.7	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Benzo[a]anthracene	**290**		40	5.4	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Benzo[a]pyrene	**280**		40	7.7	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Benzo[b]fluoranthene	**480**		40	8.6	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Benzo[g,h,i]perylene	**210**		40	13	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Benzo[k]fluoranthene	**160**		40	12	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Chrysene	**390**		40	11	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Dibenz(a,h)anthracene	**52**		40	7.7	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Fluoranthene	**480**		40	7.4	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Fluorene	**21**	**J**	40	5.6	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Indeno[1,2,3-cd]pyrene	**150**		40	10	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Naphthalene	**200**		40	6.1	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Phenanthrene	**450**		40	5.6	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1
Pyrene	**470**		40	7.9	ug/Kg	☼	08/30/19 07:35	08/30/19 21:17	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*88*		*43 - 145*	*08/30/19 07:35*	*08/30/19 21:17*	*1*
Nitrobenzene-d5 (Surr)	*71*		*37 - 147*	*08/30/19 07:35*	*08/30/19 21:17*	*1*
Terphenyl-d14 (Surr)	*109*		*42 - 157*	*08/30/19 07:35*	*08/30/19 21:17*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**41**		1.2	0.40	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1
Barium	**55**		1.2	0.13	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1
Cadmium	**1.7**	**B**	0.23	0.042	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1
Chromium	**14**		1.2	0.57	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1
Lead	**390**		0.58	0.27	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB10 (2-4)
Date Collected: 08/21/19 09:33
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-1
Matrix: Solid
Percent Solids: 83.2

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	0.84	J	1.2	0.68	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1
Silver	1.6		0.58	0.15	mg/Kg	☼	08/30/19 08:24	08/30/19 16:52	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.23		0.019	0.0063	mg/Kg	☼	08/30/19 15:10	09/03/19 08:38	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB11 (2-4)
Date Collected: 08/21/19 10:35
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-2
Matrix: Solid
Percent Solids: 83.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		69	32	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,1,1-Trichloroethane	<26		69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,1,2,2-Tetrachloroethane	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,1,2-Trichloroethane	<24		69	24	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,1-Dichloroethane	<28		69	28	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,1-Dichloroethene	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,1-Dichloropropene	<20		69	20	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2,3-Trichlorobenzene	<31		69	31	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2,3-Trichloropropane	<28		140	28	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2,4-Trichlorobenzene	<23		69	23	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2,4-Trimethylbenzene	<25		69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2-Dibromo-3-Chloropropane	<140	*	340	140	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2-Dibromoethane	<26		69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2-Dichlorobenzene	<23		69	23	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2-Dichloroethane	<27	*	69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,2-Dichloropropane	<29		69	29	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,3,5-Trimethylbenzene	<26		69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,3-Dichlorobenzene	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,3-Dichloropropane	<25		69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
1,4-Dichlorobenzene	<25		69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
2,2-Dichloropropane	<30		69	30	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
2-Chlorotoluene	<22		69	22	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
4-Chlorotoluene	<24		69	24	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Benzene	<10	*	17	10	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Bromobenzene	<24	*	69	24	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Bromochloromethane	<29		69	29	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Bromodichloromethane	<25	*	69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Bromoform	<33	*	69	33	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Bromomethane	<55		210	55	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Carbon tetrachloride	<26		69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Chlorobenzene	<26		69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Chloroethane	<35		69	35	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Chloroform	<25	*	140	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Chloromethane	<22		69	22	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
cis-1,2-Dichloroethene	<28		69	28	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
cis-1,3-Dichloropropene	<29		69	29	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Dibromochloromethane	<33		69	33	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Dibromomethane	<19	*	69	19	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Dichlorodifluoromethane	<46		210	46	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Ethylbenzene	<13		17	13	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Hexachlorobutadiene	<31		69	31	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Isopropyl ether	<19		69	19	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Isopropylbenzene	<26		69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Methyl tert-butyl ether	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Methylene Chloride	**110**	**J**	340	110	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
n-Butylbenzene	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
N-Propylbenzene	<28		69	28	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
p-Isopropyltoluene	<25		69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
sec-Butylbenzene	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB11 (2-4)
Date Collected: 08/21/19 10:35
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-2
Matrix: Solid
Percent Solids: 83.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26	*	69	26	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
tert-Butylbenzene	<27		69	27	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Tetrachloroethene	<25		69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Toluene	**43**		17	10	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
trans-1,2-Dichloroethene	<24		69	24	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
trans-1,3-Dichloropropene	<25		69	25	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Trichloroethene	<11		34	11	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Trichlorofluoromethane	<29		69	29	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Vinyl chloride	<18		69	18	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50
Xylenes, Total	<15		34	15	ug/Kg	☼	08/21/19 10:35	08/28/19 14:12	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*104*		*75 - 126*	*08/21/19 10:35*	*08/28/19 14:12*	*50*
4-Bromofluorobenzene (Surr)	*91*		*72 - 124*	*08/21/19 10:35*	*08/28/19 14:12*	*50*
Dibromofluoromethane	*104*		*75 - 120*	*08/21/19 10:35*	*08/28/19 14:12*	*50*
Toluene-d8 (Surr)	*97*		*75 - 120*	*08/21/19 10:35*	*08/28/19 14:12*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**400**		400	48	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
2-Methylnaphthalene	**510**		400	36	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Acenaphthene	**810**		200	36	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Acenaphthylene	**240**		200	26	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Anthracene	**2000**		200	33	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Benzo[a]anthracene	**5200**		200	27	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Benzo[a]pyrene	**5200**		200	38	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Benzo[b]fluoranthene	**6900**		200	43	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Benzo[g,h,i]perylene	**1700**		200	64	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Benzo[k]fluoranthene	**2800**		200	58	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Chrysene	**5900**		200	54	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Dibenz(a,h)anthracene	**440**		200	38	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Fluorene	**650**		200	28	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Indeno[1,2,3-cd]pyrene	**1500**		200	51	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Naphthalene	**520**		200	30	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Phenanthrene	**11000**		200	28	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5
Pyrene	**13000**		200	39	ug/Kg	☼	08/30/19 07:35	08/30/19 23:35	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*67*		*43 - 145*	*08/30/19 07:35*	*08/30/19 23:35*	*5*
Nitrobenzene-d5 (Surr)	*65*		*37 - 147*	*08/30/19 07:35*	*08/30/19 23:35*	*5*
Terphenyl-d14 (Surr)	*76*		*42 - 157*	*08/30/19 07:35*	*08/30/19 23:35*	*5*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoranthene	**15000**		390	73	ug/Kg	☼	08/30/19 07:35	09/04/19 00:19	10

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**9.3**		1.2	0.40	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1
Barium	**54**		1.2	0.13	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1
Cadmium	**1.2**	**B**	0.23	0.042	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB11 (2-4)
Date Collected: 08/21/19 10:35
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-2
Matrix: Solid
Percent Solids: 83.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chromium	14		1.2	0.57	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1
Lead	440		0.58	0.27	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1
Selenium	1.5		1.2	0.68	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1
Silver	1.5		0.58	0.15	mg/Kg	☼	08/30/19 08:24	08/30/19 16:56	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.41		0.018	0.0061	mg/Kg	☼	08/30/19 15:10	09/03/19 08:40	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB12 (2-4)
Date Collected: 08/21/19 09:58
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-3
Matrix: Solid
Percent Solids: 81.8

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<34		73	34	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,1,1-Trichloroethane	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,1,2,2-Tetrachloroethane	<29		73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,1,2-Trichloroethane	<26		73	26	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,1-Dichloroethane	<30		73	30	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,1-Dichloroethene	<29		73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,1-Dichloropropene	<22		73	22	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2,3-Trichlorobenzene	<34		73	34	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2,3-Trichloropropane	<30		150	30	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2,4-Trichlorobenzene	<25		73	25	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2,4-Trimethylbenzene	<26		73	26	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2-Dibromo-3-Chloropropane	<150	*	370	150	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2-Dibromoethane	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2-Dichlorobenzene	<24		73	24	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2-Dichloroethane	<29	*	73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,2-Dichloropropane	<31		73	31	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,3,5-Trimethylbenzene	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,3-Dichlorobenzene	<29		73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,3-Dichloropropane	<27		73	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
1,4-Dichlorobenzene	<27		73	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
2,2-Dichloropropane	<33		73	33	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
2-Chlorotoluene	<23		73	23	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
4-Chlorotoluene	<26		73	26	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Benzene	<11	*	18	11	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Bromobenzene	<26	*	73	26	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Bromochloromethane	<31		73	31	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Bromodichloromethane	<27	*	73	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Bromoform	<35	*	73	35	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Bromomethane	<58		220	58	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Carbon tetrachloride	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Chlorobenzene	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Chloroethane	<37		73	37	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Chloroform	<27	*	150	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Chloromethane	<23		73	23	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
cis-1,2-Dichloroethene	<30		73	30	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
cis-1,3-Dichloropropene	<30		73	30	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Dibromochloromethane	<36		73	36	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Dibromomethane	<20	*	73	20	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Ethylbenzene	<13		18	13	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Hexachlorobutadiene	<33		73	33	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Isopropyl ether	<20		73	20	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Isopropylbenzene	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Methyl tert-butyl ether	<29		73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Methylene Chloride	<120		370	120	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
n-Butylbenzene	<28		73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
N-Propylbenzene	<30		73	30	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
p-Isopropyltoluene	<27		73	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
sec-Butylbenzene	<29		73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50

Client Sample ID: SB12 (2-4)

Date Collected: 08/21/19 09:58
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-3

Matrix: Solid
Percent Solids: 81.8

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28	*	73	28	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
tert-Butylbenzene	<29		73	29	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Tetrachloroethene	<27		73	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Toluene	<11		18	11	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
trans-1,2-Dichloroethene	<26		73	26	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
trans-1,3-Dichloropropene	<27		73	27	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Trichloroethene	<12		37	12	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Trichlorofluoromethane	<31		73	31	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Vinyl chloride	<19		73	19	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50
Xylenes, Total	<16		37	16	ug/Kg	☼	08/21/19 09:58	08/28/19 14:38	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*104*		*75 - 126*	*08/21/19 09:58*	*08/28/19 14:38*	*50*
4-Bromofluorobenzene (Surr)	*93*		*72 - 124*	*08/21/19 09:58*	*08/28/19 14:38*	*50*
Dibromofluoromethane	*103*		*75 - 120*	*08/21/19 09:58*	*08/28/19 14:38*	*50*
Toluene-d8 (Surr)	*98*		*75 - 120*	*08/21/19 09:58*	*08/28/19 14:38*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**260**	**J**	400	49	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
2-Methylnaphthalene	**310**	**J**	400	37	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Acenaphthene	**47**	**J**	200	36	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Acenaphthylene	**65**	**J**	200	26	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Anthracene	**120**	**J**	200	33	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Benzo[a]anthracene	**650**		200	27	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Benzo[a]pyrene	**630**		200	39	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Benzo[b]fluoranthene	**990**		200	43	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Benzo[g,h,i]perylene	**300**		200	64	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Benzo[k]fluoranthene	**300**		200	59	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Chrysene	**920**		200	55	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Dibenz(a,h)anthracene	**92**	**J**	200	39	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Fluoranthene	**1100**		200	37	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Fluorene	**59**	**J**	200	28	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Indeno[1,2,3-cd]pyrene	**240**		200	52	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Naphthalene	**200**		200	31	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Phenanthrene	**950**		200	28	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5
Pyrene	**1300**		200	40	ug/Kg	☼	08/30/19 07:35	08/31/19 00:03	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*62*		*43 - 145*	*08/30/19 07:35*	*08/31/19 00:03*	*5*
Nitrobenzene-d5 (Surr)	*48*		*37 - 147*	*08/30/19 07:35*	*08/31/19 00:03*	*5*
Terphenyl-d14 (Surr)	*80*		*42 - 157*	*08/30/19 07:35*	*08/31/19 00:03*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		1.1	0.38	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1
Barium	**64**		1.1	0.13	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1
Cadmium	**1.6**	**B**	0.22	0.040	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1
Chromium	**16**		1.1	0.55	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1
Lead	**480**		0.55	0.25	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB12 (2-4)
Date Collected: 08/21/19 09:58
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-3
Matrix: Solid
Percent Solids: 81.8

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	2.0		1.1	0.65	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1
Silver	1.8		0.55	0.14	mg/Kg	☼	08/30/19 08:24	08/30/19 17:00	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.54		0.019	0.0062	mg/Kg	☼	08/30/19 15:10	09/03/19 08:42	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB13 (2-4)
Date Collected: 08/21/19 11:06
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-4
Matrix: Solid
Percent Solids: 83.5

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		69	32	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,1,1-Trichloroethane	<26		69	26	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,1,2,2-Tetrachloroethane	<28		69	28	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,1,2-Trichloroethane	<24		69	24	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,1-Dichloroethane	<28		69	28	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,1-Dichloroethene	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,1-Dichloropropene	<21		69	21	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2,3-Trichlorobenzene	<32		69	32	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2,4-Trichlorobenzene	<24		69	24	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2,4-Trimethylbenzene	<25		69	25	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2-Dibromo-3-Chloropropane	<140	*	350	140	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2-Dibromoethane	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2-Dichlorobenzene	<23		69	23	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2-Dichloroethane	<27	*	69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,2-Dichloropropane	<30		69	30	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,3,5-Trimethylbenzene	<26		69	26	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,3-Dichlorobenzene	<28		69	28	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,3-Dichloropropane	<25		69	25	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
1,4-Dichlorobenzene	<25		69	25	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
2,2-Dichloropropane	<31		69	31	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
2-Chlorotoluene	<22		69	22	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
4-Chlorotoluene	<24		69	24	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Benzene	<10	*	17	10	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Bromobenzene	<25	*	69	25	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Bromochloromethane	<30		69	30	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Bromodichloromethane	<26	*	69	26	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Bromoform	<34	*	69	34	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Bromomethane	<55		210	55	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Carbon tetrachloride	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Chlorobenzene	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Chloroethane	<35		69	35	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Chloroform	<26	*	140	26	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Chloromethane	<22		69	22	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
cis-1,2-Dichloroethene	<28		69	28	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
cis-1,3-Dichloropropene	<29		69	29	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Dibromochloromethane	<34		69	34	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Dibromomethane	<19	*	69	19	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Dichlorodifluoromethane	<47		210	47	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Ethylbenzene	<13		17	13	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Hexachlorobutadiene	<31		69	31	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Isopropyl ether	<19		69	19	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Isopropylbenzene	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Methyl tert-butyl ether	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Methylene Chloride	**120**	**J**	350	110	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
n-Butylbenzene	<27		69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
N-Propylbenzene	<29		69	29	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
p-Isopropyltoluene	<25		69	25	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
sec-Butylbenzene	<28		69	28	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB13 (2-4)
Date Collected: 08/21/19 11:06
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-4
Matrix: Solid
Percent Solids: 83.5

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27	*	69	27	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
tert-Butylbenzene	<28		69	28	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Tetrachloroethene	<26		69	26	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Toluene	<10		17	10	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
trans-1,2-Dichloroethene	<24		69	24	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
trans-1,3-Dichloropropene	<25		69	25	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Trichloroethene	<11		35	11	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Trichlorofluoromethane	<30		69	30	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Vinyl chloride	<18		69	18	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50
Xylenes, Total	<15		35	15	ug/Kg	☼	08/21/19 11:05	08/28/19 15:05	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*	*08/21/19 11:05*	*08/28/19 15:05*	*50*
4-Bromofluorobenzene (Surr)	*92*		*72 - 124*	*08/21/19 11:05*	*08/28/19 15:05*	*50*
Dibromofluoromethane	*105*		*75 - 120*	*08/21/19 11:05*	*08/28/19 15:05*	*50*
Toluene-d8 (Surr)	*96*		*75 - 120*	*08/21/19 11:05*	*08/28/19 15:05*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**150**		78	9.5	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
2-Methylnaphthalene	**200**		78	7.1	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Acenaphthene	**85**		39	7.0	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Acenaphthylene	**29**	**J**	39	5.1	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Anthracene	**260**		39	6.5	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Benzo[a]anthracene	**790**		39	5.2	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Benzo[a]pyrene	**840**		39	7.5	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Benzo[b]fluoranthene	**1300**		39	8.4	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Benzo[g,h,i]perylene	**320**		39	13	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Benzo[k]fluoranthene	**520**		39	11	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Chrysene	**1000**		39	11	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Dibenz(a,h)anthracene	**79**		39	7.5	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Fluoranthene	**2100**		39	7.2	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Fluorene	**68**		39	5.5	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Indeno[1,2,3-cd]pyrene	**270**		39	10	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Naphthalene	**130**		39	6.0	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Phenanthrene	**1300**		39	5.4	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1
Pyrene	**1600**		39	7.7	ug/Kg	☼	08/30/19 07:35	08/30/19 21:44	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*75*		*43 - 145*	*08/30/19 07:35*	*08/30/19 21:44*	*1*
Nitrobenzene-d5 (Surr)	*59*		*37 - 147*	*08/30/19 07:35*	*08/30/19 21:44*	*1*
Terphenyl-d14 (Surr)	*85*		*42 - 157*	*08/30/19 07:35*	*08/30/19 21:44*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**34**		1.0	0.35	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1
Barium	**60**		1.0	0.12	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1
Cadmium	**1.7**	**B**	0.20	0.037	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1
Chromium	**18**		1.0	0.51	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1
Lead	**570**		0.51	0.24	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB13 (2-4)
Date Collected: 08/21/19 11:06
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-4
Matrix: Solid
Percent Solids: 83.5

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.5		1.0	0.60	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1
Silver	1.7		0.51	0.13	mg/Kg	☼	08/30/19 08:24	08/30/19 17:04	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.60		0.019	0.0064	mg/Kg	☼	08/30/19 15:10	09/03/19 08:46	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB14 (0-2)
Date Collected: 08/21/19 11:50
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-5
Matrix: Solid
Percent Solids: 90.6

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<27		59	27	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,1,1-Trichloroethane	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,1,2,2-Tetrachloroethane	<24		59	24	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,1,2-Trichloroethane	<21		59	21	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,1-Dichloroethane	<24		59	24	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,1-Dichloroethene	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,1-Dichloropropene	<18		59	18	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2,3-Trichlorobenzene	<27		59	27	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2,3-Trichloropropane	<25		120	25	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2,4-Trichlorobenzene	<20		59	20	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2,4-Trimethylbenzene	<21		59	21	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2-Dibromo-3-Chloropropane	<120	*	300	120	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2-Dibromoethane	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2-Dichlorobenzene	<20		59	20	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2-Dichloroethane	<23	*	59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,2-Dichloropropane	<25		59	25	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,3,5-Trimethylbenzene	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,3-Dichlorobenzene	<24		59	24	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,3-Dichloropropane	<22		59	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
1,4-Dichlorobenzene	<22		59	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
2,2-Dichloropropane	<26		59	26	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
2-Chlorotoluene	<19		59	19	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
4-Chlorotoluene	<21		59	21	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Benzene	<8.7	*	15	8.7	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Bromobenzene	<21	*	59	21	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Bromochloromethane	<25		59	25	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Bromodichloromethane	<22	*	59	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Bromoform	<29	*	59	29	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Bromomethane	<47		180	47	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Carbon tetrachloride	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Chlorobenzene	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Chloroethane	<30		59	30	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Chloroform	<22	*	120	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Chloromethane	<19		59	19	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
cis-1,2-Dichloroethene	<24		59	24	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
cis-1,3-Dichloropropene	<25		59	25	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Dibromochloromethane	<29		59	29	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Dibromomethane	<16	*	59	16	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Dichlorodifluoromethane	<40		180	40	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Ethylbenzene	<11		15	11	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Hexachlorobutadiene	<26		59	26	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Isopropyl ether	<16		59	16	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Isopropylbenzene	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Methyl tert-butyl ether	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Methylene Chloride	**110**	**J**	300	97	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
n-Butylbenzene	<23		59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
N-Propylbenzene	<25		59	25	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
p-Isopropyltoluene	<22		59	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
sec-Butylbenzene	<24		59	24	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB14 (0-2)
Date Collected: 08/21/19 11:50
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-5
Matrix: Solid
Percent Solids: 90.6

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<23	*	59	23	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
tert-Butylbenzene	<24		59	24	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Tetrachloroethene	<22		59	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Toluene	<8.7		15	8.7	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
trans-1,2-Dichloroethene	<21		59	21	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
trans-1,3-Dichloropropene	<22		59	22	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Trichloroethene	<9.7		30	9.7	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Trichlorofluoromethane	<25		59	25	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Vinyl chloride	<16		59	16	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50
Xylenes, Total	<13		30	13	ug/Kg	☼	08/21/19 11:50	08/28/19 15:32	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*	*08/21/19 11:50*	*08/28/19 15:32*	*50*
4-Bromofluorobenzene (Surr)	*93*		*72 - 124*	*08/21/19 11:50*	*08/28/19 15:32*	*50*
Dibromofluoromethane	*104*		*75 - 120*	*08/21/19 11:50*	*08/28/19 15:32*	*50*
Toluene-d8 (Surr)	*96*		*75 - 120*	*08/21/19 11:50*	*08/28/19 15:32*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<8.7		72	8.7	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
2-Methylnaphthalene	**11**	**J**	72	6.5	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Acenaphthene	<6.4		35	6.4	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Acenaphthylene	<4.7		35	4.7	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Anthracene	**6.4**	**J**	35	5.9	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Benzo[a]anthracene	**33**	**J**	35	4.8	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Benzo[a]pyrene	**35**		35	6.9	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Benzo[b]fluoranthene	**52**		35	7.7	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Benzo[g,h,i]perylene	**40**		35	11	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Benzo[k]fluoranthene	**23**	**J**	35	10	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Chrysene	**61**		35	9.7	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Dibenz(a,h)anthracene	**8.2**	**J**	35	6.9	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Fluoranthene	**65**		35	6.6	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Fluorene	<5.0		35	5.0	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Indeno[1,2,3-cd]pyrene	**26**	**J**	35	9.2	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Naphthalene	**8.5**	**J**	35	5.5	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Phenanthrene	**46**		35	5.0	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1
Pyrene	**60**		35	7.1	ug/Kg	☼	08/30/19 07:35	08/30/19 20:49	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*101*		*43 - 145*	*08/30/19 07:35*	*08/30/19 20:49*	*1*
Nitrobenzene-d5 (Surr)	*82*		*37 - 147*	*08/30/19 07:35*	*08/30/19 20:49*	*1*
Terphenyl-d14 (Surr)	*135*		*42 - 157*	*08/30/19 07:35*	*08/30/19 20:49*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.7**		0.95	0.33	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1
Barium	**45**		0.95	0.11	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1
Cadmium	**0.13**	**J B**	0.19	0.034	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1
Chromium	**15**		0.95	0.47	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1
Lead	**25**		0.48	0.22	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB14 (0-2)
Date Collected: 08/21/19 11:50
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-5
Matrix: Solid
Percent Solids: 90.6

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	0.73	J	0.95	0.56	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1
Silver	2.5		0.48	0.12	mg/Kg	☼	08/30/19 08:24	08/30/19 17:16	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.067		0.017	0.0057	mg/Kg	☼	08/30/19 15:10	09/03/19 08:55	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB15 (2-4)

Date Collected: 08/21/19 12:11
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-6

Matrix: Solid
Percent Solids: 89.3

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	180		73	8.9	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
2-Methylnaphthalene	410		73	6.7	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Acenaphthene	26	J	36	6.5	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Acenaphthylene	22	J	36	4.8	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Anthracene	95		36	6.1	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Benzo[a]anthracene	310		36	4.9	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Benzo[a]pyrene	310		36	7.0	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Benzo[b]fluoranthene	660		36	7.8	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Benzo[g,h,i]perylene	220		36	12	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Benzo[k]fluoranthene	180		36	11	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Chrysene	850		36	9.9	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Dibenz(a,h)anthracene	62		36	7.0	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Fluoranthene	600		36	6.7	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Fluorene	40		36	5.1	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Indeno[1,2,3-cd]pyrene	160		36	9.4	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Naphthalene	240		36	5.6	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Phenanthrene	1000		36	5.1	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1
Pyrene	580		36	7.2	ug/Kg	☼	08/30/19 07:35	08/30/19 22:12	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*93*		*43 - 145*	*08/30/19 07:35*	*08/30/19 22:12*	*1*
Nitrobenzene-d5 (Surr)	*74*		*37 - 147*	*08/30/19 07:35*	*08/30/19 22:12*	*1*
Terphenyl-d14 (Surr)	*114*		*42 - 157*	*08/30/19 07:35*	*08/30/19 22:12*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	240		5.0	1.7	mg/Kg	☼	08/30/19 08:24	09/03/19 10:53	5
Barium	49		0.99	0.11	mg/Kg	☼	08/30/19 08:24	08/30/19 17:20	1
Cadmium	25	B ^	0.99	0.18	mg/Kg	☼	08/30/19 08:24	09/03/19 10:53	5
Chromium	13		0.99	0.49	mg/Kg	☼	08/30/19 08:24	08/30/19 17:20	1
Lead	97000		25	11	mg/Kg	☼	08/30/19 08:24	09/03/19 11:33	50
Selenium	4.4		0.99	0.58	mg/Kg	☼	08/30/19 08:24	08/30/19 17:20	1
Silver	7.4		2.5	0.64	mg/Kg	☼	08/30/19 08:24	09/03/19 16:09	5

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	12		0.34	0.11	mg/Kg	☼	08/30/19 15:10	09/03/19 11:42	20

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB15 (4-6)
Date Collected: 08/21/19 12:14
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-7
Matrix: Solid
Percent Solids: 84.5

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		68	32	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,1,1-Trichloroethane	<26		68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,1,2,2-Tetrachloroethane	<27		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,1,2-Trichloroethane	<24		68	24	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,1-Dichloroethane	<28		68	28	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,1-Dichloroethene	<27		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,1-Dichloropropene	<20		68	20	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2,3-Trichlorobenzene	<31		68	31	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2,3-Trichloropropane	<28		140	28	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2,4-Trichlorobenzene	<23		68	23	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2,4-Trimethylbenzene	**1900**		68	24	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2-Dibromo-3-Chloropropane	<140	*	340	140	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2-Dibromoethane	<26		68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2-Dichlorobenzene	<23		68	23	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2-Dichloroethane	<27	*	68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,2-Dichloropropane	<29		68	29	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,3,5-Trimethylbenzene	**540**		68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,3-Dichlorobenzene	<27		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,3-Dichloropropane	<25		68	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
1,4-Dichlorobenzene	<25		68	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
2,2-Dichloropropane	<30		68	30	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
2-Chlorotoluene	<21		68	21	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
4-Chlorotoluene	<24		68	24	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Benzene	<10	*	17	10	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Bromobenzene	<24	*	68	24	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Bromochloromethane	<29		68	29	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Bromodichloromethane	<25	*	68	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Bromoform	<33	*	68	33	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Bromomethane	<54		210	54	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Carbon tetrachloride	<26		68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Chlorobenzene	<26		68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Chloroethane	<34		68	34	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Chloroform	<25	*	140	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Chloromethane	<22		68	22	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
cis-1,2-Dichloroethene	<28		68	28	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
cis-1,3-Dichloropropene	<28		68	28	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Dibromochloromethane	<33		68	33	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Dibromomethane	<18	*	68	18	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Dichlorodifluoromethane	<46		210	46	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Ethylbenzene	<13		17	13	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Hexachlorobutadiene	<30		68	30	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Isopropyl ether	<19		68	19	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Isopropylbenzene	**98**		68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Methyl tert-butyl ether	<27		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Methylene Chloride	**130**	**J**	340	110	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
n-Butylbenzene	<27		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
N-Propylbenzene	**200**		68	28	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
p-Isopropyltoluene	**510**		68	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
sec-Butylbenzene	**200**		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB15 (4-6)
Date Collected: 08/21/19 12:14
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-7
Matrix: Solid
Percent Solids: 84.5

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26	*	68	26	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
tert-Butylbenzene	<27		68	27	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Tetrachloroethene	<25		68	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Toluene	<10		17	10	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
trans-1,2-Dichloroethene	<24		68	24	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
trans-1,3-Dichloropropene	<25		68	25	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Trichloroethene	<11		34	11	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Trichlorofluoromethane	<29		68	29	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Vinyl chloride	<18		68	18	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50
Xylenes, Total	**72**		34	15	ug/Kg	☼	08/21/19 12:14	08/28/19 15:59	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*107*		*75 - 126*	*08/21/19 12:14*	*08/28/19 15:59*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*08/21/19 12:14*	*08/28/19 15:59*	*50*
Dibromofluoromethane	*108*		*75 - 120*	*08/21/19 12:14*	*08/28/19 15:59*	*50*
Toluene-d8 (Surr)	*95*		*75 - 120*	*08/21/19 12:14*	*08/28/19 15:59*	*50*

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB16 (2-4)
Date Collected: 08/21/19 12:55
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-8
Matrix: Solid
Percent Solids: 87.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		68	31	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,1,1-Trichloroethane	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,1,2,2-Tetrachloroethane	<27		68	27	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,1,2-Trichloroethane	<24		68	24	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,1-Dichloroethane	<28		68	28	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,1-Dichloroethene	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,1-Dichloropropene	<20		68	20	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2,3-Trichlorobenzene	<31		68	31	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2,3-Trichloropropane	<28		140	28	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2,4-Trichlorobenzene	<23		68	23	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2,4-Trimethylbenzene	**150**		68	24	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2-Dibromo-3-Chloropropane	<140	*	340	140	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2-Dibromoethane	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2-Dichlorobenzene	<23		68	23	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2-Dichloroethane	<27	*	68	27	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,2-Dichloropropane	<29		68	29	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,3,5-Trimethylbenzene	**62**	**J**	68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,3-Dichlorobenzene	<27		68	27	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,3-Dichloropropane	<25		68	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
1,4-Dichlorobenzene	<25		68	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
2,2-Dichloropropane	<30		68	30	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
2-Chlorotoluene	<21		68	21	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
4-Chlorotoluene	<24		68	24	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Benzene	<9.9	*	17	9.9	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Bromobenzene	<24	*	68	24	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Bromochloromethane	<29		68	29	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Bromodichloromethane	<25	*	68	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Bromoform	<33	*	68	33	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Bromomethane	<54		200	54	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Carbon tetrachloride	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Chlorobenzene	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Chloroethane	<34		68	34	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Chloroform	<25	*	140	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Chloromethane	<22		68	22	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
cis-1,2-Dichloroethene	<28		68	28	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
cis-1,3-Dichloropropene	<28		68	28	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Dibromochloromethane	<33		68	33	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Dibromomethane	<18	*	68	18	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Dichlorodifluoromethane	<46		200	46	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Ethylbenzene	<12		17	12	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Hexachlorobutadiene	<30		68	30	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Isopropyl ether	<19		68	19	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Isopropylbenzene	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Methyl tert-butyl ether	<27		68	27	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Methylene Chloride	<110		340	110	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
n-Butylbenzene	<26		68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
N-Propylbenzene	<28		68	28	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
p-Isopropyltoluene	<25		68	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
sec-Butylbenzene	<27		68	27	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB16 (2-4)
Date Collected: 08/21/19 12:55
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-8
Matrix: Solid
Percent Solids: 87.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26	*	68	26	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
tert-Butylbenzene	<27		68	27	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Tetrachloroethene	<25		68	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Toluene	**41**		17	10	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
trans-1,2-Dichloroethene	<24		68	24	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
trans-1,3-Dichloropropene	<25		68	25	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Trichloroethene	<11		34	11	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Trichlorofluoromethane	<29		68	29	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Vinyl chloride	<18		68	18	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50
Xylenes, Total	**68**		34	15	ug/Kg	☼	08/21/19 12:55	08/28/19 16:26	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*107*		*75 - 126*	*08/21/19 12:55*	*08/28/19 16:26*	*50*
4-Bromofluorobenzene (Surr)	*94*		*72 - 124*	*08/21/19 12:55*	*08/28/19 16:26*	*50*
Dibromofluoromethane	*107*		*75 - 120*	*08/21/19 12:55*	*08/28/19 16:26*	*50*
Toluene-d8 (Surr)	*96*		*75 - 120*	*08/21/19 12:55*	*08/28/19 16:26*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**1100**		760	92	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
2-Methylnaphthalene	**830**		760	69	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Acenaphthene	**1700**		370	68	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Acenaphthylene	**420**		370	50	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Anthracene	**4000**		370	63	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Benzo[a]anthracene	**11000**		370	51	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Benzo[a]pyrene	**9000**		370	73	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Benzo[b]fluoranthene	**11000**		370	81	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Benzo[g,h,i]perylene	**2500**		370	120	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Benzo[k]fluoranthene	**3700**		370	110	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Chrysene	**13000**		370	100	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Dibenz(a,h)anthracene	**890**		370	73	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Fluoranthene	**25000**		370	70	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Fluorene	**1500**		370	53	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Indeno[1,2,3-cd]pyrene	**2100**		370	98	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10
Naphthalene	**600**		370	58	ug/Kg	☼	08/30/19 07:35	08/30/19 22:40	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*73*		*43 - 145*	*08/30/19 07:35*	*08/30/19 22:40*	*10*
Nitrobenzene-d5 (Surr)	*58*		*37 - 147*	*08/30/19 07:35*	*08/30/19 22:40*	*10*
Terphenyl-d14 (Surr)	*79*		*42 - 157*	*08/30/19 07:35*	*08/30/19 22:40*	*10*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phenanthrene	**28000**		750	110	ug/Kg	☼	08/30/19 07:35	09/04/19 00:45	20
Pyrene	**32000**		750	150	ug/Kg	☼	08/30/19 07:35	09/04/19 00:45	20

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		1.1	0.36	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1
Barium	**40**		1.1	0.12	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1
Cadmium	**0.44**	**B**	0.21	0.038	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB16 (2-4)
Date Collected: 08/21/19 12:55
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-8
Matrix: Solid
Percent Solids: 87.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chromium	16		1.1	0.52	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1
Lead	84		0.53	0.24	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1
Selenium	0.75	J	1.1	0.62	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1
Silver	1.5		0.53	0.14	mg/Kg	☼	08/30/19 08:24	08/30/19 17:24	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.10		0.018	0.0061	mg/Kg	☼	08/30/19 15:10	09/03/19 09:05	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB17 (2-4)
Date Collected: 08/21/19 13:26
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-9
Matrix: Solid
Percent Solids: 87.4

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<29		62	29	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,1,1-Trichloroethane	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,1,2,2-Tetrachloroethane	<25		62	25	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,1,2-Trichloroethane	<22		62	22	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,1-Dichloroethane	<26		62	26	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,1-Dichloroethene	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,1-Dichloropropene	<19		62	19	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2,3-Trichlorobenzene	<29		62	29	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2,3-Trichloropropane	<26		120	26	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2,4-Trichlorobenzene	<21		62	21	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2,4-Trimethylbenzene	**2700**		62	22	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2-Dibromo-3-Chloropropane	<120	*	310	120	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2-Dibromoethane	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2-Dichlorobenzene	<21		62	21	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2-Dichloroethane	<24	*	62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,2-Dichloropropane	<27		62	27	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,3,5-Trimethylbenzene	**1200**		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,3-Dichlorobenzene	<25		62	25	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,3-Dichloropropane	<23		62	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
1,4-Dichlorobenzene	<23		62	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
2,2-Dichloropropane	<28		62	28	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
2-Chlorotoluene	<20		62	20	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
4-Chlorotoluene	<22		62	22	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Benzene	<9.1	*	16	9.1	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Bromobenzene	<22	*	62	22	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Bromochloromethane	<27		62	27	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Bromodichloromethane	<23	*	62	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Bromoform	<30	*	62	30	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Bromomethane	<50		190	50	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Carbon tetrachloride	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Chlorobenzene	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Chloroethane	<31		62	31	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Chloroform	<23	*	120	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Chloromethane	<20		62	20	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
cis-1,2-Dichloroethene	<25		62	25	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
cis-1,3-Dichloropropene	<26		62	26	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Dibromochloromethane	<30		62	30	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Dibromomethane	<17	*	62	17	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Dichlorodifluoromethane	<42		190	42	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Ethylbenzene	<11		16	11	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Hexachlorobutadiene	<28		62	28	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Isopropyl ether	<17		62	17	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Isopropylbenzene	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Methyl tert-butyl ether	<25		62	25	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Methylene Chloride	**110**	**J**	310	100	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
n-Butylbenzene	<24		62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
N-Propylbenzene	**370**		62	26	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
p-Isopropyltoluene	**170**		62	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
sec-Butylbenzene	**250**		62	25	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB17 (2-4)
Date Collected: 08/21/19 13:26
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-9
Matrix: Solid
Percent Solids: 87.4

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<24	*	62	24	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
tert-Butylbenzene	<25		62	25	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Tetrachloroethene	<23		62	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Toluene	<9.2		16	9.2	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
trans-1,2-Dichloroethene	<22		62	22	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
trans-1,3-Dichloropropene	<23		62	23	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Trichloroethene	<10		31	10	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Trichlorofluoromethane	<27		62	27	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Vinyl chloride	<16		62	16	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50
Xylenes, Total	**320**		31	14	ug/Kg	☼	08/21/19 13:26	08/28/19 16:54	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*	*08/21/19 13:26*	*08/28/19 16:54*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*08/21/19 13:26*	*08/28/19 16:54*	*50*
Dibromofluoromethane	*105*		*75 - 120*	*08/21/19 13:26*	*08/28/19 16:54*	*50*
Toluene-d8 (Surr)	*94*		*75 - 120*	*08/21/19 13:26*	*08/28/19 16:54*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**940**		740	90	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
2-Methylnaphthalene	**1100**		740	68	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Acenaphthene	**1100**		370	66	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Acenaphthylene	**550**		370	48	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Anthracene	**2300**		370	61	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Benzo[a]anthracene	**5900**		370	49	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Benzo[a]pyrene	**5800**		370	71	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Benzo[b]fluoranthene	**8600**		370	79	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Benzo[g,h,i]perylene	**2000**		370	120	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Benzo[k]fluoranthene	**3800**		370	110	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Chrysene	**6800**		370	100	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Dibenz(a,h)anthracene	**520**		370	71	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Fluoranthene	**16000**		370	68	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Fluorene	**930**		370	52	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Indeno[1,2,3-cd]pyrene	**1800**		370	95	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Naphthalene	**1100**		370	57	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Phenanthrene	**13000**		370	51	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10
Pyrene	**14000**		370	73	ug/Kg	☼	08/30/19 07:35	08/30/19 23:07	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*81*		*43 - 145*	*08/30/19 07:35*	*08/30/19 23:07*	*10*
Nitrobenzene-d5 (Surr)	*71*		*37 - 147*	*08/30/19 07:35*	*08/30/19 23:07*	*10*
Terphenyl-d14 (Surr)	*90*		*42 - 157*	*08/30/19 07:35*	*08/30/19 23:07*	*10*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**15**		1.1	0.37	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1
Barium	**79**		1.1	0.12	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1
Cadmium	**1.7**	**B**	0.22	0.039	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1
Chromium	**14**		1.1	0.54	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1
Lead	**560**		0.55	0.25	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB17 (2-4)
Date Collected: 08/21/19 13:26
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-9
Matrix: Solid
Percent Solids: 87.4

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	2.2		1.1	0.64	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1
Silver	1.6		0.55	0.14	mg/Kg	☼	08/30/19 08:24	08/30/19 17:28	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.45		0.017	0.0058	mg/Kg	☼	08/30/19 15:10	09/03/19 09:07	1

Definitions/Glossary

Client: Stantec Consulting Corp. Job ID: 500-168870-1
Project/Site: Fox Shores Apt, Kaukauna 193706620

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
*	LCS or LCSD is outside acceptance limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
^	ICV,CCV,ICB,CCB, ISA, ISB, CRI, CRA, DLCK or MRL standard: Instrument related QC is outside acceptance limits.
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

GC/MS VOA

Prep Batch: 501507

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	5035	
500-168870-2	SB11 (2-4)	Total/NA	Solid	5035	
500-168870-3	SB12 (2-4)	Total/NA	Solid	5035	
500-168870-4	SB13 (2-4)	Total/NA	Solid	5035	
500-168870-5	SB14 (0-2)	Total/NA	Solid	5035	
500-168870-7	SB15 (4-6)	Total/NA	Solid	5035	
500-168870-8	SB16 (2-4)	Total/NA	Solid	5035	
500-168870-9	SB17 (2-4)	Total/NA	Solid	5035	

Analysis Batch: 501998

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	8260B	501507
500-168870-2	SB11 (2-4)	Total/NA	Solid	8260B	501507
500-168870-3	SB12 (2-4)	Total/NA	Solid	8260B	501507
500-168870-4	SB13 (2-4)	Total/NA	Solid	8260B	501507
500-168870-5	SB14 (0-2)	Total/NA	Solid	8260B	501507
500-168870-7	SB15 (4-6)	Total/NA	Solid	8260B	501507
500-168870-8	SB16 (2-4)	Total/NA	Solid	8260B	501507
500-168870-9	SB17 (2-4)	Total/NA	Solid	8260B	501507
MB 500-501998/6	Method Blank	Total/NA	Solid	8260B	
LCS 500-501998/4	Lab Control Sample	Total/NA	Solid	8260B	

GC/MS Semi VOA

Prep Batch: 502476

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	3541	
500-168870-2	SB11 (2-4)	Total/NA	Solid	3541	
500-168870-2 - DL	SB11 (2-4)	Total/NA	Solid	3541	
500-168870-3	SB12 (2-4)	Total/NA	Solid	3541	
500-168870-4	SB13 (2-4)	Total/NA	Solid	3541	
500-168870-5	SB14 (0-2)	Total/NA	Solid	3541	
500-168870-6	SB15 (2-4)	Total/NA	Solid	3541	
500-168870-8	SB16 (2-4)	Total/NA	Solid	3541	
500-168870-8 - DL	SB16 (2-4)	Total/NA	Solid	3541	
500-168870-9	SB17 (2-4)	Total/NA	Solid	3541	
MB 500-502476/1-A	Method Blank	Total/NA	Solid	3541	
LCS 500-502476/2-A	Lab Control Sample	Total/NA	Solid	3541	

Analysis Batch: 502643

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-502476/1-A	Method Blank	Total/NA	Solid	8270D	502476
LCS 500-502476/2-A	Lab Control Sample	Total/NA	Solid	8270D	502476

Analysis Batch: 502655

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	8270D	502476
500-168870-2	SB11 (2-4)	Total/NA	Solid	8270D	502476
500-168870-3	SB12 (2-4)	Total/NA	Solid	8270D	502476
500-168870-4	SB13 (2-4)	Total/NA	Solid	8270D	502476
500-168870-5	SB14 (0-2)	Total/NA	Solid	8270D	502476

GC/MS Semi VOA (Continued)

Analysis Batch: 502655 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-6	SB15 (2-4)	Total/NA	Solid	8270D	502476
500-168870-8	SB16 (2-4)	Total/NA	Solid	8270D	502476
500-168870-9	SB17 (2-4)	Total/NA	Solid	8270D	502476

Analysis Batch: 502930

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-2 - DL	SB11 (2-4)	Total/NA	Solid	8270D	502476
500-168870-8 - DL	SB16 (2-4)	Total/NA	Solid	8270D	502476

Metals

Prep Batch: 502503

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	3050B	
500-168870-2	SB11 (2-4)	Total/NA	Solid	3050B	
500-168870-3	SB12 (2-4)	Total/NA	Solid	3050B	
500-168870-4	SB13 (2-4)	Total/NA	Solid	3050B	
500-168870-5	SB14 (0-2)	Total/NA	Solid	3050B	
500-168870-6	SB15 (2-4)	Total/NA	Solid	3050B	
500-168870-8	SB16 (2-4)	Total/NA	Solid	3050B	
500-168870-9	SB17 (2-4)	Total/NA	Solid	3050B	
MB 500-502503/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-502503/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Prep Batch: 502567

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	7471B	
500-168870-2	SB11 (2-4)	Total/NA	Solid	7471B	
500-168870-3	SB12 (2-4)	Total/NA	Solid	7471B	
500-168870-4	SB13 (2-4)	Total/NA	Solid	7471B	
500-168870-5	SB14 (0-2)	Total/NA	Solid	7471B	
500-168870-6	SB15 (2-4)	Total/NA	Solid	7471B	
500-168870-8	SB16 (2-4)	Total/NA	Solid	7471B	
500-168870-9	SB17 (2-4)	Total/NA	Solid	7471B	
MB 500-502567/12-A	Method Blank	Total/NA	Solid	7471B	
LCS 500-502567/13-A	Lab Control Sample	Total/NA	Solid	7471B	

Analysis Batch: 502784

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	6010C	502503
500-168870-2	SB11 (2-4)	Total/NA	Solid	6010C	502503
500-168870-3	SB12 (2-4)	Total/NA	Solid	6010C	502503
500-168870-4	SB13 (2-4)	Total/NA	Solid	6010C	502503
500-168870-5	SB14 (0-2)	Total/NA	Solid	6010C	502503
500-168870-6	SB15 (2-4)	Total/NA	Solid	6010C	502503
500-168870-8	SB16 (2-4)	Total/NA	Solid	6010C	502503
500-168870-9	SB17 (2-4)	Total/NA	Solid	6010C	502503
MB 500-502503/1-A	Method Blank	Total/NA	Solid	6010C	502503
LCS 500-502503/2-A	Lab Control Sample	Total/NA	Solid	6010C	502503

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Metals

Analysis Batch: 502896

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	7471B	502567
500-168870-2	SB11 (2-4)	Total/NA	Solid	7471B	502567
500-168870-3	SB12 (2-4)	Total/NA	Solid	7471B	502567
500-168870-4	SB13 (2-4)	Total/NA	Solid	7471B	502567
500-168870-5	SB14 (0-2)	Total/NA	Solid	7471B	502567
500-168870-6	SB15 (2-4)	Total/NA	Solid	7471B	502567
500-168870-8	SB16 (2-4)	Total/NA	Solid	7471B	502567
500-168870-9	SB17 (2-4)	Total/NA	Solid	7471B	502567
MB 500-502567/12-A	Method Blank	Total/NA	Solid	7471B	502567
LCS 500-502567/13-A	Lab Control Sample	Total/NA	Solid	7471B	502567

Analysis Batch: 502911

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-6	SB15 (2-4)	Total/NA	Solid	6010C	502503
500-168870-6	SB15 (2-4)	Total/NA	Solid	6010C	502503

Analysis Batch: 503025

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-6	SB15 (2-4)	Total/NA	Solid	6010C	502503

General Chemistry

Analysis Batch: 502096

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-168870-1	SB10 (2-4)	Total/NA	Solid	Moisture	
500-168870-2	SB11 (2-4)	Total/NA	Solid	Moisture	
500-168870-3	SB12 (2-4)	Total/NA	Solid	Moisture	
500-168870-4	SB13 (2-4)	Total/NA	Solid	Moisture	
500-168870-5	SB14 (0-2)	Total/NA	Solid	Moisture	
500-168870-6	SB15 (2-4)	Total/NA	Solid	Moisture	
500-168870-7	SB15 (4-6)	Total/NA	Solid	Moisture	
500-168870-8	SB16 (2-4)	Total/NA	Solid	Moisture	
500-168870-9	SB17 (2-4)	Total/NA	Solid	Moisture	
500-168870-5 DU	SB14 (0-2)	Total/NA	Solid	Moisture	

Surrogate Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Solid

Prep Type: Total/NA

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(75-126)	(72-124)	(75-120)	(75-120)
500-168870-1	SB10 (2-4)	102	91	104	98
500-168870-2	SB11 (2-4)	104	91	104	97
500-168870-3	SB12 (2-4)	104	93	103	98
500-168870-4	SB13 (2-4)	105	92	105	96
500-168870-5	SB14 (0-2)	105	93	104	96
500-168870-7	SB15 (4-6)	107	89	108	95
500-168870-8	SB16 (2-4)	107	94	107	96
500-168870-9	SB17 (2-4)	102	89	105	94
LCS 500-501998/4	Lab Control Sample	95	94	98	100
MB 500-501998/6	Method Blank	103	91	107	95

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane
TOL = Toluene-d8 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Solid

Prep Type: Total/NA

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(43-145)	(37-147)	(42-157)
500-168870-1	SB10 (2-4)	88	71	109
500-168870-2	SB11 (2-4)	67	65	76
500-168870-2 - DL	SB11 (2-4)	100	76	129
500-168870-3	SB12 (2-4)	62	48	80
500-168870-4	SB13 (2-4)	75	59	85
500-168870-5	SB14 (0-2)	101	82	135
500-168870-6	SB15 (2-4)	93	74	114
500-168870-8	SB16 (2-4)	73	58	79
500-168870-8 - DL	SB16 (2-4)	0 D	0 D	0 D
500-168870-9	SB17 (2-4)	81	71	90
LCS 500-502476/2-A	Lab Control Sample	87	83	98
MB 500-502476/1-A	Method Blank	80	81	91

Surrogate Legend

FBP = 2-Fluorobiphenyl
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-501998/6
Matrix: Solid
Analysis Batch: 501998

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/Kg			08/28/19 11:03	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/Kg			08/28/19 11:03	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/Kg			08/28/19 11:03	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/Kg			08/28/19 11:03	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/Kg			08/28/19 11:03	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/Kg			08/28/19 11:03	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/Kg			08/28/19 11:03	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/Kg			08/28/19 11:03	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/Kg			08/28/19 11:03	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/Kg			08/28/19 11:03	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/Kg			08/28/19 11:03	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/Kg			08/28/19 11:03	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/Kg			08/28/19 11:03	1
1,3,5-Trimethylbenzene	<0.38		1.0	0.38	ug/Kg			08/28/19 11:03	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/Kg			08/28/19 11:03	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/Kg			08/28/19 11:03	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/Kg			08/28/19 11:03	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/Kg			08/28/19 11:03	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/Kg			08/28/19 11:03	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/Kg			08/28/19 11:03	1
Benzene	<0.15		0.25	0.15	ug/Kg			08/28/19 11:03	1
Bromobenzene	<0.36		1.0	0.36	ug/Kg			08/28/19 11:03	1
Bromochloromethane	<0.43		1.0	0.43	ug/Kg			08/28/19 11:03	1
Bromodichloromethane	<0.37		1.0	0.37	ug/Kg			08/28/19 11:03	1
Bromoform	<0.48		1.0	0.48	ug/Kg			08/28/19 11:03	1
Bromomethane	<0.80		3.0	0.80	ug/Kg			08/28/19 11:03	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/Kg			08/28/19 11:03	1
Chlorobenzene	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
Chloroethane	<0.50		1.0	0.50	ug/Kg			08/28/19 11:03	1
Chloroform	<0.37		2.0	0.37	ug/Kg			08/28/19 11:03	1
Chloromethane	<0.32		1.0	0.32	ug/Kg			08/28/19 11:03	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/Kg			08/28/19 11:03	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/Kg			08/28/19 11:03	1
Dibromochloromethane	<0.49		1.0	0.49	ug/Kg			08/28/19 11:03	1
Dibromomethane	<0.27		1.0	0.27	ug/Kg			08/28/19 11:03	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/Kg			08/28/19 11:03	1
Ethylbenzene	<0.18		0.25	0.18	ug/Kg			08/28/19 11:03	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/Kg			08/28/19 11:03	1
Isopropyl ether	<0.28		1.0	0.28	ug/Kg			08/28/19 11:03	1
Isopropylbenzene	<0.38		1.0	0.38	ug/Kg			08/28/19 11:03	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
Methylene Chloride	<1.6		5.0	1.6	ug/Kg			08/28/19 11:03	1
n-Butylbenzene	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
N-Propylbenzene	<0.41		1.0	0.41	ug/Kg			08/28/19 11:03	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/Kg			08/28/19 11:03	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-501998/6
Matrix: Solid
Analysis Batch: 501998

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/Kg			08/28/19 11:03	1
Styrene	<0.39		1.0	0.39	ug/Kg			08/28/19 11:03	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/Kg			08/28/19 11:03	1
Tetrachloroethene	<0.37		1.0	0.37	ug/Kg			08/28/19 11:03	1
Toluene	<0.15		0.25	0.15	ug/Kg			08/28/19 11:03	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/Kg			08/28/19 11:03	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/Kg			08/28/19 11:03	1
Trichloroethene	<0.16		0.50	0.16	ug/Kg			08/28/19 11:03	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/Kg			08/28/19 11:03	1
Vinyl chloride	<0.26		1.0	0.26	ug/Kg			08/28/19 11:03	1
Xylenes, Total	<0.22		0.50	0.22	ug/Kg			08/28/19 11:03	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*		*08/28/19 11:03*	*1*
4-Bromofluorobenzene (Surr)	*91*		*72 - 124*		*08/28/19 11:03*	*1*
Dibromofluoromethane	*107*		*75 - 120*		*08/28/19 11:03*	*1*
Toluene-d8 (Surr)	*95*		*75 - 120*		*08/28/19 11:03*	*1*

Lab Sample ID: LCS 500-501998/4
Matrix: Solid
Analysis Batch: 501998

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	58.3		ug/Kg		117	70 - 125
1,1,1-Trichloroethane	50.0	56.9		ug/Kg		114	70 - 125
1,1,2,2-Tetrachloroethane	50.0	57.6		ug/Kg		115	62 - 140
1,1,2-Trichloroethane	50.0	55.9		ug/Kg		112	71 - 130
1,1-Dichloroethane	50.0	47.7		ug/Kg		95	70 - 125
1,1-Dichloroethene	50.0	55.9		ug/Kg		112	67 - 122
1,1-Dichloropropene	50.0	55.1		ug/Kg		110	70 - 121
1,2,3-Trichlorobenzene	50.0	48.9		ug/Kg		98	51 - 145
1,2,3-Trichloropropane	50.0	58.0		ug/Kg		116	50 - 133
1,2,4-Trichlorobenzene	50.0	49.0		ug/Kg		98	57 - 137
1,2,4-Trimethylbenzene	50.0	50.3		ug/Kg		101	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	63.5	*	ug/Kg		127	56 - 123
1,2-Dibromoethane	50.0	57.1		ug/Kg		114	70 - 125
1,2-Dichlorobenzene	50.0	50.6		ug/Kg		101	70 - 125
1,2-Dichloroethane	50.0	48.6		ug/Kg		97	68 - 127
1,2-Dichloropropane	50.0	48.2		ug/Kg		96	67 - 130
1,3,5-Trimethylbenzene	50.0	52.1		ug/Kg		104	70 - 123
1,3-Dichlorobenzene	50.0	52.5		ug/Kg		105	70 - 125
1,3-Dichloropropane	50.0	54.6		ug/Kg		109	62 - 136
1,4-Dichlorobenzene	50.0	53.0		ug/Kg		106	70 - 120
2,2-Dichloropropane	50.0	51.3		ug/Kg		103	58 - 139
2-Chlorotoluene	50.0	51.1		ug/Kg		102	70 - 125
4-Chlorotoluene	50.0	50.4		ug/Kg		101	68 - 124
Benzene	50.0	51.9		ug/Kg		104	70 - 120
Bromobenzene	50.0	53.4		ug/Kg		107	70 - 122

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-501998/4
Matrix: Solid
Analysis Batch: 501998

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromochloromethane	50.0	55.7		ug/Kg		111	65 - 122
Bromodichloromethane	50.0	55.4		ug/Kg		111	69 - 120
Bromoform	50.0	74.7	*	ug/Kg		149	56 - 132
Bromomethane	50.0	47.5		ug/Kg		95	40 - 152
Carbon tetrachloride	50.0	66.1		ug/Kg		132	59 - 133
Chlorobenzene	50.0	51.6		ug/Kg		103	70 - 120
Chloroethane	50.0	38.2		ug/Kg		76	48 - 136
Chloroform	50.0	51.3		ug/Kg		103	70 - 120
Chloromethane	50.0	33.0		ug/Kg		66	56 - 152
cis-1,2-Dichloroethene	50.0	53.7		ug/Kg		107	70 - 125
cis-1,3-Dichloropropene	50.0	52.1		ug/Kg		104	64 - 127
Dibromochloromethane	50.0	62.4		ug/Kg		125	68 - 125
Dibromomethane	50.0	53.6		ug/Kg		107	70 - 120
Dichlorodifluoromethane	50.0	36.3		ug/Kg		73	40 - 159
Ethylbenzene	50.0	57.1		ug/Kg		114	70 - 123
Hexachlorobutadiene	50.0	47.1		ug/Kg		94	51 - 150
Isopropylbenzene	50.0	53.9		ug/Kg		108	70 - 126
Methyl tert-butyl ether	50.0	51.5		ug/Kg		103	55 - 123
Methylene Chloride	50.0	54.2		ug/Kg		108	69 - 125
Naphthalene	50.0	52.9		ug/Kg		106	53 - 144
n-Butylbenzene	50.0	51.6		ug/Kg		103	68 - 125
N-Propylbenzene	50.0	52.6		ug/Kg		105	69 - 127
p-Isopropyltoluene	50.0	53.1		ug/Kg		106	70 - 125
sec-Butylbenzene	50.0	53.7		ug/Kg		107	70 - 123
Styrene	50.0	53.1		ug/Kg		106	70 - 120
tert-Butylbenzene	50.0	52.3		ug/Kg		105	70 - 121
Tetrachloroethene	50.0	58.2		ug/Kg		116	70 - 128
Toluene	50.0	50.3		ug/Kg		101	70 - 125
trans-1,2-Dichloroethene	50.0	54.2		ug/Kg		108	70 - 125
trans-1,3-Dichloropropene	50.0	53.8		ug/Kg		108	62 - 128
Trichloroethene	50.0	56.2		ug/Kg		112	70 - 125
Trichlorofluoromethane	50.0	50.5		ug/Kg		101	55 - 128
Vinyl chloride	50.0	37.9		ug/Kg		76	64 - 126
Xylenes, Total	100	108		ug/Kg		108	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*95*		*75 - 126*
4-Bromofluorobenzene (Surr)	*94*		*72 - 124*
Dibromofluoromethane	*98*		*75 - 120*
Toluene-d8 (Surr)	*100*		*75 - 120*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-502476/1-A
Matrix: Solid
Analysis Batch: 502643

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 502476

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<8.1		67	8.1	ug/Kg		08/30/19 07:35	08/30/19 20:39	1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-502476/1-A
Matrix: Solid
Analysis Batch: 502643

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 502476

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2-Methylnaphthalene	<6.1		67	6.1	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Acenaphthene	<6.0		33	6.0	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Acenaphthylene	<4.4		33	4.4	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Anthracene	<5.6		33	5.6	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Benzo[a]anthracene	<4.5		33	4.5	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Benzo[a]pyrene	<6.4		33	6.4	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Benzo[b]fluoranthene	<7.2		33	7.2	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Benzo[g,h,i]perylene	<11		33	11	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Benzo[k]fluoranthene	<9.8		33	9.8	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Chrysene	<9.1		33	9.1	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Dibenz(a,h)anthracene	<6.4		33	6.4	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Fluoranthene	<6.2		33	6.2	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Fluorene	<4.7		33	4.7	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Indeno[1,2,3-cd]pyrene	<8.6		33	8.6	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Naphthalene	<5.1		33	5.1	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Phenanthrene	<4.6		33	4.6	ug/Kg		08/30/19 07:35	08/30/19 20:39	1
Pyrene	<6.6		33	6.6	ug/Kg		08/30/19 07:35	08/30/19 20:39	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*80*		*43 - 145*	*08/30/19 07:35*	*08/30/19 20:39*	*1*
Nitrobenzene-d5 (Surr)	*81*		*37 - 147*	*08/30/19 07:35*	*08/30/19 20:39*	*1*
Terphenyl-d14 (Surr)	*91*		*42 - 157*	*08/30/19 07:35*	*08/30/19 20:39*	*1*

Lab Sample ID: LCS 500-502476/2-A
Matrix: Solid
Analysis Batch: 502643

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 502476

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	1330	1090		ug/Kg		82	68 - 111
2-Methylnaphthalene	1330	1180		ug/Kg		89	69 - 112
Acenaphthene	1330	1190		ug/Kg		89	65 - 124
Acenaphthylene	1330	1200		ug/Kg		90	68 - 120
Anthracene	1330	1230		ug/Kg		92	70 - 114
Benzo[a]anthracene	1330	1320		ug/Kg		99	67 - 122
Benzo[a]pyrene	1330	1240		ug/Kg		93	65 - 133
Benzo[b]fluoranthene	1330	1290		ug/Kg		97	69 - 129
Benzo[g,h,i]perylene	1330	1280		ug/Kg		96	72 - 131
Benzo[k]fluoranthene	1330	1150		ug/Kg		86	68 - 127
Chrysene	1330	1260		ug/Kg		95	63 - 120
Dibenz(a,h)anthracene	1330	1250		ug/Kg		94	64 - 131
Fluoranthene	1330	1220		ug/Kg		91	62 - 120
Fluorene	1330	1110		ug/Kg		83	62 - 120
Indeno[1,2,3-cd]pyrene	1330	1270		ug/Kg		96	68 - 130
Naphthalene	1330	1150		ug/Kg		86	63 - 110
Phenanthrene	1330	1160		ug/Kg		87	62 - 120
Pyrene	1330	1270		ug/Kg		96	61 - 128

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-502476/2-A
Matrix: Solid
Analysis Batch: 502643

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 502476

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl	*87*		*43 - 145*
Nitrobenzene-d5 (Surr)	*83*		*37 - 147*
Terphenyl-d14 (Surr)	*98*		*42 - 157*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 500-502503/1-A
Matrix: Solid
Analysis Batch: 502784

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 502503

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.34		1.0	0.34	mg/Kg		08/30/19 08:24	08/30/19 15:39	1
Barium	<0.11		1.0	0.11	mg/Kg		08/30/19 08:24	08/30/19 15:39	1
Cadmium	0.0373	J	0.20	0.036	mg/Kg		08/30/19 08:24	08/30/19 15:39	1
Chromium	<0.50		1.0	0.50	mg/Kg		08/30/19 08:24	08/30/19 15:39	1
Lead	<0.23		0.50	0.23	mg/Kg		08/30/19 08:24	08/30/19 15:39	1
Selenium	<0.59		1.0	0.59	mg/Kg		08/30/19 08:24	08/30/19 15:39	1
Silver	<0.13		0.50	0.13	mg/Kg		08/30/19 08:24	08/30/19 15:39	1

Lab Sample ID: LCS 500-502503/2-A
Matrix: Solid
Analysis Batch: 502784

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 502503

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	10.0	9.59		mg/Kg		96	80 - 120
Barium	200	195		mg/Kg		98	80 - 120
Cadmium	5.00	4.78		mg/Kg		96	80 - 120
Chromium	20.0	19.6		mg/Kg		98	80 - 120
Lead	10.0	9.59		mg/Kg		96	80 - 120
Selenium	10.0	8.93		mg/Kg		89	80 - 120
Silver	5.00	4.57		mg/Kg		91	80 - 120

Method: 7471B - Mercury (CVAA)

Lab Sample ID: MB 500-502567/12-A
Matrix: Solid
Analysis Batch: 502896

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 502567

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.0056		0.017	0.0056	mg/Kg		08/30/19 15:10	09/03/19 08:34	1

Lab Sample ID: LCS 500-502567/13-A
Matrix: Solid
Analysis Batch: 502896

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 502567

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.167	0.186		mg/Kg		111	80 - 120

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB10 (2-4)
Date Collected: 08/21/19 09:33
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB10 (2-4)
Date Collected: 08/21/19 09:33
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-1
Matrix: Solid
Percent Solids: 83.2

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 09:33	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 13:45	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		1	502655	08/30/19 21:17	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 16:52	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 08:38	MJG	TAL CHI

Client Sample ID: SB11 (2-4)
Date Collected: 08/21/19 10:35
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB11 (2-4)
Date Collected: 08/21/19 10:35
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-2
Matrix: Solid
Percent Solids: 83.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 10:35	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 14:12	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		5	502655	08/30/19 23:35	NRJ	TAL CHI
Total/NA	Prep	3541	DL		502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D	DL	10	502930	09/04/19 00:19	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 16:56	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 08:40	MJG	TAL CHI

Client Sample ID: SB12 (2-4)
Date Collected: 08/21/19 09:58
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB12 (2-4)

Lab Sample ID: 500-168870-3
Date Collected: 08/21/19 09:58
Matrix: Solid
Date Received: 08/23/19 08:45
Percent Solids: 81.8

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 09:58	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 14:38	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		5	502655	08/31/19 00:03	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 17:00	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 08:42	MJG	TAL CHI

Client Sample ID: SB13 (2-4)

Lab Sample ID: 500-168870-4
Date Collected: 08/21/19 11:06
Matrix: Solid
Date Received: 08/23/19 08:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB13 (2-4)

Lab Sample ID: 500-168870-4
Date Collected: 08/21/19 11:06
Matrix: Solid
Date Received: 08/23/19 08:45
Percent Solids: 83.5

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 11:05	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 15:05	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		1	502655	08/30/19 21:44	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 17:04	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 08:46	MJG	TAL CHI

Client Sample ID: SB14 (0-2)

Lab Sample ID: 500-168870-5
Date Collected: 08/21/19 11:50
Matrix: Solid
Date Received: 08/23/19 08:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB14 (0-2)

Lab Sample ID: 500-168870-5
Date Collected: 08/21/19 11:50
Matrix: Solid
Date Received: 08/23/19 08:45
Percent Solids: 90.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 11:50	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 15:32	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		1	502655	08/30/19 20:49	NRJ	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB14 (0-2)

Date Collected: 08/21/19 11:50
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-5

Matrix: Solid
Percent Solids: 90.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 17:16	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 08:55	MJG	TAL CHI

Client Sample ID: SB15 (2-4)

Date Collected: 08/21/19 12:11
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-6

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB15 (2-4)

Date Collected: 08/21/19 12:11
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-6

Matrix: Solid
Percent Solids: 89.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		1	502655	08/30/19 22:12	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		5	502911	09/03/19 10:53	EEN	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		50	502911	09/03/19 11:33	EEN	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 17:20	JEF	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		5	503025	09/03/19 16:09	EEN	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		20	502896	09/03/19 11:42	MJG	TAL CHI

Client Sample ID: SB15 (4-6)

Date Collected: 08/21/19 12:14
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-7

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB15 (4-6)

Date Collected: 08/21/19 12:14
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-7

Matrix: Solid
Percent Solids: 84.5

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 12:14	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 15:59	JLC	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt, Kaukauna 193706620

Job ID: 500-168870-1

Client Sample ID: SB16 (2-4)
Date Collected: 08/21/19 12:55
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-8
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB16 (2-4)
Date Collected: 08/21/19 12:55
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-8
Matrix: Solid
Percent Solids: 87.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 12:55	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 16:26	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		10	502655	08/30/19 22:40	NRJ	TAL CHI
Total/NA	Prep	3541	DL		502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D	DL	20	502930	09/04/19 00:45	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 17:24	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 09:05	MJG	TAL CHI

Client Sample ID: SB17 (2-4)
Date Collected: 08/21/19 13:26
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-9
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	502096	08/28/19 12:28	LWN	TAL CHI

Client Sample ID: SB17 (2-4)
Date Collected: 08/21/19 13:26
Date Received: 08/23/19 08:45

Lab Sample ID: 500-168870-9
Matrix: Solid
Percent Solids: 87.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			501507	08/21/19 13:26	WRE	TAL CHI
Total/NA	Analysis	8260B		50	501998	08/28/19 16:54	JLC	TAL CHI
Total/NA	Prep	3541			502476	08/30/19 07:35	DX	TAL CHI
Total/NA	Analysis	8270D		10	502655	08/30/19 23:07	NRJ	TAL CHI
Total/NA	Prep	3050B			502503	08/30/19 08:24	SAH	TAL CHI
Total/NA	Analysis	6010C		1	502784	08/30/19 17:28	JEF	TAL CHI
Total/NA	Prep	7471B			502567	08/30/19 15:10	MJG	TAL CHI
Total/NA	Analysis	7471B		1	502896	09/03/19 09:07	MJG	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Stantec Consulting Corp. Job ID: 500-168870-1
Project/Site: Fox Shores Apt, Kaukauna 193706620

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State Program	999580010	08-31-20

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins | Environment Testing TestAmerica

Client Information	Sampler:	Lab PM: Fredrick, Sandie	Carrier: 500-168870 COC	COC No: 500-74296-34609.1
Client Contact: Mr. Jeff Brand	Phone: 920-883-8501	E-Mail: sandie.fredrick@testamericainc.com		Page: Page 1 of 1
Company: Stantec Consulting Corp.				Job #: 500-168870
Address: 1165 Scheuring Road	Due Date Requested:			
City: De Pere	TAT Requested (days):			
State, Zip: WI, 54115				
Phone:	PO #: 193706620			
Email: Jeff.Brand@stantec.com	WO #:			
Project Name: Fox Shores Apt, Kaukauna 193706620	Project #: 50009659			
Site:	SSOW#:			

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=wasteoil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 7471B, 8270D	8260B - VOC	8270D - PAH	6020A, 7470A	8260B - VOC	RCRA Metals	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	N	N	D	A			
SB10 (2-4)	8-21-19	933	G	Solid				X	X			X		
SB11 (2-4)		1035	G	Solid				X	X			X		
SB12 (2-4)		958	G	Solid				X	X			X		
SB13 (2-4)		1106	G	Solid				X	X			X		
SB14 (0-2)		1150	G	Solid				X	X			X		
SB15 (2-4)		1211	G	Solid					X			X		
SB15 (4-6)		1214	G	Solid				X						
SB16 (2-4)		1255	G	Solid				X	X			X		
SB17 (2-4)		1326	G	~~Water~~ Solid				X	X			X		
				Water										
				Water										

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

1 2 3 4 5 6 7 8 9

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	8-22-19 15:00			8/23/19 0845	TA
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: △ Yes △ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 1.2 -2.7

1-48 ort.



TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Part # 159469-494 RT2 EXP 05/19

500-168870 Waybill

ORIGIN ID:RRLA (262) 202-5955
JEFF BRAND
STANTEC
1165 SCHEURING ROAD
DE PERE, WI 54115
UNITED STATES US

SHIP DATE: 05AUG19
ACTWGT: 25.00 LB MAN
CAD: 525155/CAFE3211

TO

TESTAMERICA CHICAGO
2417 BOND STREET

UNIVERSITY PARK IL 60484-3101
(708) 534-5200 REF:
INV:
PO: DEPT:

RMA:

FedEx Express

E

J181113060501dx

FedEx
TRK# 0221 7125 4940 5776

FRI - 23 AUG 10:30A
PRIORITY OVERNIGHT

NA JOTA

60484
IL-US
ORD

FID 6006119 22AUG19 GRDA 668C2/F661/0C0A

Login Sample Receipt Checklist

Client: Stantec Consulting Corp.

Job Number: 500-168870-1

Login Number: 168870
List Number: 1
Creator: James, Jeff A

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	2.7
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

eurofins | Environment Testing TestAmerica



ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-180867-1
Client Project/Site: Fox Shores Kaukauna - 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Tyler Hischke

Authorized for release by:
5/1/2020 12:21:31 PM

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Detection Summary 4
Method Summary 12
Sample Summary 13
Client Sample Results 14
Definitions 68
QC Association 69
Surrogate Summary 75
QC Sample Results 77
Chronicle 90
Certification Summary 98
Chain of Custody 99
Receipt Checklists 101

Case Narrative

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Job ID: 500-180867-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-180867-1

Comments
No additional comments.

Receipt
The samples were received on 4/17/2020 9:45 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperatures of the 2 coolers at receipt time were 0.5º C and 2.6º C.

Receipt Exceptions
A trip blank was submitted for analysis with these samples; however, it was not listed on the Chain of Custody (COC). Added to COC and logged in.

GC/MS VOA
Method 8260B: The laboratory control sample (LCS) for batches 539816 and 539811 recovered outside control limits for Bromomethane. This analyte was biased high in the LCSs and was not detected in the associated samples; therefore, the data have been reported.HA-1 (500-180867-1), HA-2 (500-180867-2), HA-3 (500-180867-3), HA-4 (500-180867-4), HA-5 (500-180867-5), HA-6 (500-180867-6), HA-7 (500-180867-7), HA-8 (500-180867-8), HA-9 (500-180867-9), HA-10 (500-180867-10), HA-11 (500-180867-11), HA-12 (500-180867-12), TW-10 (500-180867-14), TW-11 (500-180867-15), TW-13 (500-180867-16), TW-15 (500-180867-17), TW-17 (500-180867-18) and Trip Blank (500-180867-19)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method 8270D: The following samples were diluted due to the nature of the sample matrix: HA-2 (500-180867-2), HA-3 (500-180867-3), HA-4 (500-180867-4), HA-5 (500-180867-5), HA-6 (500-180867-6), HA-10 (500-180867-10) and HA-11 (500-180867-11). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Field Service / Mobile Lab
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1

Lab Sample ID: 500-180867-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	24	J	81	9.8	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	30	J	81	7.4	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	9.5	J	40	5.3	ug/Kg	1	☼	8270D	Total/NA
Anthracene	18	J	40	6.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	92		40	5.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	110		40	7.8	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	150		40	8.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	74		40	13	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	65		40	12	ug/Kg	1	☼	8270D	Total/NA
Chrysene	130		40	11	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	190		40	7.4	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	63		40	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	17	J	40	6.2	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	100		40	5.6	ug/Kg	1	☼	8270D	Total/NA
Pyrene	190		40	8.0	ug/Kg	1	☼	8270D	Total/NA
Arsenic	3.5		1.1	0.39	mg/Kg	1	☼	6010C	Total/NA
Barium	79		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.24		0.23	0.041	mg/Kg	1	☼	6010C	Total/NA
Chromium	26		1.1	0.57	mg/Kg	1	☼	6010C	Total/NA
Lead	73		0.57	0.26	mg/Kg	1	☼	6010C	Total/NA
Silver	0.45	J	0.57	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.070		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-2

Lab Sample ID: 500-180867-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	28		18	11	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	64		37	16	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	390	J	410	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	410		410	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	52	J	200	36	ug/Kg	5	☼	8270D	Total/NA
Anthracene	160	J	200	34	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	950		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1200		200	39	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	1800		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	460		200	65	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	730		200	59	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1300		200	55	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	120	J	200	39	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2300		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	55	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	420		200	52	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	240		200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1400		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2000		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	11		1.1	0.38	mg/Kg	1	☼	6010C	Total/NA
Barium	61		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	2.6		0.22	0.040	mg/Kg	1	☼	6010C	Total/NA
Chromium	15		1.1	0.55	mg/Kg	1	☼	6010C	Total/NA
Lead	470		0.55	0.26	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.0	J	1.1	0.65	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-2 (Continued)

Lab Sample ID: 500-180867-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Silver	0.97		0.55	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.19		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-3

Lab Sample ID: 500-180867-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	42	J	70	25	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	24		17	13	ug/Kg	50	☼	8260B	Total/NA
Toluene	74		17	10	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	130		35	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	340	J	400	48	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	410		400	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	56	J	200	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	41	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	180	J	200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	1200		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1400		200	38	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	2000		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	820		200	63	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	780		200	58	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1600		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	140	J	200	38	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2500		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	61	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	710		200	51	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	260		200	30	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1500		200	27	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2300		200	39	ug/Kg	5	☼	8270D	Total/NA
Arsenic	11		1.2	0.40	mg/Kg	1	☼	6010C	Total/NA
Barium	56		1.2	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.92		0.24	0.043	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.2	0.59	mg/Kg	1	☼	6010C	Total/NA
Lead	220		0.59	0.27	mg/Kg	1	☼	6010C	Total/NA
Selenium	0.74	J	1.2	0.70	mg/Kg	1	☼	6010C	Total/NA
Silver	0.56	J	0.59	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.32		0.020	0.0065	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-4

Lab Sample ID: 500-180867-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	56	J	65	23	ug/Kg	50	☼	8260B	Total/NA
Benzene	18		16	9.5	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	26		16	12	ug/Kg	50	☼	8260B	Total/NA
Toluene	77		16	9.6	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	160		32	14	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	420		400	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	460		400	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	190	J	200	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	150	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	540		200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	2400		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	2700		200	39	ug/Kg	5	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-4 (Continued)

Lab Sample ID: 500-180867-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[b]fluoranthene	3600		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	890		200	64	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	1200		200	59	ug/Kg	5	☼	8270D	Total/NA
Chrysene	2800		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	250		200	39	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	4800		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	160	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	870		200	52	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	410		200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	3100		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	4900		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	6.7		1.1	0.39	mg/Kg	1	☼	6010C	Total/NA
Barium	59		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.1		0.23	0.041	mg/Kg	1	☼	6010C	Total/NA
Chromium	13		1.1	0.57	mg/Kg	1	☼	6010C	Total/NA
Lead	140		0.57	0.26	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.1		1.1	0.67	mg/Kg	1	☼	6010C	Total/NA
Silver	0.78		0.57	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.12		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-5

Lab Sample ID: 500-180867-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	77		68	24	ug/Kg	50	☼	8260B	Total/NA
Benzene	140		17	10	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	49		17	13	ug/Kg	50	☼	8260B	Total/NA
Toluene	260		17	10	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	270		34	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	220	J	400	48	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	300	J	400	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	80	J	200	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	64	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	200		200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	1100		200	26	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1400		200	38	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	2200		200	42	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	510		200	63	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	730		200	58	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1400		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	180	J	200	38	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2100		200	36	ug/Kg	5	☼	8270D	Total/NA
Fluorene	51	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	480		200	51	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	290		200	30	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1200		200	27	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2100		200	39	ug/Kg	5	☼	8270D	Total/NA
Arsenic	8.1		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	55		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.64		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	160		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-5 (Continued)

Lab Sample ID: 500-180867-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Silver	0.45	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.15		0.018	0.0061	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-6

Lab Sample ID: 500-180867-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	13	J	17	9.8	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	25	J	33	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	120	J	390	47	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	120	J	390	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	190		190	34	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	39	J	190	25	ug/Kg	5	☼	8270D	Total/NA
Anthracene	400		190	32	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	1300		190	26	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1400		190	37	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	1900		190	41	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	440		190	62	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	570		190	56	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1300		190	52	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	100	J	190	37	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2400		190	35	ug/Kg	5	☼	8270D	Total/NA
Fluorene	160	J	190	27	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	320		190	50	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	150	J	190	29	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1900		190	27	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2300		190	38	ug/Kg	5	☼	8270D	Total/NA
Arsenic	6.8		1.0	0.35	mg/Kg	1	☼	6010C	Total/NA
Barium	37		1.0	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.36		0.21	0.037	mg/Kg	1	☼	6010C	Total/NA
Chromium	12		1.0	0.51	mg/Kg	1	☼	6010C	Total/NA
Lead	91		0.52	0.24	mg/Kg	1	☼	6010C	Total/NA
Silver	0.27	J	0.52	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.053		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-7

Lab Sample ID: 500-180867-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Xylenes, Total	53		33	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	86		79	9.5	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	100		79	7.2	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	49		39	7.0	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	41		39	5.1	ug/Kg	1	☼	8270D	Total/NA
Anthracene	100		39	6.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	440		39	5.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	450		39	7.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	580		39	8.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	180		39	13	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	260		39	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	480		39	11	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	41		39	7.5	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	760		39	7.2	ug/Kg	1	☼	8270D	Total/NA
Fluorene	43		39	5.5	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-7 (Continued)

Lab Sample ID: 500-180867-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Indeno[1,2,3-cd]pyrene	170		39	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	81		39	6.0	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	630		39	5.4	ug/Kg	1	☼	8270D	Total/NA
Pyrene	800		39	7.7	ug/Kg	1	☼	8270D	Total/NA
Arsenic	5.0		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	44		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.43		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	86		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.53	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.041		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-8

Lab Sample ID: 500-180867-8

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	23	J	65	23	ug/Kg	50	☼	8260B	Total/NA
Benzene	19		16	9.4	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	18		16	12	ug/Kg	50	☼	8260B	Total/NA
Toluene	49		16	9.5	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	67		32	14	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	100		75	9.1	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	140		75	6.8	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	100		37	6.7	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	140		37	4.9	ug/Kg	1	☼	8270D	Total/NA
Anthracene	310		37	6.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	1100		37	5.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	1200		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	1600		37	8.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	340		37	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	630		37	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	1200		37	10	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	100		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	2300		37	6.9	ug/Kg	1	☼	8270D	Total/NA
Fluorene	96		37	5.2	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	330		37	9.6	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	160		37	5.7	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	1600		37	5.2	ug/Kg	1	☼	8270D	Total/NA
Pyrene	2600		37	7.4	ug/Kg	1	☼	8270D	Total/NA
Arsenic	6.2		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	54		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.58		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	150		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.51	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.080		0.018	0.0061	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-9

Lab Sample ID: 500-180867-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	21	J	73	8.9	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	35	J	73	6.7	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	14	J	36	6.5	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-9 (Continued)

Lab Sample ID: 500-180867-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Acenaphthylene	14	J	36	4.8	ug/Kg	1	☼	8270D	Total/NA
Anthracene	48		36	6.1	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	180		36	4.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	170		36	7.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	210		36	7.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	100		36	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	55		36	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	190		36	9.9	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	24	J	36	7.0	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	300		36	6.8	ug/Kg	1	☼	8270D	Total/NA
Fluorene	12	J	36	5.1	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	93		36	9.4	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	25	J	36	5.6	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	240		36	5.1	ug/Kg	1	☼	8270D	Total/NA
Pyrene	300		36	7.2	ug/Kg	1	☼	8270D	Total/NA
Arsenic	3.0		1.1	0.38	mg/Kg	1	☼	6010C	Total/NA
Barium	37		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.18	J	0.22	0.040	mg/Kg	1	☼	6010C	Total/NA
Chromium	13		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	53		0.55	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.23	J	0.55	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.16		0.018	0.0059	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-10

Lab Sample ID: 500-180867-10

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	23		17	9.7	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	46		33	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	120	J	380	46	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	160	J	380	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	40	J	190	34	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	44	J	190	25	ug/Kg	5	☼	8270D	Total/NA
Anthracene	150	J	190	31	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	530		190	25	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	620		190	36	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	1000		190	41	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	150	J	190	61	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	250		190	55	ug/Kg	5	☼	8270D	Total/NA
Chrysene	720		190	51	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	980		190	35	ug/Kg	5	☼	8270D	Total/NA
Fluorene	35	J	190	26	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	220		190	49	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	150	J	190	29	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	600		190	26	ug/Kg	5	☼	8270D	Total/NA
Pyrene	970		190	37	ug/Kg	5	☼	8270D	Total/NA
Arsenic	5.0		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	41		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.44		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	190		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.36	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-10 (Continued)

Lab Sample ID: 500-180867-10

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Mercury	0.22		0.018	0.0059	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-11

Lab Sample ID: 500-180867-11

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	230	J	410	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	390	J	410	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	33	J	200	27	ug/Kg	5	☼	8270D	Total/NA
Anthracene	140	J	200	34	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	350		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	370		200	39	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	350		200	44	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	120	J	200	60	ug/Kg	5	☼	8270D	Total/NA
Chrysene	460		200	55	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	530		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	59	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	130	J	200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	650		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	690		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	7.9		1.0	0.35	mg/Kg	1	☼	6010C	Total/NA
Barium	70		1.0	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.83		0.21	0.037	mg/Kg	1	☼	6010C	Total/NA
Chromium	19		1.0	0.51	mg/Kg	1	☼	6010C	Total/NA
Lead	250		0.52	0.24	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.1		1.0	0.61	mg/Kg	1	☼	6010C	Total/NA
Silver	0.82		0.52	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.19		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[a]anthracene	36	J	37	5.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	37		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	46		37	8.1	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	22	J	37	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	18	J	37	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	43		37	10	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	57		37	6.9	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	23	J	37	9.7	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	17	J	37	5.2	ug/Kg	1	☼	8270D	Total/NA
Pyrene	59		37	7.4	ug/Kg	1	☼	8270D	Total/NA
Arsenic	2.0		0.97	0.33	mg/Kg	1	☼	6010C	Total/NA
Barium	31		0.97	0.11	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.040	J	0.19	0.035	mg/Kg	1	☼	6010C	Total/NA
Chromium	14		0.97	0.48	mg/Kg	1	☼	6010C	Total/NA
Lead	7.2		0.49	0.22	mg/Kg	1	☼	6010C	Total/NA
Silver	0.13	J	0.49	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.0083	J	0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: Soil-Composite-1

Lab Sample ID: 500-180867-13

No Detections.

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Stantec Consulting Corp.
Job ID: 500-180867-1
Project/Site: Fox Shores Kaukauna - 193706620

Client Sample ID: TW-10
Lab Sample ID: 500-180867-14

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	0.56	J	1.0	0.23	ug/L	1		6020A	Dissolved
Barium	29		2.5	0.73	ug/L	1		6020A	Dissolved
Selenium	1.3	J	2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW-11
Lab Sample ID: 500-180867-15

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	5.2		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	330		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: TW-13
Lab Sample ID: 500-180867-16

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	0.77	J	1.0	0.23	ug/L	1		6020A	Dissolved
Barium	91		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: TW-15
Lab Sample ID: 500-180867-17

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	3.9		1.0	0.36	ug/L	1		8260B	Total/NA
1,3,5-Trimethylbenzene	2.4		1.0	0.25	ug/L	1		8260B	Total/NA
Ethylbenzene	0.21	J	0.50	0.18	ug/L	1		8260B	Total/NA
Isopropylbenzene	2.9		1.0	0.39	ug/L	1		8260B	Total/NA
n-Butylbenzene	9.2		1.0	0.39	ug/L	1		8260B	Total/NA
N-Propylbenzene	4.6		1.0	0.41	ug/L	1		8260B	Total/NA
p-Isopropyltoluene	2.1		1.0	0.36	ug/L	1		8260B	Total/NA
sec-Butylbenzene	3.6		1.0	0.40	ug/L	1		8260B	Total/NA
Xylenes, Total	1.6		1.0	0.22	ug/L	1		8260B	Total/NA
Arsenic	2.0		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	47		2.5	0.73	ug/L	1		6020A	Dissolved
Selenium	7.9		2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW-17
Lab Sample ID: 500-180867-18

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[a]anthracene	0.21		0.18	0.050	ug/L	1		8270D	Total/NA
Benzo[a]pyrene	0.36		0.18	0.087	ug/L	1		8270D	Total/NA
Benzo[b]fluoranthene	0.29		0.18	0.071	ug/L	1		8270D	Total/NA
Benzo[k]fluoranthene	0.23		0.18	0.056	ug/L	1		8270D	Total/NA
Chrysene	0.17	J	0.18	0.060	ug/L	1		8270D	Total/NA
Indeno[1,2,3-cd]pyrene	0.23		0.18	0.066	ug/L	1		8270D	Total/NA
Phenanthrene	0.29	J	0.88	0.27	ug/L	1		8270D	Total/NA
Arsenic	1.3		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	67		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: Trip Blank
Lab Sample ID: 500-180867-19

No Detections.

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL CHI
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL CHI
6010C	Metals (ICP)	SW846	TAL CHI
6020A	Metals (ICP/MS)	SW846	TAL CHI
7470A	Mercury (CVAA)	SW846	TAL CHI
7471B	Mercury (CVAA)	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
1311	TCLP Extraction	SW846	TAL CHI
3005A	Preparation, Total Recoverable or Dissolved Metals	SW846	TAL CHI
3010A	Preparation, Total Metals	SW846	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
3510C	Liquid-Liquid Extraction (Separatory Funnel)	SW846	TAL CHI
3541	Automated Soxhlet Extraction	SW846	TAL CHI
5030B	Purge and Trap	SW846	TAL CHI
5035	Closed System Purge and Trap	SW846	TAL CHI
7470A	Preparation, Mercury	SW846	TAL CHI
7471B	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
500-180867-1	HA-1	Solid	04/15/20 08:45	04/17/20 09:45	
500-180867-2	HA-2	Solid	04/15/20 09:10	04/17/20 09:45	
500-180867-3	HA-3	Solid	04/15/20 09:25	04/17/20 09:45	
500-180867-4	HA-4	Solid	04/15/20 09:50	04/17/20 09:45	
500-180867-5	HA-5	Solid	04/15/20 10:05	04/17/20 09:45	
500-180867-6	HA-6	Solid	04/15/20 10:25	04/17/20 09:45	
500-180867-7	HA-7	Solid	04/15/20 10:40	04/17/20 09:45	
500-180867-8	HA-8	Solid	04/15/20 10:55	04/17/20 09:45	
500-180867-9	HA-9	Solid	04/15/20 11:15	04/17/20 09:45	
500-180867-10	HA-10	Solid	04/15/20 11:30	04/17/20 09:45	
500-180867-11	HA-11	Solid	04/15/20 11:50	04/17/20 09:45	
500-180867-12	HA-12	Solid	04/15/20 12:10	04/17/20 09:45	
500-180867-13	Soil-Composite-1	Solid	04/15/20 12:40	04/17/20 09:45	
500-180867-14	TW-10	Water	04/16/20 08:50	04/17/20 09:45	
500-180867-15	TW-11	Water	04/16/20 11:15	04/17/20 09:45	
500-180867-16	TW-13	Water	04/16/20 09:40	04/17/20 09:45	
500-180867-17	TW-15	Water	04/16/20 10:20	04/17/20 09:45	
500-180867-18	TW-17	Water	04/16/20 12:00	04/17/20 09:45	
500-180867-19	Trip Blank	Water	04/16/20 00:00	04/17/20 09:45	

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<33		72	33	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1,1-Trichloroethane	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1,2,2-Tetrachloroethane	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1,2-Trichloroethane	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1-Dichloroethane	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1-Dichloroethene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1-Dichloropropene	<22		72	22	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,3-Trichlorobenzene	<33		72	33	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,3-Trichloropropane	<30		140	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,4-Trichlorobenzene	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,4-Trimethylbenzene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dibromo-3-Chloropropane	<140		360	140	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dibromoethane	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dichlorobenzene	<24		72	24	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dichloroethane	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dichloropropane	<31		72	31	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,3,5-Trimethylbenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,3-Dichlorobenzene	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,3-Dichloropropane	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,4-Dichlorobenzene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
2,2-Dichloropropane	<32		72	32	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
2-Chlorotoluene	<23		72	23	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
4-Chlorotoluene	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Benzene	<11		18	11	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromobenzene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromochloromethane	<31		72	31	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromodichloromethane	<27		72	27	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromoform	<35		72	35	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromomethane	<58	*	220	58	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Carbon tetrachloride	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chlorobenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chloroethane	<36		72	36	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chloroform	<27		140	27	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chloromethane	<23		72	23	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
cis-1,2-Dichloroethene	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
cis-1,3-Dichloropropene	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Dibromochloromethane	<35		72	35	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Dibromomethane	<20		72	20	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Ethylbenzene	<13		18	13	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Hexachlorobutadiene	<32		72	32	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Isopropyl ether	<20		72	20	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Isopropylbenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Methyl tert-butyl ether	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Methylene Chloride	<120		360	120	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
n-Butylbenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
N-Propylbenzene	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
p-Isopropyltoluene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
sec-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
tert-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Tetrachloroethene	<27		72	27	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Toluene	<11		18	11	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
trans-1,2-Dichloroethene	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
trans-1,3-Dichloropropene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Trichloroethene	<12		36	12	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Trichlorofluoromethane	<31		72	31	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Vinyl chloride	<19		72	19	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Xylenes, Total	<16		36	16	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*94*		*75 - 126*	*04/15/20 08:45*	*04/27/20 11:22*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*04/15/20 08:45*	*04/27/20 11:22*	*50*
Dibromofluoromethane (Surr)	*98*		*75 - 120*	*04/15/20 08:45*	*04/27/20 11:22*	*50*
Toluene-d8 (Surr)	*107*		*75 - 120*	*04/15/20 08:45*	*04/27/20 11:22*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**24**	**J**	81	9.8	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
2-Methylnaphthalene	**30**	**J**	81	7.4	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Acenaphthene	<7.2		40	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Acenaphthylene	**9.5**	**J**	40	5.3	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Anthracene	**18**	**J**	40	6.7	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[a]anthracene	**92**		40	5.4	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[a]pyrene	**110**		40	7.8	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[b]fluoranthene	**150**		40	8.7	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[g,h,i]perylene	**74**		40	13	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[k]fluoranthene	**65**		40	12	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Chrysene	**130**		40	11	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Dibenz(a,h)anthracene	<7.8		40	7.8	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Fluoranthene	**190**		40	7.4	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Fluorene	<5.6		40	5.6	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Indeno[1,2,3-cd]pyrene	**63**		40	10	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Naphthalene	**17**	**J**	40	6.2	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Phenanthrene	**100**		40	5.6	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Pyrene	**190**		40	8.0	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*95*		*43 - 145*	*04/29/20 07:52*	*04/29/20 23:26*	*1*
Nitrobenzene-d5 (Surr)	*94*		*37 - 147*	*04/29/20 07:52*	*04/29/20 23:26*	*1*
Terphenyl-d14 (Surr)	*123*		*42 - 157*	*04/29/20 07:52*	*04/29/20 23:26*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.5**		1.1	0.39	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Barium	**79**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Cadmium	**0.24**		0.23	0.041	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Chromium	**26**		1.1	0.57	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Lead	**73**		0.57	0.26	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.67		1.1	0.67	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Silver	**0.45**	**J**	0.57	0.15	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.070**		0.019	0.0064	mg/Kg	☼	04/24/20 14:15	04/27/20 10:10	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid
Percent Solids: 81.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<34		73	34	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1,1-Trichloroethane	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1,2,2-Tetrachloroethane	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1,2-Trichloroethane	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1-Dichloroethane	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1-Dichloroethene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1-Dichloropropene	<22		73	22	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,3-Trichlorobenzene	<34		73	34	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,3-Trichloropropane	<30		150	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,4-Trichlorobenzene	<25		73	25	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,4-Trimethylbenzene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dibromo-3-Chloropropane	<150		370	150	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dibromoethane	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dichlorobenzene	<24		73	24	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dichloroethane	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dichloropropane	<31		73	31	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,3,5-Trimethylbenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,3-Dichlorobenzene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,3-Dichloropropane	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,4-Dichlorobenzene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
2,2-Dichloropropane	<33		73	33	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
2-Chlorotoluene	<23		73	23	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
4-Chlorotoluene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Benzene	<11		18	11	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromobenzene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromochloromethane	<31		73	31	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromodichloromethane	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromoform	<35		73	35	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromomethane	<58	*	220	58	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Carbon tetrachloride	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chlorobenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chloroethane	<37		73	37	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chloroform	<27		150	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chloromethane	<23		73	23	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
cis-1,2-Dichloroethene	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
cis-1,3-Dichloropropene	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Dibromochloromethane	<36		73	36	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Dibromomethane	<20		73	20	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Ethylbenzene	<13		18	13	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Hexachlorobutadiene	<33		73	33	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Isopropyl ether	<20		73	20	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Isopropylbenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Methyl tert-butyl ether	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Methylene Chloride	<120		370	120	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
n-Butylbenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
N-Propylbenzene	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
p-Isopropyltoluene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
sec-Butylbenzene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid
Percent Solids: 81.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
tert-Butylbenzene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Tetrachloroethene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Toluene	**28**		18	11	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
trans-1,2-Dichloroethene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
trans-1,3-Dichloropropene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Trichloroethene	<12		37	12	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Trichlorofluoromethane	<31		73	31	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Vinyl chloride	<19		73	19	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Xylenes, Total	**64**		37	16	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*94*		*75 - 126*	*04/15/20 09:10*	*04/27/20 11:46*	*50*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*	*04/15/20 09:10*	*04/27/20 11:46*	*50*
Dibromofluoromethane (Surr)	*97*		*75 - 120*	*04/15/20 09:10*	*04/27/20 11:46*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 09:10*	*04/27/20 11:46*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**390**	**J**	410	49	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
2-Methylnaphthalene	**410**		410	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Acenaphthene	**52**	**J**	200	36	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Acenaphthylene	<26		200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Anthracene	**160**	**J**	200	34	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[a]anthracene	**950**		200	27	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[a]pyrene	**1200**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[b]fluoranthene	**1800**		200	43	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[g,h,i]perylene	**460**		200	65	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[k]fluoranthene	**730**		200	59	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Chrysene	**1300**		200	55	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Dibenz(a,h)anthracene	**120**	**J**	200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Fluoranthene	**2300**		200	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Fluorene	**55**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Indeno[1,2,3-cd]pyrene	**420**		200	52	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Naphthalene	**240**		200	31	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Phenanthrene	**1400**		200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Pyrene	**2000**		200	40	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*99*		*43 - 145*	*04/29/20 07:52*	*04/30/20 01:18*	*5*
Nitrobenzene-d5 (Surr)	*98*		*37 - 147*	*04/29/20 07:52*	*04/30/20 01:18*	*5*
Terphenyl-d14 (Surr)	*120*		*42 - 157*	*04/29/20 07:52*	*04/30/20 01:18*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		1.1	0.38	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Barium	**61**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Cadmium	**2.6**		0.22	0.040	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Chromium	**15**		1.1	0.55	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Lead	**470**		0.55	0.26	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-2

Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2

Matrix: Solid
Percent Solids: 81.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.0	J	1.1	0.65	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Silver	0.97		0.55	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.19		0.019	0.0064	mg/Kg	☼	04/24/20 14:15	04/27/20 10:18	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid
Percent Solids: 82.9

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		70	32	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1,1-Trichloroethane	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1,2,2-Tetrachloroethane	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1,2-Trichloroethane	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1-Dichloroethane	<29		70	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1-Dichloroethene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1-Dichloropropene	<21		70	21	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,3-Trichlorobenzene	<32		70	32	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,4-Trichlorobenzene	<24		70	24	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,4-Trimethylbenzene	**42**	**J**	70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dibromo-3-Chloropropane	<140		350	140	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dibromoethane	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dichlorobenzene	<23		70	23	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dichloroethane	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dichloropropane	<30		70	30	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,3,5-Trimethylbenzene	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,3-Dichlorobenzene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,3-Dichloropropane	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,4-Dichlorobenzene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
2,2-Dichloropropane	<31		70	31	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
2-Chlorotoluene	<22		70	22	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
4-Chlorotoluene	<24		70	24	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Benzene	<10		17	10	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromobenzene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromochloromethane	<30		70	30	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromodichloromethane	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromoform	<34		70	34	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromomethane	<55	*	210	55	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Carbon tetrachloride	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chlorobenzene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chloroethane	<35		70	35	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chloroform	<26		140	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chloromethane	<22		70	22	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
cis-1,2-Dichloroethene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
cis-1,3-Dichloropropene	<29		70	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Dibromochloromethane	<34		70	34	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Dibromomethane	<19		70	19	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Dichlorodifluoromethane	<47		210	47	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Ethylbenzene	**24**		17	13	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Hexachlorobutadiene	<31		70	31	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Isopropyl ether	<19		70	19	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Isopropylbenzene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Methyl tert-butyl ether	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Methylene Chloride	<110		350	110	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
n-Butylbenzene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
N-Propylbenzene	<29		70	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
p-Isopropyltoluene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
sec-Butylbenzene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid
Percent Solids: 82.9

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
tert-Butylbenzene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Tetrachloroethene	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Toluene	**74**		17	10	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
trans-1,2-Dichloroethene	<24		70	24	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
trans-1,3-Dichloropropene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Trichloroethene	<11		35	11	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Trichlorofluoromethane	<30		70	30	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Vinyl chloride	<18		70	18	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Xylenes, Total	**130**		35	15	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*	*04/15/20 09:25*	*04/27/20 12:10*	*50*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*	*04/15/20 09:25*	*04/27/20 12:10*	*50*
Dibromofluoromethane (Surr)	*101*		*75 - 120*	*04/15/20 09:25*	*04/27/20 12:10*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 09:25*	*04/27/20 12:10*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**340**	**J**	400	48	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
2-Methylnaphthalene	**410**		400	36	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Acenaphthene	**56**	**J**	200	35	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Acenaphthylene	**41**	**J**	200	26	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Anthracene	**180**	**J**	200	33	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[a]anthracene	**1200**		200	27	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[a]pyrene	**1400**		200	38	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[b]fluoranthene	**2000**		200	43	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[g,h,i]perylene	**820**		200	63	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[k]fluoranthene	**780**		200	58	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Chrysene	**1600**		200	54	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Dibenz(a,h)anthracene	**140**	**J**	200	38	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Fluoranthene	**2500**		200	37	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Fluorene	**61**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Indeno[1,2,3-cd]pyrene	**710**		200	51	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Naphthalene	**260**		200	30	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Phenanthrene	**1500**		200	27	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Pyrene	**2300**		200	39	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*106*		*43 - 145*	*04/29/20 07:52*	*04/29/20 23:54*	*5*
Nitrobenzene-d5 (Surr)	*90*		*37 - 147*	*04/29/20 07:52*	*04/29/20 23:54*	*5*
Terphenyl-d14 (Surr)	*117*		*42 - 157*	*04/29/20 07:52*	*04/29/20 23:54*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		1.2	0.40	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Barium	**56**		1.2	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Cadmium	**0.92**		0.24	0.043	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Chromium	**16**		1.2	0.59	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Lead	**220**		0.59	0.27	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-3

Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3

Matrix: Solid
Percent Solids: 82.9

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	0.74	J	1.2	0.70	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Silver	0.56	J	0.59	0.15	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.32		0.020	0.0065	mg/Kg	☼	04/24/20 14:15	04/27/20 10:20	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid
Percent Solids: 83.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		65	30	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1,1-Trichloroethane	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1,2,2-Tetrachloroethane	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1,2-Trichloroethane	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1-Dichloroethane	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1-Dichloroethene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1-Dichloropropene	<19		65	19	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,3-Trichlorobenzene	<30		65	30	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,4-Trichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,4-Trimethylbenzene	**56**	**J**	65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dibromoethane	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dichloroethane	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dichloropropane	<28		65	28	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,3,5-Trimethylbenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,3-Dichlorobenzene	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,3-Dichloropropane	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,4-Dichlorobenzene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
2,2-Dichloropropane	<29		65	29	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
2-Chlorotoluene	<20		65	20	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
4-Chlorotoluene	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Benzene	**18**		16	9.5	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromobenzene	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromochloromethane	<28		65	28	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromodichloromethane	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromoform	<31		65	31	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromomethane	<52	*	190	52	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Carbon tetrachloride	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chlorobenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chloroethane	<33		65	33	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chloromethane	<21		65	21	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
cis-1,2-Dichloroethene	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
cis-1,3-Dichloropropene	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Dibromochloromethane	<32		65	32	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Dibromomethane	<18		65	18	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Dichlorodifluoromethane	<44		190	44	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Ethylbenzene	**26**		16	12	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Hexachlorobutadiene	<29		65	29	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Isopropyl ether	<18		65	18	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Isopropylbenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Methyl tert-butyl ether	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Methylene Chloride	<110		320	110	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
n-Butylbenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
N-Propylbenzene	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
p-Isopropyltoluene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
sec-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50

Client Sample ID: HA-4

Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4

Matrix: Solid
Percent Solids: 83.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
tert-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Tetrachloroethene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Toluene	**77**		16	9.6	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
trans-1,2-Dichloroethene	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
trans-1,3-Dichloropropene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Trichloroethene	<11		32	11	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Trichlorofluoromethane	<28		65	28	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Vinyl chloride	<17		65	17	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Xylenes, Total	**160**		32	14	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*96*		*75 - 126*	*04/15/20 09:50*	*04/27/20 12:35*	*50*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*	*04/15/20 09:50*	*04/27/20 12:35*	*50*
Dibromofluoromethane (Surr)	*99*		*75 - 120*	*04/15/20 09:50*	*04/27/20 12:35*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 09:50*	*04/27/20 12:35*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**420**		400	49	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
2-Methylnaphthalene	**460**		400	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Acenaphthene	**190**	**J**	200	36	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Acenaphthylene	**150**	**J**	200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Anthracene	**540**		200	33	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[a]anthracene	**2400**		200	27	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[a]pyrene	**2700**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[b]fluoranthene	**3600**		200	43	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[g,h,i]perylene	**890**		200	64	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[k]fluoranthene	**1200**		200	59	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Chrysene	**2800**		200	54	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Dibenz(a,h)anthracene	**250**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Fluoranthene	**4800**		200	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Fluorene	**160**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Indeno[1,2,3-cd]pyrene	**870**		200	52	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Naphthalene	**410**		200	31	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Phenanthrene	**3100**		200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Pyrene	**4900**		200	40	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*100*		*43 - 145*	*04/29/20 07:52*	*04/30/20 01:46*	*5*
Nitrobenzene-d5 (Surr)	*91*		*37 - 147*	*04/29/20 07:52*	*04/30/20 01:46*	*5*
Terphenyl-d14 (Surr)	*117*		*42 - 157*	*04/29/20 07:52*	*04/30/20 01:46*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**6.7**		1.1	0.39	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Barium	**59**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Cadmium	**1.1**		0.23	0.041	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Chromium	**13**		1.1	0.57	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Lead	**140**		0.57	0.26	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid
Percent Solids: 83.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.1		1.1	0.67	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Silver	0.78		0.57	0.15	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.12		0.019	0.0064	mg/Kg	☼	04/24/20 14:15	04/27/20 10:26	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-5

Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5

Matrix: Solid
Percent Solids: 84.4

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		68	32	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1,1-Trichloroethane	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1,2,2-Tetrachloroethane	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1,2-Trichloroethane	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1-Dichloroethane	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1-Dichloroethene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1-Dichloropropene	<20		68	20	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,3-Trichlorobenzene	<31		68	31	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,3-Trichloropropane	<28		140	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,4-Trichlorobenzene	<23		68	23	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,4-Trimethylbenzene	**77**		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dibromo-3-Chloropropane	<140		340	140	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dibromoethane	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dichlorobenzene	<23		68	23	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dichloroethane	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dichloropropane	<29		68	29	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,3,5-Trimethylbenzene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,3-Dichlorobenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,3-Dichloropropane	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,4-Dichlorobenzene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
2,2-Dichloropropane	<30		68	30	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
2-Chlorotoluene	<21		68	21	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
4-Chlorotoluene	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Benzene	**140**		17	10	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromobenzene	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromochloromethane	<29		68	29	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromodichloromethane	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromoform	<33		68	33	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromomethane	<54	*	200	54	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Carbon tetrachloride	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chlorobenzene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chloroethane	<34		68	34	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chloroform	<25		140	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chloromethane	<22		68	22	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
cis-1,2-Dichloroethene	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
cis-1,3-Dichloropropene	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Dibromochloromethane	<33		68	33	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Dibromomethane	<18		68	18	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Dichlorodifluoromethane	<46		200	46	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Ethylbenzene	**49**		17	13	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Hexachlorobutadiene	<30		68	30	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Isopropyl ether	<19		68	19	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Isopropylbenzene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Methyl tert-butyl ether	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Methylene Chloride	<110		340	110	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
n-Butylbenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
N-Propylbenzene	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
p-Isopropyltoluene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
sec-Butylbenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
tert-Butylbenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Tetrachloroethene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Toluene	**260**		17	10	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
trans-1,2-Dichloroethene	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
trans-1,3-Dichloropropene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Trichloroethene	<11		34	11	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Trichlorofluoromethane	<29		68	29	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Vinyl chloride	<18		68	18	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Xylenes, Total	**270**		34	15	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*	*04/15/20 10:05*	*04/27/20 12:59*	*50*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*	*04/15/20 10:05*	*04/27/20 12:59*	*50*
Dibromofluoromethane (Surr)	*98*		*75 - 120*	*04/15/20 10:05*	*04/27/20 12:59*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 10:05*	*04/27/20 12:59*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**220**	**J**	400	48	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
2-Methylnaphthalene	**300**	**J**	400	36	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Acenaphthene	**80**	**J**	200	35	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Acenaphthylene	**64**	**J**	200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Anthracene	**200**		200	33	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[a]anthracene	**1100**		200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[a]pyrene	**1400**		200	38	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[b]fluoranthene	**2200**		200	42	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[g,h,i]perylene	**510**		200	63	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[k]fluoranthene	**730**		200	58	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Chrysene	**1400**		200	54	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Dibenz(a,h)anthracene	**180**	**J**	200	38	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Fluoranthene	**2100**		200	36	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Fluorene	**51**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Indeno[1,2,3-cd]pyrene	**480**		200	51	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Naphthalene	**290**		200	30	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Phenanthrene	**1200**		200	27	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Pyrene	**2100**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*78*		*43 - 145*	*04/29/20 07:52*	*04/30/20 02:14*	*5*
Nitrobenzene-d5 (Surr)	*79*		*37 - 147*	*04/29/20 07:52*	*04/30/20 02:14*	*5*
Terphenyl-d14 (Surr)	*110*		*42 - 157*	*04/29/20 07:52*	*04/30/20 02:14*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**8.1**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Barium	**55**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Cadmium	**0.64**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Lead	**160**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Silver	**0.45**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.15**		0.018	0.0061	mg/Kg	☼	04/24/20 14:15	04/27/20 10:29	1

Client Sample ID: HA-6

Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6

Matrix: Solid
Percent Solids: 85.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		66	31	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1,1-Trichloroethane	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1,2,2-Tetrachloroethane	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1,2-Trichloroethane	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1-Dichloroethane	<27		66	27	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1-Dichloroethene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1-Dichloropropene	<20		66	20	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,3-Trichlorobenzene	<30		66	30	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,3-Trichloropropane	<28		130	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,4-Trichlorobenzene	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,4-Trimethylbenzene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dibromo-3-Chloropropane	<130		330	130	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dibromoethane	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dichlorobenzene	<22		66	22	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dichloroethane	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dichloropropane	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,3,5-Trimethylbenzene	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,3-Dichlorobenzene	<27		66	27	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,3-Dichloropropane	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,4-Dichlorobenzene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
2,2-Dichloropropane	<30		66	30	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
2-Chlorotoluene	<21		66	21	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
4-Chlorotoluene	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Benzene	<9.7		17	9.7	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromobenzene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromochloromethane	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromodichloromethane	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromoform	<32		66	32	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromomethane	<53	*	200	53	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Carbon tetrachloride	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chlorobenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chloroethane	<34		66	34	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chloroform	<25		130	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chloromethane	<21		66	21	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
cis-1,2-Dichloroethene	<27		66	27	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
cis-1,3-Dichloropropene	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Dibromochloromethane	<32		66	32	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Dibromomethane	<18		66	18	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Ethylbenzene	<12		17	12	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Hexachlorobutadiene	<30		66	30	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Isopropyl ether	<18		66	18	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Isopropylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Methyl tert-butyl ether	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Methylene Chloride	<110		330	110	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
n-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
N-Propylbenzene	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
p-Isopropyltoluene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
sec-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50

Client Sample ID: HA-6
Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6
Matrix: Solid
Percent Solids: 85.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
tert-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Tetrachloroethene	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Toluene	**13**	**J**	17	9.8	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
trans-1,2-Dichloroethene	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
trans-1,3-Dichloropropene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Trichloroethene	<11		33	11	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Trichlorofluoromethane	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Vinyl chloride	<17		66	17	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Xylenes, Total	**25**	**J**	33	15	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*98*		*75 - 126*	*04/15/20 10:25*	*04/27/20 13:23*	*50*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*	*04/15/20 10:25*	*04/27/20 13:23*	*50*
Dibromofluoromethane (Surr)	*99*		*75 - 120*	*04/15/20 10:25*	*04/27/20 13:23*	*50*
Toluene-d8 (Surr)	*104*		*75 - 120*	*04/15/20 10:25*	*04/27/20 13:23*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**120**	**J**	390	47	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
2-Methylnaphthalene	**120**	**J**	390	35	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Acenaphthene	**190**		190	34	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Acenaphthylene	**39**	**J**	190	25	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Anthracene	**400**		190	32	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[a]anthracene	**1300**		190	26	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[a]pyrene	**1400**		190	37	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[b]fluoranthene	**1900**		190	41	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[g,h,i]perylene	**440**		190	62	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[k]fluoranthene	**570**		190	56	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Chrysene	**1300**		190	52	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Dibenz(a,h)anthracene	**100**	**J**	190	37	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Fluoranthene	**2400**		190	35	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Fluorene	**160**	**J**	190	27	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Indeno[1,2,3-cd]pyrene	**320**		190	50	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Naphthalene	**150**	**J**	190	29	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Phenanthrene	**1900**		190	27	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Pyrene	**2300**		190	38	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*101*		*43 - 145*	*04/29/20 07:52*	*04/30/20 02:42*	*5*
Nitrobenzene-d5 (Surr)	*103*		*37 - 147*	*04/29/20 07:52*	*04/30/20 02:42*	*5*
Terphenyl-d14 (Surr)	*117*		*42 - 157*	*04/29/20 07:52*	*04/30/20 02:42*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**6.8**		1.0	0.35	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Barium	**37**		1.0	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Cadmium	**0.36**		0.21	0.037	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Chromium	**12**		1.0	0.51	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Lead	**91**		0.52	0.24	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-6

Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6

Matrix: Solid
Percent Solids: 85.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.61		1.0	0.61	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Silver	**0.27**	**J**	0.52	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.053**		0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 10:31	1

Client Sample ID: HA-7

Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7

Matrix: Solid
Percent Solids: 85.1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		67	31	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1,1-Trichloroethane	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1,2,2-Tetrachloroethane	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1,2-Trichloroethane	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1-Dichloroethane	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1-Dichloroethene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1-Dichloropropene	<20		67	20	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,3-Trichlorobenzene	<31		67	31	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,3-Trichloropropane	<28		130	28	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,4-Trichlorobenzene	<23		67	23	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,4-Trimethylbenzene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dibromo-3-Chloropropane	<130		330	130	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dibromoethane	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dichlorobenzene	<22		67	22	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dichloroethane	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dichloropropane	<29		67	29	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,3,5-Trimethylbenzene	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,3-Dichlorobenzene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,3-Dichloropropane	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,4-Dichlorobenzene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
2,2-Dichloropropane	<30		67	30	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
2-Chlorotoluene	<21		67	21	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
4-Chlorotoluene	<23		67	23	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Benzene	<9.8		17	9.8	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromobenzene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromochloromethane	<29		67	29	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromodichloromethane	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromoform	<32		67	32	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromomethane	<53	*	200	53	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Carbon tetrachloride	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chlorobenzene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chloroethane	<34		67	34	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chloroform	<25		130	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chloromethane	<21		67	21	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
cis-1,2-Dichloroethene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
cis-1,3-Dichloropropene	<28		67	28	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Dibromochloromethane	<33		67	33	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Dibromomethane	<18		67	18	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Ethylbenzene	<12		17	12	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Hexachlorobutadiene	<30		67	30	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Isopropyl ether	<18		67	18	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Isopropylbenzene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Methyl tert-butyl ether	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Methylene Chloride	<110		330	110	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
n-Butylbenzene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
N-Propylbenzene	<28		67	28	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
p-Isopropyltoluene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
sec-Butylbenzene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50

Client Sample ID: HA-7

Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7

Matrix: Solid
Percent Solids: 85.1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
tert-Butylbenzene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Tetrachloroethene	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Toluene	<9.8		17	9.8	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
trans-1,2-Dichloroethene	<23		67	23	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
trans-1,3-Dichloropropene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Trichloroethene	<11		33	11	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Trichlorofluoromethane	<29		67	29	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Vinyl chloride	<18		67	18	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Xylenes, Total	**53**		33	15	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*98*		*75 - 126*	*04/15/20 10:40*	*04/27/20 13:47*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*04/15/20 10:40*	*04/27/20 13:47*	*50*
Dibromofluoromethane (Surr)	*101*		*75 - 120*	*04/15/20 10:40*	*04/27/20 13:47*	*50*
Toluene-d8 (Surr)	*103*		*75 - 120*	*04/15/20 10:40*	*04/27/20 13:47*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**86**		79	9.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
2-Methylnaphthalene	**100**		79	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Acenaphthene	**49**		39	7.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Acenaphthylene	**41**		39	5.1	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Anthracene	**100**		39	6.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[a]anthracene	**440**		39	5.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[a]pyrene	**450**		39	7.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[b]fluoranthene	**580**		39	8.4	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[g,h,i]perylene	**180**		39	13	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[k]fluoranthene	**260**		39	11	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Chrysene	**480**		39	11	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Dibenz(a,h)anthracene	**41**		39	7.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Fluoranthene	**760**		39	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Fluorene	**43**		39	5.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Indeno[1,2,3-cd]pyrene	**170**		39	10	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Naphthalene	**81**		39	6.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Phenanthrene	**630**		39	5.4	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Pyrene	**800**		39	7.7	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*94*		*43 - 145*	*04/29/20 07:52*	*04/30/20 00:22*	*1*
Nitrobenzene-d5 (Surr)	*84*		*37 - 147*	*04/29/20 07:52*	*04/30/20 00:22*	*1*
Terphenyl-d14 (Surr)	*118*		*42 - 157*	*04/29/20 07:52*	*04/30/20 00:22*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.0**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Barium	**44**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Cadmium	**0.43**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Lead	**86**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-7

Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7

Matrix: Solid
Percent Solids: 85.1

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Silver	**0.53**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.041**		0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 10:33	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		65	30	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1,1-Trichloroethane	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1,2,2-Tetrachloroethane	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1,2-Trichloroethane	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1-Dichloroethane	<27		65	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1-Dichloroethene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1-Dichloropropene	<19		65	19	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,3-Trichlorobenzene	<30		65	30	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,4-Trichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,4-Trimethylbenzene	**23**	**J**	65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dibromoethane	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dichloroethane	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dichloropropane	<28		65	28	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,3,5-Trimethylbenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,3-Dichlorobenzene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,3-Dichloropropane	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,4-Dichlorobenzene	<24		65	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
2,2-Dichloropropane	<29		65	29	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
2-Chlorotoluene	<20		65	20	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
4-Chlorotoluene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Benzene	**19**		16	9.4	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromobenzene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromochloromethane	<28		65	28	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromodichloromethane	<24		65	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromoform	<31		65	31	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromomethane	<51	*	190	51	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Carbon tetrachloride	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chlorobenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chloroethane	<33		65	33	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chloromethane	<21		65	21	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
cis-1,2-Dichloroethene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
cis-1,3-Dichloropropene	<27		65	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Dibromochloromethane	<32		65	32	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Dibromomethane	<17		65	17	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Dichlorodifluoromethane	<44		190	44	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Ethylbenzene	**18**		16	12	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Hexachlorobutadiene	<29		65	29	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Isopropyl ether	<18		65	18	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Isopropylbenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Methyl tert-butyl ether	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Methylene Chloride	<110		320	110	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
n-Butylbenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
N-Propylbenzene	<27		65	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
p-Isopropyltoluene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
sec-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
tert-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Tetrachloroethene	<24		65	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Toluene	**49**		16	9.5	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
trans-1,2-Dichloroethene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
trans-1,3-Dichloropropene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Trichloroethene	<11		32	11	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Trichlorofluoromethane	<28		65	28	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Vinyl chloride	<17		65	17	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Xylenes, Total	**67**		32	14	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*	*04/15/20 10:55*	*04/27/20 14:11*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*04/15/20 10:55*	*04/27/20 14:11*	*50*
Dibromofluoromethane (Surr)	*99*		*75 - 120*	*04/15/20 10:55*	*04/27/20 14:11*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 10:55*	*04/27/20 14:11*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**100**		75	9.1	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
2-Methylnaphthalene	**140**		75	6.8	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Acenaphthene	**100**		37	6.7	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Acenaphthylene	**140**		37	4.9	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Anthracene	**310**		37	6.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[a]anthracene	**1100**		37	5.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[a]pyrene	**1200**		37	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[b]fluoranthene	**1600**		37	8.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[g,h,i]perylene	**340**		37	12	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[k]fluoranthene	**630**		37	11	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Chrysene	**1200**		37	10	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Dibenz(a,h)anthracene	**100**		37	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Fluoranthene	**2300**		37	6.9	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Fluorene	**96**		37	5.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Indeno[1,2,3-cd]pyrene	**330**		37	9.6	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Naphthalene	**160**		37	5.7	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Phenanthrene	**1600**		37	5.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Pyrene	**2600**		37	7.4	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*88*		*43 - 145*	*04/29/20 07:52*	*04/30/20 00:50*	*1*
Nitrobenzene-d5 (Surr)	*85*		*37 - 147*	*04/29/20 07:52*	*04/30/20 00:50*	*1*
Terphenyl-d14 (Surr)	*110*		*42 - 157*	*04/29/20 07:52*	*04/30/20 00:50*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**6.2**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Barium	**54**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Cadmium	**0.58**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Lead	**150**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Silver	**0.51**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.080**		0.018	0.0061	mg/Kg	☼	04/24/20 14:15	04/27/20 10:35	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid
Percent Solids: 87.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<29		64	29	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1,1-Trichloroethane	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1,2,2-Tetrachloroethane	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1,2-Trichloroethane	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1-Dichloroethane	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1-Dichloroethene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1-Dichloropropene	<19		64	19	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,3-Trichlorobenzene	<29		64	29	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,3-Trichloropropane	<26		130	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,4-Trichlorobenzene	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,4-Trimethylbenzene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dibromoethane	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dichlorobenzene	<21		64	21	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dichloroethane	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dichloropropane	<27		64	27	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,3,5-Trimethylbenzene	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,3-Dichlorobenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,3-Dichloropropane	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,4-Dichlorobenzene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
2,2-Dichloropropane	<28		64	28	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
2-Chlorotoluene	<20		64	20	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
4-Chlorotoluene	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Benzene	<9.3		16	9.3	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromobenzene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromochloromethane	<27		64	27	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromodichloromethane	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromoform	<31		64	31	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromomethane	<51	*	190	51	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Carbon tetrachloride	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chlorobenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chloroethane	<32		64	32	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chloromethane	<20		64	20	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
cis-1,2-Dichloroethene	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
cis-1,3-Dichloropropene	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Dibromochloromethane	<31		64	31	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Dibromomethane	<17		64	17	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Dichlorodifluoromethane	<43		190	43	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Ethylbenzene	<12		16	12	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Hexachlorobutadiene	<28		64	28	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Isopropyl ether	<18		64	18	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Isopropylbenzene	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Methyl tert-butyl ether	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Methylene Chloride	<100		320	100	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
n-Butylbenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
N-Propylbenzene	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
p-Isopropyltoluene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
sec-Butylbenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50

Client Sample ID: HA-9

Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9

Matrix: Solid
Percent Solids: 87.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
tert-Butylbenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Tetrachloroethene	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Toluene	<9.4		16	9.4	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
trans-1,2-Dichloroethene	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
trans-1,3-Dichloropropene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Trichloroethene	<10		32	10	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Trichlorofluoromethane	<27		64	27	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Vinyl chloride	<17		64	17	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Xylenes, Total	<14		32	14	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*	*04/15/20 11:15*	*04/27/20 14:35*	*50*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*	*04/15/20 11:15*	*04/27/20 14:35*	*50*
Dibromofluoromethane (Surr)	*102*		*75 - 120*	*04/15/20 11:15*	*04/27/20 14:35*	*50*
Toluene-d8 (Surr)	*102*		*75 - 120*	*04/15/20 11:15*	*04/27/20 14:35*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**21**	**J**	73	8.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
2-Methylnaphthalene	**35**	**J**	73	6.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Acenaphthene	**14**	**J**	36	6.5	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Acenaphthylene	**14**	**J**	36	4.8	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Anthracene	**48**		36	6.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[a]anthracene	**180**		36	4.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[a]pyrene	**170**		36	7.0	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[b]fluoranthene	**210**		36	7.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[g,h,i]perylene	**100**		36	12	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[k]fluoranthene	**55**		36	11	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Chrysene	**190**		36	9.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Dibenz(a,h)anthracene	**24**	**J**	36	7.0	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Fluoranthene	**300**		36	6.8	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Fluorene	**12**	**J**	36	5.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Indeno[1,2,3-cd]pyrene	**93**		36	9.4	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Naphthalene	**25**	**J**	36	5.6	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Phenanthrene	**240**		36	5.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Pyrene	**300**		36	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*86*		*43 - 145*	*04/29/20 07:52*	*04/29/20 22:59*	*1*
Nitrobenzene-d5 (Surr)	*78*		*37 - 147*	*04/29/20 07:52*	*04/29/20 22:59*	*1*
Terphenyl-d14 (Surr)	*109*		*42 - 157*	*04/29/20 07:52*	*04/29/20 22:59*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.0**		1.1	0.38	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Barium	**37**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Cadmium	**0.18**	**J**	0.22	0.040	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Chromium	**13**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Lead	**53**		0.55	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid
Percent Solids: 87.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.65		1.1	0.65	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Silver	**0.23**	**J**	0.55	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.16**		0.018	0.0059	mg/Kg	☼	04/24/20 14:15	04/27/20 10:37	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-10
Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10
Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		66	31	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1,1-Trichloroethane	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1,2,2-Tetrachloroethane	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1,2-Trichloroethane	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1-Dichloroethane	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1-Dichloroethene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1-Dichloropropene	<20		66	20	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,3-Trichlorobenzene	<30		66	30	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,4-Trichlorobenzene	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,4-Trimethylbenzene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dibromo-3-Chloropropane	<130		330	130	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dibromoethane	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dichlorobenzene	<22		66	22	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dichloroethane	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dichloropropane	<28		66	28	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,3,5-Trimethylbenzene	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,3-Dichlorobenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,3-Dichloropropane	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,4-Dichlorobenzene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
2,2-Dichloropropane	<29		66	29	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
2-Chlorotoluene	<21		66	21	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
4-Chlorotoluene	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Benzene	<9.6		17	9.6	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromobenzene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromochloromethane	<28		66	28	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromodichloromethane	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromoform	<32		66	32	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromomethane	<53	*	200	53	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Carbon tetrachloride	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chlorobenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chloroethane	<33		66	33	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chloromethane	<21		66	21	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
cis-1,2-Dichloroethene	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
cis-1,3-Dichloropropene	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Dibromochloromethane	<32		66	32	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Dibromomethane	<18		66	18	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Ethylbenzene	<12		17	12	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Hexachlorobutadiene	<29		66	29	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Isopropyl ether	<18		66	18	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Isopropylbenzene	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Methyl tert-butyl ether	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Methylene Chloride	<110		330	110	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
n-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
N-Propylbenzene	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
p-Isopropyltoluene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
sec-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50

Client Sample ID: HA-10

Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10

Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
tert-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Tetrachloroethene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Toluene	**23**		17	9.7	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
trans-1,2-Dichloroethene	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
trans-1,3-Dichloropropene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Trichloroethene	<11		33	11	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Trichlorofluoromethane	<28		66	28	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Vinyl chloride	<17		66	17	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Xylenes, Total	**46**		33	15	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*104*		*75 - 126*	*04/15/20 11:30*	*04/27/20 14:59*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*04/15/20 11:30*	*04/27/20 14:59*	*50*
Dibromofluoromethane (Surr)	*103*		*75 - 120*	*04/15/20 11:30*	*04/27/20 14:59*	*50*
Toluene-d8 (Surr)	*103*		*75 - 120*	*04/15/20 11:30*	*04/27/20 14:59*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**120**	**J**	380	46	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
2-Methylnaphthalene	**160**	**J**	380	35	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Acenaphthene	**40**	**J**	190	34	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Acenaphthylene	**44**	**J**	190	25	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Anthracene	**150**	**J**	190	31	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[a]anthracene	**530**		190	25	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[a]pyrene	**620**		190	36	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[b]fluoranthene	**1000**		190	41	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[g,h,i]perylene	**150**	**J**	190	61	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[k]fluoranthene	**250**		190	55	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Chrysene	**720**		190	51	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Dibenz(a,h)anthracene	<36		190	36	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Fluoranthene	**980**		190	35	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Fluorene	**35**	**J**	190	26	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Indeno[1,2,3-cd]pyrene	**220**		190	49	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Naphthalene	**150**	**J**	190	29	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Phenanthrene	**600**		190	26	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Pyrene	**970**		190	37	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*87*		*43 - 145*	*04/29/20 07:52*	*04/30/20 03:10*	*5*
Nitrobenzene-d5 (Surr)	*81*		*37 - 147*	*04/29/20 07:52*	*04/30/20 03:10*	*5*
Terphenyl-d14 (Surr)	*103*		*42 - 157*	*04/29/20 07:52*	*04/30/20 03:10*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.0**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Barium	**41**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Cadmium	**0.44**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Lead	**190**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 11:05	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-10
Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10
Matrix: Solid
Percent Solids: 86.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Silver	**0.36**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.22**		0.018	0.0059	mg/Kg	☼	04/24/20 14:15	04/27/20 10:39	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-11
Date Collected: 04/15/20 11:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-11
Matrix: Solid
Percent Solids: 81.6

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<33		72	33	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1,1-Trichloroethane	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1,2,2-Tetrachloroethane	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1,2-Trichloroethane	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1-Dichloroethane	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1-Dichloroethene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1-Dichloropropene	<22		72	22	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,3-Trichlorobenzene	<33		72	33	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,3-Trichloropropane	<30		140	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,4-Trichlorobenzene	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,4-Trimethylbenzene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dibromo-3-Chloropropane	<140		360	140	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dibromoethane	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dichlorobenzene	<24		72	24	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dichloroethane	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dichloropropane	<31		72	31	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,3,5-Trimethylbenzene	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,3-Dichlorobenzene	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,3-Dichloropropane	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,4-Dichlorobenzene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
2,2-Dichloropropane	<32		72	32	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
2-Chlorotoluene	<23		72	23	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
4-Chlorotoluene	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Benzene	<11		18	11	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromobenzene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromochloromethane	<31		72	31	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromodichloromethane	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromoform	<35		72	35	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromomethane	<58	*	220	58	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Carbon tetrachloride	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chlorobenzene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chloroethane	<36		72	36	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chloroform	<27		140	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chloromethane	<23		72	23	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
cis-1,2-Dichloroethene	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
cis-1,3-Dichloropropene	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Dibromochloromethane	<35		72	35	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Dibromomethane	<20		72	20	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Ethylbenzene	<13		18	13	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Hexachlorobutadiene	<32		72	32	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Isopropyl ether	<20		72	20	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Isopropylbenzene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Methyl tert-butyl ether	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Methylene Chloride	<120		360	120	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
n-Butylbenzene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
N-Propylbenzene	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
p-Isopropyltoluene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
sec-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50

Client Sample ID: HA-11
Date Collected: 04/15/20 11:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-11
Matrix: Solid
Percent Solids: 81.6

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
tert-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Tetrachloroethene	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Toluene	<11		18	11	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
trans-1,2-Dichloroethene	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
trans-1,3-Dichloropropene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Trichloroethene	<12		36	12	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Trichlorofluoromethane	<31		72	31	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Vinyl chloride	<19		72	19	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Xylenes, Total	<16		36	16	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*	*04/15/20 11:50*	*04/27/20 15:23*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*04/15/20 11:50*	*04/27/20 15:23*	*50*
Dibromofluoromethane (Surr)	*102*		*75 - 120*	*04/15/20 11:50*	*04/27/20 15:23*	*50*
Toluene-d8 (Surr)	*105*		*75 - 120*	*04/15/20 11:50*	*04/27/20 15:23*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**230**	**J**	410	49	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
2-Methylnaphthalene	**390**	**J**	410	37	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Acenaphthene	<36		200	36	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Acenaphthylene	**33**	**J**	200	27	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Anthracene	**140**	**J**	200	34	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[a]anthracene	**350**		200	27	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[a]pyrene	**370**		200	39	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[b]fluoranthene	**350**		200	44	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[g,h,i]perylene	<65		200	65	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[k]fluoranthene	**120**	**J**	200	60	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Chrysene	**460**		200	55	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Dibenz(a,h)anthracene	<39		200	39	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Fluoranthene	**530**		200	37	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Fluorene	**59**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Indeno[1,2,3-cd]pyrene	<52		200	52	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Naphthalene	**130**	**J**	200	31	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Phenanthrene	**650**		200	28	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Pyrene	**690**		200	40	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*96*		*43 - 145*	*04/29/20 07:52*	*05/01/20 04:47*	*5*
Nitrobenzene-d5 (Surr)	*85*		*37 - 147*	*04/29/20 07:52*	*05/01/20 04:47*	*5*
Terphenyl-d14 (Surr)	*120*		*42 - 157*	*04/29/20 07:52*	*05/01/20 04:47*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**7.9**		1.0	0.35	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Barium	**70**		1.0	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Cadmium	**0.83**		0.21	0.037	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Chromium	**19**		1.0	0.51	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Lead	**250**		0.52	0.24	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-11
Date Collected: 04/15/20 11:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-11
Matrix: Solid
Percent Solids: 81.6

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.1		1.0	0.61	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Silver	0.82		0.52	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.19		0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 08:26	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-12
Date Collected: 04/15/20 12:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-12
Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		65	30	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1,1-Trichloroethane	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1,2,2-Tetrachloroethane	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1,2-Trichloroethane	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1-Dichloroethane	<27		65	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1-Dichloroethene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1-Dichloropropene	<19		65	19	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,3-Trichlorobenzene	<30		65	30	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,4-Trichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,4-Trimethylbenzene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dibromoethane	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dichloroethane	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dichloropropane	<28		65	28	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,3,5-Trimethylbenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,3-Dichlorobenzene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,3-Dichloropropane	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,4-Dichlorobenzene	<24		65	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
2,2-Dichloropropane	<29		65	29	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
2-Chlorotoluene	<20		65	20	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
4-Chlorotoluene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Benzene	<9.4		16	9.4	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromobenzene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromochloromethane	<28		65	28	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromodichloromethane	<24		65	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromoform	<31		65	31	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromomethane	<52	*	190	52	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Carbon tetrachloride	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chlorobenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chloroethane	<33		65	33	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chloromethane	<21		65	21	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
cis-1,2-Dichloroethene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
cis-1,3-Dichloropropene	<27		65	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Dibromochloromethane	<32		65	32	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Dibromomethane	<17		65	17	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Dichlorodifluoromethane	<44		190	44	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Ethylbenzene	<12		16	12	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Hexachlorobutadiene	<29		65	29	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Isopropyl ether	<18		65	18	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Isopropylbenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Methyl tert-butyl ether	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Methylene Chloride	<110		320	110	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
n-Butylbenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
N-Propylbenzene	<27		65	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
p-Isopropyltoluene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
sec-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50

Client Sample ID: HA-12

Date Collected: 04/15/20 12:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-12

Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
tert-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Tetrachloroethene	<24		65	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Toluene	<9.5		16	9.5	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
trans-1,2-Dichloroethene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
trans-1,3-Dichloropropene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Trichloroethene	<11		32	11	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Trichlorofluoromethane	<28		65	28	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Vinyl chloride	<17		65	17	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Xylenes, Total	<14		32	14	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*	*04/15/20 12:10*	*04/27/20 15:47*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*04/15/20 12:10*	*04/27/20 15:47*	*50*
Dibromofluoromethane (Surr)	*103*		*75 - 120*	*04/15/20 12:10*	*04/27/20 15:47*	*50*
Toluene-d8 (Surr)	*101*		*75 - 120*	*04/15/20 12:10*	*04/27/20 15:47*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<9.1		75	9.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
2-Methylnaphthalene	<6.9		75	6.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Acenaphthene	<6.7		37	6.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Acenaphthylene	<4.9		37	4.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Anthracene	<6.2		37	6.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[a]anthracene	**36**	**J**	37	5.0	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[a]pyrene	**37**		37	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[b]fluoranthene	**46**		37	8.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[g,h,i]perylene	**22**	**J**	37	12	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[k]fluoranthene	**18**	**J**	37	11	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Chrysene	**43**		37	10	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Dibenz(a,h)anthracene	<7.2		37	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Fluoranthene	**57**		37	6.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Fluorene	<5.2		37	5.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Indeno[1,2,3-cd]pyrene	**23**	**J**	37	9.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Naphthalene	<5.7		37	5.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Phenanthrene	**17**	**J**	37	5.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Pyrene	**59**		37	7.4	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*72*		*43 - 145*	*04/29/20 07:52*	*04/29/20 22:31*	*1*
Nitrobenzene-d5 (Surr)	*70*		*37 - 147*	*04/29/20 07:52*	*04/29/20 22:31*	*1*
Terphenyl-d14 (Surr)	*104*		*42 - 157*	*04/29/20 07:52*	*04/29/20 22:31*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.0**		0.97	0.33	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Barium	**31**		0.97	0.11	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Cadmium	**0.040**	**J**	0.19	0.035	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Chromium	**14**		0.97	0.48	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Lead	**7.2**		0.49	0.22	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-12
Date Collected: 04/15/20 12:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-12
Matrix: Solid
Percent Solids: 86.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.57		0.97	0.57	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Silver	**0.13**	**J**	0.49	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.0083**	**J**	0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 08:28	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: Soil-Composite-1

Date Collected: 04/15/20 12:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-13

Matrix: Solid

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.010		0.050	0.010	mg/L		04/29/20 06:08	04/29/20 17:37	1
Lead	<0.0075		0.050	0.0075	mg/L		04/29/20 06:08	04/29/20 17:37	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.00020		0.00020	0.00020	mg/L		04/29/20 09:35	04/30/20 10:23	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-10
Date Collected: 04/16/20 08:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-14
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 16:11	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 16:11	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 16:11	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 16:11	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 16:11	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 16:11	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 16:11	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 16:11	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 16:11	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 16:11	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 16:11	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 16:11	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 16:11	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 16:11	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 16:11	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 16:11	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:11	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 16:11	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 16:11	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 16:11	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 16:11	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 16:11	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 16:11	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 16:11	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 16:11	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 16:11	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 16:11	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 16:11	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 16:11	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 16:11	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 16:11	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 16:11	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 16:11	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 16:11	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-10

Date Collected: 04/16/20 08:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-14

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 16:11	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 16:11	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 16:11	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 16:11	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:11	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 16:11	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 16:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*		*04/27/20 16:11*	*1*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*		*04/27/20 16:11*	*1*
Dibromofluoromethane (Surr)	*105*		*75 - 120*		*04/27/20 16:11*	*1*
Toluene-d8 (Surr)	*99*		*75 - 120*		*04/27/20 16:11*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.25		1.7	0.25	ug/L		04/21/20 18:29	04/23/20 00:53	1
2-Methylnaphthalene	<0.054		1.7	0.054	ug/L		04/21/20 18:29	04/23/20 00:53	1
Acenaphthene	<0.26		0.84	0.26	ug/L		04/21/20 18:29	04/23/20 00:53	1
Acenaphthylene	<0.22		0.84	0.22	ug/L		04/21/20 18:29	04/23/20 00:53	1
Anthracene	<0.28		0.84	0.28	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[a]anthracene	<0.047		0.17	0.047	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[a]pyrene	<0.083		0.17	0.083	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[b]fluoranthene	<0.067		0.17	0.067	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[g,h,i]perylene	<0.31		0.84	0.31	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[k]fluoranthene	<0.054		0.17	0.054	ug/L		04/21/20 18:29	04/23/20 00:53	1
Chrysene	<0.057		0.17	0.057	ug/L		04/21/20 18:29	04/23/20 00:53	1
Dibenz(a,h)anthracene	<0.042		0.25	0.042	ug/L		04/21/20 18:29	04/23/20 00:53	1
Fluoranthene	<0.38		0.84	0.38	ug/L		04/21/20 18:29	04/23/20 00:53	1
Fluorene	<0.20		0.84	0.20	ug/L		04/21/20 18:29	04/23/20 00:53	1
Indeno[1,2,3-cd]pyrene	<0.063		0.17	0.063	ug/L		04/21/20 18:29	04/23/20 00:53	1
Naphthalene	<0.26		0.84	0.26	ug/L		04/21/20 18:29	04/23/20 00:53	1
Phenanthrene	<0.25		0.84	0.25	ug/L		04/21/20 18:29	04/23/20 00:53	1
Pyrene	<0.36		0.84	0.36	ug/L		04/21/20 18:29	04/23/20 00:53	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*86*		*34 - 110*	*04/21/20 18:29*	*04/23/20 00:53*	*1*
Nitrobenzene-d5 (Surr)	*84*		*36 - 120*	*04/21/20 18:29*	*04/23/20 00:53*	*1*
Terphenyl-d14 (Surr)	*125*		*40 - 145*	*04/21/20 18:29*	*04/23/20 00:53*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.56**	**J**	1.0	0.23	ug/L		04/21/20 17:30	04/22/20 17:59	1
Barium	**29**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 17:59	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 17:59	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:36	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:36	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-10
Date Collected: 04/16/20 08:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-14
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	**1.3**	**J**	2.5	0.98	ug/L		04/21/20 17:30	04/22/20 17:59	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:36	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:29	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-11
Date Collected: 04/16/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-15
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 16:35	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 16:35	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 16:35	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 16:35	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 16:35	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 16:35	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 16:35	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 16:35	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 16:35	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 16:35	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 16:35	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 16:35	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 16:35	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 16:35	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 16:35	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 16:35	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:35	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 16:35	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 16:35	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 16:35	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 16:35	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 16:35	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 16:35	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 16:35	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 16:35	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 16:35	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 16:35	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 16:35	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 16:35	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 16:35	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 16:35	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 16:35	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 16:35	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 16:35	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-11

Date Collected: 04/16/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-15

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 16:35	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 16:35	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 16:35	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 16:35	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:35	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 16:35	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 16:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*		*04/27/20 16:35*	*1*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*		*04/27/20 16:35*	*1*
Dibromofluoromethane (Surr)	*103*		*75 - 120*		*04/27/20 16:35*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 16:35*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.27		1.8	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
2-Methylnaphthalene	<0.058		1.8	0.058	ug/L		04/21/20 18:29	04/23/20 01:21	1
Acenaphthene	<0.27		0.89	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
Acenaphthylene	<0.24		0.89	0.24	ug/L		04/21/20 18:29	04/23/20 01:21	1
Anthracene	<0.30		0.89	0.30	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[a]anthracene	<0.050		0.18	0.050	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[a]pyrene	<0.088		0.18	0.088	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[b]fluoranthene	<0.072		0.18	0.072	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[g,h,i]perylene	<0.33		0.89	0.33	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[k]fluoranthene	<0.057		0.18	0.057	ug/L		04/21/20 18:29	04/23/20 01:21	1
Chrysene	<0.061		0.18	0.061	ug/L		04/21/20 18:29	04/23/20 01:21	1
Dibenz(a,h)anthracene	<0.045		0.27	0.045	ug/L		04/21/20 18:29	04/23/20 01:21	1
Fluoranthene	<0.40		0.89	0.40	ug/L		04/21/20 18:29	04/23/20 01:21	1
Fluorene	<0.22		0.89	0.22	ug/L		04/21/20 18:29	04/23/20 01:21	1
Indeno[1,2,3-cd]pyrene	<0.067		0.18	0.067	ug/L		04/21/20 18:29	04/23/20 01:21	1
Naphthalene	<0.27		0.89	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
Phenanthrene	<0.27		0.89	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
Pyrene	<0.38		0.89	0.38	ug/L		04/21/20 18:29	04/23/20 01:21	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*84*		*34 - 110*	*04/21/20 18:29*	*04/23/20 01:21*	*1*
Nitrobenzene-d5 (Surr)	*80*		*36 - 120*	*04/21/20 18:29*	*04/23/20 01:21*	*1*
Terphenyl-d14 (Surr)	*118*		*40 - 145*	*04/21/20 18:29*	*04/23/20 01:21*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.2**		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:03	1
Barium	**330**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:03	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 18:03	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:41	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:41	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-11
Date Collected: 04/16/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-15
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:03	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:41	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:31	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-13
Date Collected: 04/16/20 09:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-16
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 16:59	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 16:59	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 16:59	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 16:59	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 16:59	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 16:59	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 16:59	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 16:59	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 16:59	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 16:59	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 16:59	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 16:59	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 16:59	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 16:59	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 16:59	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 16:59	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:59	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 16:59	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 16:59	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 16:59	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 16:59	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 16:59	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 16:59	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 16:59	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 16:59	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 16:59	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 16:59	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 16:59	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 16:59	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 16:59	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 16:59	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 16:59	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 16:59	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 16:59	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1

Client Sample ID: TW-13

Date Collected: 04/16/20 09:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-16

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 16:59	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 16:59	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 16:59	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 16:59	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:59	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 16:59	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 16:59	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*		*04/27/20 16:59*	*1*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*		*04/27/20 16:59*	*1*
Dibromofluoromethane (Surr)	*108*		*75 - 120*		*04/27/20 16:59*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*		*04/27/20 16:59*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.26		1.8	0.26	ug/L		04/21/20 18:29	04/23/20 01:49	1
2-Methylnaphthalene	<0.057		1.8	0.057	ug/L		04/21/20 18:29	04/23/20 01:49	1
Acenaphthene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 01:49	1
Acenaphthylene	<0.23		0.88	0.23	ug/L		04/21/20 18:29	04/23/20 01:49	1
Anthracene	<0.29		0.88	0.29	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[a]anthracene	<0.050		0.18	0.050	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[a]pyrene	<0.087		0.18	0.087	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[b]fluoranthene	<0.071		0.18	0.071	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[g,h,i]perylene	<0.33		0.88	0.33	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[k]fluoranthene	<0.056		0.18	0.056	ug/L		04/21/20 18:29	04/23/20 01:49	1
Chrysene	<0.060		0.18	0.060	ug/L		04/21/20 18:29	04/23/20 01:49	1
Dibenz(a,h)anthracene	<0.044		0.26	0.044	ug/L		04/21/20 18:29	04/23/20 01:49	1
Fluoranthene	<0.40		0.88	0.40	ug/L		04/21/20 18:29	04/23/20 01:49	1
Fluorene	<0.21		0.88	0.21	ug/L		04/21/20 18:29	04/23/20 01:49	1
Indeno[1,2,3-cd]pyrene	<0.065		0.18	0.065	ug/L		04/21/20 18:29	04/23/20 01:49	1
Naphthalene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 01:49	1
Phenanthrene	<0.26		0.88	0.26	ug/L		04/21/20 18:29	04/23/20 01:49	1
Pyrene	<0.37		0.88	0.37	ug/L		04/21/20 18:29	04/23/20 01:49	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*91*		*34 - 110*	*04/21/20 18:29*	*04/23/20 01:49*	*1*
Nitrobenzene-d5 (Surr)	*85*		*36 - 120*	*04/21/20 18:29*	*04/23/20 01:49*	*1*
Terphenyl-d14 (Surr)	*111*		*40 - 145*	*04/21/20 18:29*	*04/23/20 01:49*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.77**	**J**	1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:07	1
Barium	**91**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:07	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 18:07	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:45	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:45	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-13
Date Collected: 04/16/20 09:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-16
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:07	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:45	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:53	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-15
Date Collected: 04/16/20 10:20
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-17
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 17:23	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 17:23	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 17:23	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 17:23	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 17:23	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 17:23	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 17:23	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 17:23	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 17:23	1
1,2,4-Trimethylbenzene	**3.9**		1.0	0.36	ug/L			04/27/20 17:23	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 17:23	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 17:23	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 17:23	1
1,3,5-Trimethylbenzene	**2.4**		1.0	0.25	ug/L			04/27/20 17:23	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:23	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 17:23	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 17:23	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 17:23	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 17:23	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:23	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 17:23	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 17:23	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 17:23	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 17:23	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 17:23	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 17:23	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 17:23	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 17:23	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 17:23	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 17:23	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 17:23	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 17:23	1
Ethylbenzene	**0.21**	**J**	0.50	0.18	ug/L			04/27/20 17:23	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 17:23	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 17:23	1
Isopropylbenzene	**2.9**		1.0	0.39	ug/L			04/27/20 17:23	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 17:23	1
n-Butylbenzene	**9.2**		1.0	0.39	ug/L			04/27/20 17:23	1
N-Propylbenzene	**4.6**		1.0	0.41	ug/L			04/27/20 17:23	1
p-Isopropyltoluene	**2.1**		1.0	0.36	ug/L			04/27/20 17:23	1
sec-Butylbenzene	**3.6**		1.0	0.40	ug/L			04/27/20 17:23	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-15

Date Collected: 04/16/20 10:20
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-17

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:23	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 17:23	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 17:23	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 17:23	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 17:23	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:23	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 17:23	1
Xylenes, Total	**1.6**		1.0	0.22	ug/L			04/27/20 17:23	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*		*04/27/20 17:23*	*1*
4-Bromofluorobenzene (Surr)	*82*		*72 - 124*		*04/27/20 17:23*	*1*
Dibromofluoromethane (Surr)	*105*		*75 - 120*		*04/27/20 17:23*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 17:23*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.26		1.7	0.26	ug/L		04/21/20 18:29	04/23/20 02:17	1
2-Methylnaphthalene	<0.057		1.7	0.057	ug/L		04/21/20 18:29	04/23/20 02:17	1
Acenaphthene	<0.27		0.87	0.27	ug/L		04/21/20 18:29	04/23/20 02:17	1
Acenaphthylene	<0.23		0.87	0.23	ug/L		04/21/20 18:29	04/23/20 02:17	1
Anthracene	<0.29		0.87	0.29	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[a]anthracene	<0.049		0.17	0.049	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[a]pyrene	<0.086		0.17	0.086	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[b]fluoranthene	<0.070		0.17	0.070	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[g,h,i]perylene	<0.33		0.87	0.33	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[k]fluoranthene	<0.056		0.17	0.056	ug/L		04/21/20 18:29	04/23/20 02:17	1
Chrysene	<0.059		0.17	0.059	ug/L		04/21/20 18:29	04/23/20 02:17	1
Dibenz(a,h)anthracene	<0.044		0.26	0.044	ug/L		04/21/20 18:29	04/23/20 02:17	1
Fluoranthene	<0.39		0.87	0.39	ug/L		04/21/20 18:29	04/23/20 02:17	1
Fluorene	<0.21		0.87	0.21	ug/L		04/21/20 18:29	04/23/20 02:17	1
Indeno[1,2,3-cd]pyrene	<0.065		0.17	0.065	ug/L		04/21/20 18:29	04/23/20 02:17	1
Naphthalene	<0.27		0.87	0.27	ug/L		04/21/20 18:29	04/23/20 02:17	1
Phenanthrene	<0.26		0.87	0.26	ug/L		04/21/20 18:29	04/23/20 02:17	1
Pyrene	<0.37		0.87	0.37	ug/L		04/21/20 18:29	04/23/20 02:17	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*85*		*34 - 110*	*04/21/20 18:29*	*04/23/20 02:17*	*1*
Nitrobenzene-d5 (Surr)	*86*		*36 - 120*	*04/21/20 18:29*	*04/23/20 02:17*	*1*
Terphenyl-d14 (Surr)	*114*		*40 - 145*	*04/21/20 18:29*	*04/23/20 02:17*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.0**		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:18	1
Barium	**47**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:18	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/23/20 12:48	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:48	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:48	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-15
Date Collected: 04/16/20 10:20
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-17
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	**7.9**		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:18	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:48	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:55	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-17
Date Collected: 04/16/20 12:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-18
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 17:47	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 17:47	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 17:47	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 17:47	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 17:47	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 17:47	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 17:47	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 17:47	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 17:47	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 17:47	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 17:47	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 17:47	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 17:47	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 17:47	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 17:47	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 17:47	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:47	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 17:47	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 17:47	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 17:47	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 17:47	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 17:47	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 17:47	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 17:47	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 17:47	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 17:47	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 17:47	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 17:47	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 17:47	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 17:47	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 17:47	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 17:47	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 17:47	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 17:47	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1

Client Sample ID: TW-17

Date Collected: 04/16/20 12:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-18

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 17:47	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 17:47	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 17:47	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 17:47	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:47	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 17:47	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 17:47	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*		*04/27/20 17:47*	*1*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*		*04/27/20 17:47*	*1*
Dibromofluoromethane (Surr)	*105*		*75 - 120*		*04/27/20 17:47*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 17:47*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.27		1.8	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
2-Methylnaphthalene	<0.057		1.8	0.057	ug/L		04/21/20 18:29	04/23/20 02:45	1
Acenaphthene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
Acenaphthylene	<0.24		0.88	0.24	ug/L		04/21/20 18:29	04/23/20 02:45	1
Anthracene	<0.29		0.88	0.29	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[a]anthracene	**0.21**		0.18	0.050	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[a]pyrene	**0.36**		0.18	0.087	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[b]fluoranthene	**0.29**		0.18	0.071	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[g,h,i]perylene	<0.33		0.88	0.33	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[k]fluoranthene	**0.23**		0.18	0.056	ug/L		04/21/20 18:29	04/23/20 02:45	1
Chrysene	**0.17**	**J**	0.18	0.060	ug/L		04/21/20 18:29	04/23/20 02:45	1
Dibenz(a,h)anthracene	<0.045		0.26	0.045	ug/L		04/21/20 18:29	04/23/20 02:45	1
Fluoranthene	<0.40		0.88	0.40	ug/L		04/21/20 18:29	04/23/20 02:45	1
Fluorene	<0.21		0.88	0.21	ug/L		04/21/20 18:29	04/23/20 02:45	1
Indeno[1,2,3-cd]pyrene	**0.23**		0.18	0.066	ug/L		04/21/20 18:29	04/23/20 02:45	1
Naphthalene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
Phenanthrene	**0.29**	**J**	0.88	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
Pyrene	<0.38		0.88	0.38	ug/L		04/21/20 18:29	04/23/20 02:45	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*98*		*34 - 110*	*04/21/20 18:29*	*04/23/20 02:45*	*1*
Nitrobenzene-d5 (Surr)	*88*		*36 - 120*	*04/21/20 18:29*	*04/23/20 02:45*	*1*
Terphenyl-d14 (Surr)	*109*		*40 - 145*	*04/21/20 18:29*	*04/23/20 02:45*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.3**		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:22	1
Barium	**67**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:22	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/23/20 12:52	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:52	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:52	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-17
Date Collected: 04/16/20 12:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-18
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:22	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:52	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:57	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: Trip Blank

Date Collected: 04/16/20 00:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-19

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 18:11	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 18:11	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 18:11	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 18:11	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 18:11	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 18:11	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 18:11	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 18:11	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 18:11	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 18:11	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 18:11	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 18:11	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 18:11	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 18:11	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 18:11	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 18:11	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 18:11	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 18:11	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 18:11	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 18:11	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 18:11	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 18:11	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 18:11	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 18:11	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 18:11	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 18:11	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 18:11	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 18:11	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 18:11	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 18:11	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 18:11	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 18:11	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 18:11	1
Naphthalene	<0.34		1.0	0.34	ug/L			04/27/20 18:11	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 18:11	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: Trip Blank
Date Collected: 04/16/20 00:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-19
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 18:11	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 18:11	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 18:11	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 18:11	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 18:11	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 18:11	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 18:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*		*04/27/20 18:11*	*1*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*		*04/27/20 18:11*	*1*
Dibromofluoromethane (Surr)	*109*		*75 - 120*		*04/27/20 18:11*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 18:11*	*1*

Definitions/Glossary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
*	LCS or LCSD is outside acceptance limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

GC/MS VOA

Prep Batch: 539190

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	5035	
500-180867-2	HA-2	Total/NA	Solid	5035	
500-180867-3	HA-3	Total/NA	Solid	5035	
500-180867-4	HA-4	Total/NA	Solid	5035	
500-180867-5	HA-5	Total/NA	Solid	5035	
500-180867-6	HA-6	Total/NA	Solid	5035	
500-180867-7	HA-7	Total/NA	Solid	5035	
500-180867-8	HA-8	Total/NA	Solid	5035	
500-180867-9	HA-9	Total/NA	Solid	5035	
500-180867-10	HA-10	Total/NA	Solid	5035	
500-180867-11	HA-11	Total/NA	Solid	5035	
500-180867-12	HA-12	Total/NA	Solid	5035	

Analysis Batch: 539811

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	8260B	539190
500-180867-2	HA-2	Total/NA	Solid	8260B	539190
500-180867-3	HA-3	Total/NA	Solid	8260B	539190
500-180867-4	HA-4	Total/NA	Solid	8260B	539190
500-180867-5	HA-5	Total/NA	Solid	8260B	539190
500-180867-6	HA-6	Total/NA	Solid	8260B	539190
500-180867-7	HA-7	Total/NA	Solid	8260B	539190
500-180867-8	HA-8	Total/NA	Solid	8260B	539190
500-180867-9	HA-9	Total/NA	Solid	8260B	539190
500-180867-10	HA-10	Total/NA	Solid	8260B	539190
500-180867-11	HA-11	Total/NA	Solid	8260B	539190
500-180867-12	HA-12	Total/NA	Solid	8260B	539190
MB 500-539811/6	Method Blank	Total/NA	Solid	8260B	
LCS 500-539811/4	Lab Control Sample	Total/NA	Solid	8260B	

Analysis Batch: 539816

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Total/NA	Water	8260B	
500-180867-15	TW-11	Total/NA	Water	8260B	
500-180867-16	TW-13	Total/NA	Water	8260B	
500-180867-17	TW-15	Total/NA	Water	8260B	
500-180867-18	TW-17	Total/NA	Water	8260B	
500-180867-19	Trip Blank	Total/NA	Water	8260B	
MB 500-539816/6	Method Blank	Total/NA	Water	8260B	
LCS 500-539816/4	Lab Control Sample	Total/NA	Water	8260B	

GC/MS Semi VOA

Prep Batch: 539168

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Total/NA	Water	3510C	
500-180867-15	TW-11	Total/NA	Water	3510C	
500-180867-16	TW-13	Total/NA	Water	3510C	
500-180867-17	TW-15	Total/NA	Water	3510C	
500-180867-18	TW-17	Total/NA	Water	3510C	
MB 500-539168/1-A	Method Blank	Total/NA	Water	3510C	

GC/MS Semi VOA (Continued)

Prep Batch: 539168 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 500-539168/2-A	Lab Control Sample	Total/NA	Water	3510C	
LCSD 500-539168/3-A	Lab Control Sample Dup	Total/NA	Water	3510C	

Analysis Batch: 539355

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Total/NA	Water	8270D	539168
500-180867-15	TW-11	Total/NA	Water	8270D	539168
500-180867-16	TW-13	Total/NA	Water	8270D	539168
500-180867-17	TW-15	Total/NA	Water	8270D	539168
500-180867-18	TW-17	Total/NA	Water	8270D	539168
MB 500-539168/1-A	Method Blank	Total/NA	Water	8270D	539168
LCS 500-539168/2-A	Lab Control Sample	Total/NA	Water	8270D	539168
LCSD 500-539168/3-A	Lab Control Sample Dup	Total/NA	Water	8270D	539168

Prep Batch: 540269

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	3541	
500-180867-2	HA-2	Total/NA	Solid	3541	
500-180867-3	HA-3	Total/NA	Solid	3541	
500-180867-4	HA-4	Total/NA	Solid	3541	
500-180867-5	HA-5	Total/NA	Solid	3541	
500-180867-6	HA-6	Total/NA	Solid	3541	
500-180867-7	HA-7	Total/NA	Solid	3541	
500-180867-8	HA-8	Total/NA	Solid	3541	
500-180867-9	HA-9	Total/NA	Solid	3541	
500-180867-10	HA-10	Total/NA	Solid	3541	
500-180867-11	HA-11	Total/NA	Solid	3541	
500-180867-12	HA-12	Total/NA	Solid	3541	
MB 500-540269/1-A	Method Blank	Total/NA	Solid	3541	
LCS 500-540269/2-A	Lab Control Sample	Total/NA	Solid	3541	

Analysis Batch: 540348

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-540269/1-A	Method Blank	Total/NA	Solid	8270D	540269
LCS 500-540269/2-A	Lab Control Sample	Total/NA	Solid	8270D	540269

Analysis Batch: 540354

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	8270D	540269
500-180867-2	HA-2	Total/NA	Solid	8270D	540269
500-180867-3	HA-3	Total/NA	Solid	8270D	540269
500-180867-4	HA-4	Total/NA	Solid	8270D	540269
500-180867-5	HA-5	Total/NA	Solid	8270D	540269
500-180867-6	HA-6	Total/NA	Solid	8270D	540269
500-180867-7	HA-7	Total/NA	Solid	8270D	540269
500-180867-8	HA-8	Total/NA	Solid	8270D	540269
500-180867-9	HA-9	Total/NA	Solid	8270D	540269
500-180867-10	HA-10	Total/NA	Solid	8270D	540269
500-180867-12	HA-12	Total/NA	Solid	8270D	540269

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

GC/MS Semi VOA

Analysis Batch: 540575

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-11	HA-11	Total/NA	Solid	8270D	540269

Metals

Prep Batch: 539043

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	3050B	
500-180867-2	HA-2	Total/NA	Solid	3050B	
500-180867-3	HA-3	Total/NA	Solid	3050B	
500-180867-4	HA-4	Total/NA	Solid	3050B	
500-180867-5	HA-5	Total/NA	Solid	3050B	
500-180867-6	HA-6	Total/NA	Solid	3050B	
500-180867-7	HA-7	Total/NA	Solid	3050B	
500-180867-8	HA-8	Total/NA	Solid	3050B	
500-180867-9	HA-9	Total/NA	Solid	3050B	
500-180867-10	HA-10	Total/NA	Solid	3050B	
500-180867-11	HA-11	Total/NA	Solid	3050B	
500-180867-12	HA-12	Total/NA	Solid	3050B	
MB 500-539043/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-539043/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Prep Batch: 539129

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	3005A	
500-180867-15	TW-11	Dissolved	Water	3005A	
500-180867-16	TW-13	Dissolved	Water	3005A	
500-180867-17	TW-15	Dissolved	Water	3005A	
500-180867-18	TW-17	Dissolved	Water	3005A	
MB 500-539129/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 500-539129/2-A	Lab Control Sample	Total Recoverable	Water	3005A	

Analysis Batch: 539203

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	6010C	539043
500-180867-2	HA-2	Total/NA	Solid	6010C	539043
500-180867-3	HA-3	Total/NA	Solid	6010C	539043
500-180867-4	HA-4	Total/NA	Solid	6010C	539043
500-180867-5	HA-5	Total/NA	Solid	6010C	539043
500-180867-6	HA-6	Total/NA	Solid	6010C	539043
500-180867-7	HA-7	Total/NA	Solid	6010C	539043
500-180867-8	HA-8	Total/NA	Solid	6010C	539043
500-180867-9	HA-9	Total/NA	Solid	6010C	539043
500-180867-10	HA-10	Total/NA	Solid	6010C	539043
500-180867-11	HA-11	Total/NA	Solid	6010C	539043
500-180867-12	HA-12	Total/NA	Solid	6010C	539043
MB 500-539043/1-A	Method Blank	Total/NA	Solid	6010C	539043
LCS 500-539043/2-A	Lab Control Sample	Total/NA	Solid	6010C	539043

Analysis Batch: 539324

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-10	HA-10	Total/NA	Solid	6010C	539043

Metals

Analysis Batch: 539487

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	6020A	539129
500-180867-15	TW-11	Dissolved	Water	6020A	539129
500-180867-16	TW-13	Dissolved	Water	6020A	539129
500-180867-17	TW-15	Dissolved	Water	6020A	539129
500-180867-18	TW-17	Dissolved	Water	6020A	539129
MB 500-539129/1-A	Method Blank	Total Recoverable	Water	6020A	539129
LCS 500-539129/2-A	Lab Control Sample	Total Recoverable	Water	6020A	539129

Analysis Batch: 539529

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	6020A	539129
500-180867-15	TW-11	Dissolved	Water	6020A	539129
500-180867-16	TW-13	Dissolved	Water	6020A	539129
500-180867-17	TW-15	Dissolved	Water	6020A	539129
500-180867-18	TW-17	Dissolved	Water	6020A	539129
MB 500-539129/1-A	Method Blank	Total Recoverable	Water	6020A	539129
LCS 500-539129/2-A	Lab Control Sample	Total Recoverable	Water	6020A	539129

Prep Batch: 539655

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	7470A	
500-180867-15	TW-11	Dissolved	Water	7470A	
500-180867-16	TW-13	Dissolved	Water	7470A	
500-180867-17	TW-15	Dissolved	Water	7470A	
500-180867-18	TW-17	Dissolved	Water	7470A	
MB 500-539655/12-A	Method Blank	Total/NA	Water	7470A	
LCS 500-539655/13-A	Lab Control Sample	Total/NA	Water	7470A	
500-180867-15 MS	TW-11	Dissolved	Water	7470A	
500-180867-15 MSD	TW-11	Dissolved	Water	7470A	
500-180867-15 DU	TW-11	Dissolved	Water	7470A	

Prep Batch: 539663

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	7471B	
500-180867-2	HA-2	Total/NA	Solid	7471B	
500-180867-3	HA-3	Total/NA	Solid	7471B	
500-180867-4	HA-4	Total/NA	Solid	7471B	
500-180867-5	HA-5	Total/NA	Solid	7471B	
500-180867-6	HA-6	Total/NA	Solid	7471B	
500-180867-7	HA-7	Total/NA	Solid	7471B	
500-180867-8	HA-8	Total/NA	Solid	7471B	
500-180867-9	HA-9	Total/NA	Solid	7471B	
500-180867-10	HA-10	Total/NA	Solid	7471B	
MB 500-539663/12-A	Method Blank	Total/NA	Solid	7471B	
LCS 500-539663/13-A	Lab Control Sample	Total/NA	Solid	7471B	
500-180867-1 MS	HA-1	Total/NA	Solid	7471B	
500-180867-1 MSD	HA-1	Total/NA	Solid	7471B	
500-180867-1 DU	HA-1	Total/NA	Solid	7471B	

Metals

Prep Batch: 539665

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-11	HA-11	Total/NA	Solid	7471B	
500-180867-12	HA-12	Total/NA	Solid	7471B	
MB 500-539665/12-A	Method Blank	Total/NA	Solid	7471B	
LCS 500-539665/13-A	Lab Control Sample	Total/NA	Solid	7471B	

Analysis Batch: 539879

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	7470A	539655
500-180867-15	TW-11	Dissolved	Water	7470A	539655
500-180867-16	TW-13	Dissolved	Water	7470A	539655
500-180867-17	TW-15	Dissolved	Water	7470A	539655
500-180867-18	TW-17	Dissolved	Water	7470A	539655
MB 500-539655/12-A	Method Blank	Total/NA	Water	7470A	539655
LCS 500-539655/13-A	Lab Control Sample	Total/NA	Water	7470A	539655
500-180867-15 MS	TW-11	Dissolved	Water	7470A	539655
500-180867-15 MSD	TW-11	Dissolved	Water	7470A	539655
500-180867-15 DU	TW-11	Dissolved	Water	7470A	539655

Analysis Batch: 539887

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	7471B	539663
500-180867-2	HA-2	Total/NA	Solid	7471B	539663
500-180867-3	HA-3	Total/NA	Solid	7471B	539663
500-180867-4	HA-4	Total/NA	Solid	7471B	539663
500-180867-5	HA-5	Total/NA	Solid	7471B	539663
500-180867-6	HA-6	Total/NA	Solid	7471B	539663
500-180867-7	HA-7	Total/NA	Solid	7471B	539663
500-180867-8	HA-8	Total/NA	Solid	7471B	539663
500-180867-9	HA-9	Total/NA	Solid	7471B	539663
500-180867-10	HA-10	Total/NA	Solid	7471B	539663
500-180867-11	HA-11	Total/NA	Solid	7471B	539665
500-180867-12	HA-12	Total/NA	Solid	7471B	539665
MB 500-539663/12-A	Method Blank	Total/NA	Solid	7471B	539663
MB 500-539665/12-A	Method Blank	Total/NA	Solid	7471B	539665
LCS 500-539663/13-A	Lab Control Sample	Total/NA	Solid	7471B	539663
LCS 500-539665/13-A	Lab Control Sample	Total/NA	Solid	7471B	539665
500-180867-1 MS	HA-1	Total/NA	Solid	7471B	539663
500-180867-1 MSD	HA-1	Total/NA	Solid	7471B	539663
500-180867-1 DU	HA-1	Total/NA	Solid	7471B	539663

Leach Batch: 539901

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	1311	
LB 500-539901/1-B	Method Blank	TCLP	Solid	1311	
LB 500-539901/1-D	Method Blank	TCLP	Solid	1311	

Prep Batch: 540208

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	3010A	539901
LB 500-539901/1-B	Method Blank	TCLP	Solid	3010A	539901
LCS 500-540208/2-A	Lab Control Sample	Total/NA	Solid	3010A	

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Metals

Prep Batch: 540294

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	7470A	539901
LB 500-539901/1-D	Method Blank	TCLP	Solid	7470A	539901
MB 500-540294/12-A	Method Blank	Total/NA	Solid	7470A	
LCS 500-540294/14-A	Lab Control Sample	Total/NA	Solid	7470A	

Analysis Batch: 540392

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	6010C	540208
LB 500-539901/1-B	Method Blank	TCLP	Solid	6010C	540208
LCS 500-540208/2-A	Lab Control Sample	Total/NA	Solid	6010C	540208

Analysis Batch: 540518

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	7470A	540294
LB 500-539901/1-D	Method Blank	TCLP	Solid	7470A	540294
MB 500-540294/12-A	Method Blank	Total/NA	Solid	7470A	540294
LCS 500-540294/14-A	Lab Control Sample	Total/NA	Solid	7470A	540294

General Chemistry

Analysis Batch: 538860

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	Moisture	
500-180867-2	HA-2	Total/NA	Solid	Moisture	
500-180867-3	HA-3	Total/NA	Solid	Moisture	
500-180867-4	HA-4	Total/NA	Solid	Moisture	
500-180867-5	HA-5	Total/NA	Solid	Moisture	
500-180867-6	HA-6	Total/NA	Solid	Moisture	
500-180867-7	HA-7	Total/NA	Solid	Moisture	
500-180867-8	HA-8	Total/NA	Solid	Moisture	
500-180867-9	HA-9	Total/NA	Solid	Moisture	
500-180867-10	HA-10	Total/NA	Solid	Moisture	
500-180867-11	HA-11	Total/NA	Solid	Moisture	
500-180867-12	HA-12	Total/NA	Solid	Moisture	
500-180867-2 DU	HA-2	Total/NA	Solid	Moisture	

Surrogate Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Solid — **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(75-126)	(72-124)	(75-120)	(75-120)
500-180867-1	HA-1	94	89	98	107
500-180867-2	HA-2	94	88	97	106
500-180867-3	HA-3	100	87	101	106
500-180867-4	HA-4	96	87	99	106
500-180867-5	HA-5	101	87	98	106
500-180867-6	HA-6	98	88	99	104
500-180867-7	HA-7	98	90	101	103
500-180867-8	HA-8	99	89	99	106
500-180867-9	HA-9	103	88	102	102
500-180867-10	HA-10	104	90	103	103
500-180867-11	HA-11	102	89	102	105
500-180867-12	HA-12	105	90	103	101
LCS 500-539811/4	Lab Control Sample	101	89	106	102
MB 500-539811/6	Method Blank	100	89	103	103

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Water — **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(75-126)	(72-124)	(75-120)	(75-120)
500-180867-14	TW-10	105	88	105	99
500-180867-15	TW-11	101	87	103	102
500-180867-16	TW-13	102	90	108	103
500-180867-17	TW-15	99	82	105	102
500-180867-18	TW-17	103	90	105	102
500-180867-19	Trip Blank	105	89	109	102
LCS 500-539816/4	Lab Control Sample	101	89	106	102
MB 500-539816/6	Method Blank	100	89	103	103

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Solid — **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(43-145)	(37-147)	(42-157)
500-180867-1	HA-1	95	94	123
500-180867-2	HA-2	99	98	120
500-180867-3	HA-3	106	90	117

Surrogate Summary

Client: Stantec Consulting Corp. Job ID: 500-180867-1
Project/Site: Fox Shores Kaukauna - 193706620

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Matrix: Solid **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(43-145)	(37-147)	(42-157)
500-180867-4	HA-4	100	91	117
500-180867-5	HA-5	78	79	110
500-180867-6	HA-6	101	103	117
500-180867-7	HA-7	94	84	118
500-180867-8	HA-8	88	85	110
500-180867-9	HA-9	86	78	109
500-180867-10	HA-10	87	81	103
500-180867-11	HA-11	96	85	120
500-180867-12	HA-12	72	70	104
LCS 500-540269/2-A	Lab Control Sample	85	91	97
MB 500-540269/1-A	Method Blank	83	85	109

Surrogate Legend

FBP = 2-Fluorobiphenyl (Surr)
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Water **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(34-110)	(36-120)	(40-145)
500-180867-14	TW-10	86	84	125
500-180867-15	TW-11	84	80	118
500-180867-16	TW-13	91	85	111
500-180867-17	TW-15	85	86	114
500-180867-18	TW-17	98	88	109
LCS 500-539168/2-A	Lab Control Sample	92	89	111
LCSD 500-539168/3-A	Lab Control Sample Dup	91	95	120
MB 500-539168/1-A	Method Blank	85	89	123

Surrogate Legend

FBP = 2-Fluorobiphenyl (Surr)
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-539811/6
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/Kg			04/27/20 10:58	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/Kg			04/27/20 10:58	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/Kg			04/27/20 10:58	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/Kg			04/27/20 10:58	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/Kg			04/27/20 10:58	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/Kg			04/27/20 10:58	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/Kg			04/27/20 10:58	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/Kg			04/27/20 10:58	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/Kg			04/27/20 10:58	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/Kg			04/27/20 10:58	1
1,3,5-Trimethylbenzene	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/Kg			04/27/20 10:58	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/Kg			04/27/20 10:58	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/Kg			04/27/20 10:58	1
Benzene	<0.15		0.25	0.15	ug/Kg			04/27/20 10:58	1
Bromobenzene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
Bromochloromethane	<0.43		1.0	0.43	ug/Kg			04/27/20 10:58	1
Bromodichloromethane	<0.37		1.0	0.37	ug/Kg			04/27/20 10:58	1
Bromoform	<0.48		1.0	0.48	ug/Kg			04/27/20 10:58	1
Bromomethane	<0.80		3.0	0.80	ug/Kg			04/27/20 10:58	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
Chlorobenzene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
Chloroethane	<0.50		1.0	0.50	ug/Kg			04/27/20 10:58	1
Chloroform	<0.37		2.0	0.37	ug/Kg			04/27/20 10:58	1
Chloromethane	<0.32		1.0	0.32	ug/Kg			04/27/20 10:58	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/Kg			04/27/20 10:58	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/Kg			04/27/20 10:58	1
Dibromochloromethane	<0.49		1.0	0.49	ug/Kg			04/27/20 10:58	1
Dibromomethane	<0.27		1.0	0.27	ug/Kg			04/27/20 10:58	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/Kg			04/27/20 10:58	1
Ethylbenzene	<0.18		0.25	0.18	ug/Kg			04/27/20 10:58	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/Kg			04/27/20 10:58	1
Isopropyl ether	<0.28		1.0	0.28	ug/Kg			04/27/20 10:58	1
Isopropylbenzene	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
Methylene Chloride	<1.6		5.0	1.6	ug/Kg			04/27/20 10:58	1
Naphthalene	0.486	J	1.0	0.33	ug/Kg			04/27/20 10:58	1
n-Butylbenzene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
N-Propylbenzene	<0.41		1.0	0.41	ug/Kg			04/27/20 10:58	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539811/6
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
p-Isopropyltoluene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
Styrene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
Tetrachloroethene	<0.37		1.0	0.37	ug/Kg			04/27/20 10:58	1
Toluene	<0.15		0.25	0.15	ug/Kg			04/27/20 10:58	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/Kg			04/27/20 10:58	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
Trichloroethene	<0.16		0.50	0.16	ug/Kg			04/27/20 10:58	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/Kg			04/27/20 10:58	1
Vinyl chloride	<0.26		1.0	0.26	ug/Kg			04/27/20 10:58	1
Xylenes, Total	<0.22		0.50	0.22	ug/Kg			04/27/20 10:58	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*		*04/27/20 10:58*	*1*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*		*04/27/20 10:58*	*1*
Dibromofluoromethane (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*

Lab Sample ID: LCS 500-539811/4
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	52.3		ug/Kg		105	70 - 125
1,1,1-Trichloroethane	50.0	48.1		ug/Kg		96	70 - 125
1,1,2,2-Tetrachloroethane	50.0	51.4		ug/Kg		103	62 - 140
1,1,2-Trichloroethane	50.0	51.8		ug/Kg		104	71 - 130
1,1-Dichloroethane	50.0	44.7		ug/Kg		89	70 - 125
1,1-Dichloroethene	50.0	40.9		ug/Kg		82	67 - 122
1,1-Dichloropropene	50.0	46.8		ug/Kg		94	70 - 121
1,2,3-Trichlorobenzene	50.0	51.2		ug/Kg		102	51 - 145
1,2,3-Trichloropropane	50.0	48.4		ug/Kg		97	50 - 133
1,2,4-Trichlorobenzene	50.0	50.4		ug/Kg		101	57 - 137
1,2,4-Trimethylbenzene	50.0	48.0		ug/Kg		96	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	47.3		ug/Kg		95	56 - 123
1,2-Dibromoethane	50.0	53.1		ug/Kg		106	70 - 125
1,2-Dichlorobenzene	50.0	51.5		ug/Kg		103	70 - 125
1,2-Dichloroethane	50.0	49.4		ug/Kg		99	68 - 127
1,2-Dichloropropane	50.0	46.0		ug/Kg		92	67 - 130
1,3,5-Trimethylbenzene	50.0	48.5		ug/Kg		97	70 - 123
1,3-Dichlorobenzene	50.0	50.6		ug/Kg		101	70 - 125
1,3-Dichloropropane	50.0	50.8		ug/Kg		102	62 - 136
1,4-Dichlorobenzene	50.0	50.3		ug/Kg		101	70 - 120
2,2-Dichloropropane	50.0	46.6		ug/Kg		93	58 - 139
2-Chlorotoluene	50.0	48.3		ug/Kg		97	70 - 125
4-Chlorotoluene	50.0	48.7		ug/Kg		97	68 - 124
Benzene	50.0	50.1		ug/Kg		100	70 - 120

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-539811/4
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromobenzene	50.0	48.6		ug/Kg		97	70 - 122
Bromochloromethane	50.0	50.7		ug/Kg		101	65 - 122
Bromodichloromethane	50.0	50.3		ug/Kg		101	69 - 120
Bromoform	50.0	56.2		ug/Kg		112	56 - 132
Bromomethane	50.0	78.7	*	ug/Kg		157	40 - 152
Carbon tetrachloride	50.0	47.4		ug/Kg		95	59 - 133
Chlorobenzene	50.0	51.7		ug/Kg		103	70 - 120
Chloroethane	50.0	59.5		ug/Kg		119	48 - 136
Chloroform	50.0	49.0		ug/Kg		98	70 - 120
Chloromethane	50.0	28.1		ug/Kg		56	56 - 152
cis-1,2-Dichloroethene	50.0	50.8		ug/Kg		102	70 - 125
cis-1,3-Dichloropropene	50.0	50.0		ug/Kg		100	64 - 127
Dibromochloromethane	50.0	52.1		ug/Kg		104	68 - 125
Dibromomethane	50.0	55.4		ug/Kg		111	70 - 120
Dichlorodifluoromethane	50.0	26.3		ug/Kg		53	40 - 159
Ethylbenzene	50.0	51.6		ug/Kg		103	70 - 123
Hexachlorobutadiene	50.0	46.5		ug/Kg		93	51 - 150
Isopropylbenzene	50.0	48.2		ug/Kg		96	70 - 126
Methyl tert-butyl ether	50.0	50.3		ug/Kg		101	55 - 123
Methylene Chloride	50.0	48.6		ug/Kg		97	69 - 125
Naphthalene	50.0	49.9		ug/Kg		100	53 - 144
n-Butylbenzene	50.0	50.3		ug/Kg		101	68 - 125
N-Propylbenzene	50.0	49.3		ug/Kg		99	69 - 127
p-Isopropyltoluene	50.0	48.2		ug/Kg		96	70 - 125
sec-Butylbenzene	50.0	49.5		ug/Kg		99	70 - 123
Styrene	50.0	51.9		ug/Kg		104	70 - 120
tert-Butylbenzene	50.0	46.7		ug/Kg		93	70 - 121
Tetrachloroethene	50.0	52.3		ug/Kg		105	70 - 128
Toluene	50.0	51.1		ug/Kg		102	70 - 125
trans-1,2-Dichloroethene	50.0	48.0		ug/Kg		96	70 - 125
trans-1,3-Dichloropropene	50.0	49.7		ug/Kg		99	62 - 128
Trichloroethene	50.0	49.7		ug/Kg		99	70 - 125
Trichlorofluoromethane	50.0	48.0		ug/Kg		96	55 - 128
Vinyl chloride	50.0	36.9		ug/Kg		74	64 - 126
Xylenes, Total	100	103		ug/Kg		103	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*
Dibromofluoromethane (Surr)	*106*		*75 - 120*
Toluene-d8 (Surr)	*102*		*75 - 120*

Lab Sample ID: MB 500-539816/6
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 10:58	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539816/6
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 10:58	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 10:58	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 10:58	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 10:58	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 10:58	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 10:58	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 10:58	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 10:58	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 10:58	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 10:58	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 10:58	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 10:58	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 10:58	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 10:58	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 10:58	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 10:58	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 10:58	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 10:58	1
Bromomethane	<0.80		3.0	0.80	ug/L			04/27/20 10:58	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 10:58	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 10:58	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 10:58	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 10:58	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 10:58	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 10:58	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 10:58	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 10:58	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 10:58	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 10:58	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 10:58	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 10:58	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 10:58	1
Naphthalene	0.486	J	1.0	0.34	ug/L			04/27/20 10:58	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 10:58	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539816/6
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 10:58	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 10:58	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 10:58	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 10:58	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 10:58	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 10:58	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 10:58	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*		*04/27/20 10:58*	*1*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*		*04/27/20 10:58*	*1*
Dibromofluoromethane (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*

Lab Sample ID: LCS 500-539816/4
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	52.3		ug/L		105	70 - 125
1,1,1-Trichloroethane	50.0	48.1		ug/L		96	70 - 125
1,1,2,2-Tetrachloroethane	50.0	51.4		ug/L		103	62 - 140
1,1,2-Trichloroethane	50.0	51.8		ug/L		104	71 - 130
1,1-Dichloroethane	50.0	44.7		ug/L		89	70 - 125
1,1-Dichloroethene	50.0	40.9		ug/L		82	67 - 122
1,1-Dichloropropene	50.0	46.8		ug/L		94	70 - 121
1,2,3-Trichlorobenzene	50.0	51.2		ug/L		102	51 - 145
1,2,3-Trichloropropane	50.0	48.4		ug/L		97	50 - 133
1,2,4-Trichlorobenzene	50.0	50.4		ug/L		101	57 - 137
1,2,4-Trimethylbenzene	50.0	48.0		ug/L		96	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	47.3		ug/L		95	56 - 123
1,2-Dibromoethane	50.0	53.1		ug/L		106	70 - 125
1,2-Dichlorobenzene	50.0	51.5		ug/L		103	70 - 125
1,2-Dichloroethane	50.0	49.4		ug/L		99	68 - 127
1,2-Dichloropropane	50.0	46.0		ug/L		92	67 - 130
1,3,5-Trimethylbenzene	50.0	48.5		ug/L		97	70 - 123
1,3-Dichlorobenzene	50.0	50.6		ug/L		101	70 - 125
1,3-Dichloropropane	50.0	50.8		ug/L		102	62 - 136
1,4-Dichlorobenzene	50.0	50.3		ug/L		101	70 - 120
2,2-Dichloropropane	50.0	46.6		ug/L		93	58 - 139
2-Chlorotoluene	50.0	48.3		ug/L		97	70 - 125
4-Chlorotoluene	50.0	48.7		ug/L		97	68 - 124
Benzene	50.0	50.1		ug/L		100	70 - 120
Bromobenzene	50.0	48.6		ug/L		97	70 - 122
Bromochloromethane	50.0	50.7		ug/L		101	65 - 122

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-539816/4
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromodichloromethane	50.0	50.3		ug/L		101	69 - 120
Bromoform	50.0	56.2		ug/L		112	56 - 132
Bromomethane	50.0	78.7	*	ug/L		157	40 - 152
Carbon tetrachloride	50.0	47.4		ug/L		95	59 - 133
Chlorobenzene	50.0	51.7		ug/L		103	70 - 120
Chloroethane	50.0	59.5		ug/L		119	48 - 136
Chloroform	50.0	49.0		ug/L		98	70 - 120
Chloromethane	50.0	28.1		ug/L		56	56 - 152
cis-1,2-Dichloroethene	50.0	50.8		ug/L		102	70 - 125
cis-1,3-Dichloropropene	50.0	50.0		ug/L		100	64 - 127
Dibromochloromethane	50.0	52.1		ug/L		104	68 - 125
Dibromomethane	50.0	55.4		ug/L		111	70 - 120
Dichlorodifluoromethane	50.0	26.3		ug/L		53	40 - 159
Ethylbenzene	50.0	51.6		ug/L		103	70 - 123
Hexachlorobutadiene	50.0	46.5		ug/L		93	51 - 150
Isopropylbenzene	50.0	48.2		ug/L		96	70 - 126
Methyl tert-butyl ether	50.0	50.3		ug/L		101	55 - 123
Methylene Chloride	50.0	48.6		ug/L		97	69 - 125
Naphthalene	50.0	49.9		ug/L		100	53 - 144
n-Butylbenzene	50.0	50.3		ug/L		101	68 - 125
N-Propylbenzene	50.0	49.3		ug/L		99	69 - 127
p-Isopropyltoluene	50.0	48.2		ug/L		96	70 - 125
sec-Butylbenzene	50.0	49.5		ug/L		99	70 - 123
Styrene	50.0	51.9		ug/L		104	70 - 120
tert-Butylbenzene	50.0	46.7		ug/L		93	70 - 121
Tetrachloroethene	50.0	52.3		ug/L		105	70 - 128
Toluene	50.0	51.1		ug/L		102	70 - 125
trans-1,2-Dichloroethene	50.0	48.0		ug/L		96	70 - 125
trans-1,3-Dichloropropene	50.0	49.7		ug/L		99	62 - 128
Trichloroethene	50.0	49.7		ug/L		99	70 - 125
Trichlorofluoromethane	50.0	48.0		ug/L		96	55 - 128
Vinyl chloride	50.0	36.9		ug/L		74	64 - 126
Xylenes, Total	100	103		ug/L		103	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*
Dibromofluoromethane (Surr)	*106*		*75 - 120*
Toluene-d8 (Surr)	*102*		*75 - 120*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-539168/1-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539168

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.24		1.6	0.24	ug/L		04/21/20 18:29	04/22/20 23:30	1
2-Methylnaphthalene	<0.052		1.6	0.052	ug/L		04/21/20 18:29	04/22/20 23:30	1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539168/1-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539168

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	<0.25		0.80	0.25	ug/L		04/21/20 18:29	04/22/20 23:30	1
Acenaphthylene	<0.21		0.80	0.21	ug/L		04/21/20 18:29	04/22/20 23:30	1
Anthracene	<0.27		0.80	0.27	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[a]anthracene	<0.045		0.16	0.045	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[a]pyrene	<0.079		0.16	0.079	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[b]fluoranthene	<0.065		0.16	0.065	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[g,h,i]perylene	<0.30		0.80	0.30	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[k]fluoranthene	<0.051		0.16	0.051	ug/L		04/21/20 18:29	04/22/20 23:30	1
Chrysene	<0.055		0.16	0.055	ug/L		04/21/20 18:29	04/22/20 23:30	1
Dibenz(a,h)anthracene	<0.041		0.24	0.041	ug/L		04/21/20 18:29	04/22/20 23:30	1
Fluoranthene	<0.36		0.80	0.36	ug/L		04/21/20 18:29	04/22/20 23:30	1
Fluorene	<0.20		0.80	0.20	ug/L		04/21/20 18:29	04/22/20 23:30	1
Indeno[1,2,3-cd]pyrene	<0.060		0.16	0.060	ug/L		04/21/20 18:29	04/22/20 23:30	1
Naphthalene	<0.25		0.80	0.25	ug/L		04/21/20 18:29	04/22/20 23:30	1
Phenanthrene	<0.24		0.80	0.24	ug/L		04/21/20 18:29	04/22/20 23:30	1
Pyrene	<0.34		0.80	0.34	ug/L		04/21/20 18:29	04/22/20 23:30	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*85*		*34 - 110*	*04/21/20 18:29*	*04/22/20 23:30*	*1*
Nitrobenzene-d5 (Surr)	*89*		*36 - 120*	*04/21/20 18:29*	*04/22/20 23:30*	*1*
Terphenyl-d14 (Surr)	*123*		*40 - 145*	*04/21/20 18:29*	*04/22/20 23:30*	*1*

Lab Sample ID: LCS 500-539168/2-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539168

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	32.0	16.2		ug/L		51	38 - 110
2-Methylnaphthalene	32.0	16.0		ug/L		50	34 - 110
Acenaphthene	32.0	21.8		ug/L		68	46 - 110
Acenaphthylene	32.0	24.8		ug/L		78	47 - 113
Anthracene	32.0	34.2		ug/L		107	67 - 118
Benzo[a]anthracene	32.0	34.3		ug/L		107	70 - 126
Benzo[a]pyrene	32.0	34.3		ug/L		107	70 - 135
Benzo[b]fluoranthene	32.0	33.9		ug/L		106	69 - 136
Benzo[g,h,i]perylene	32.0	38.2		ug/L		119	70 - 135
Benzo[k]fluoranthene	32.0	32.0		ug/L		100	70 - 133
Chrysene	32.0	35.8		ug/L		112	68 - 129
Dibenz(a,h)anthracene	32.0	32.9		ug/L		103	70 - 134
Fluoranthene	32.0	39.3		ug/L		123	68 - 126
Fluorene	32.0	25.1		ug/L		78	53 - 120
Indeno[1,2,3-cd]pyrene	32.0	34.4		ug/L		107	65 - 133
Naphthalene	32.0	16.4		ug/L		51	36 - 110
Phenanthrene	32.0	32.3		ug/L		101	65 - 120
Pyrene	32.0	33.6		ug/L		105	70 - 126

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl (Surr)	*92*		*34 - 110*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-539168/2-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539168

Surrogate	LCS %Recovery	LCS Qualifier	Limits
Nitrobenzene-d5 (Surr)	89		36 - 120
Terphenyl-d14 (Surr)	111		40 - 145

Lab Sample ID: LCSD 500-539168/3-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 539168

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1-Methylnaphthalene			32.0	15.6		ug/L		49	38 - 110	4	20
2-Methylnaphthalene			32.0	15.6		ug/L		49	34 - 110	2	20
Acenaphthene			32.0	21.0		ug/L		66	46 - 110	4	20
Acenaphthylene			32.0	23.6		ug/L		74	47 - 113	5	20
Anthracene			32.0	34.1		ug/L		107	67 - 118	0	20
Benzo[a]anthracene			32.0	35.4		ug/L		111	70 - 126	3	20
Benzo[a]pyrene			32.0	35.0		ug/L		109	70 - 135	2	20
Benzo[b]fluoranthene			32.0	34.4		ug/L		108	69 - 136	2	20
Benzo[g,h,i]perylene			32.0	39.6		ug/L		124	70 - 135	4	20
Benzo[k]fluoranthene			32.0	33.6		ug/L		105	70 - 133	5	20
Chrysene			32.0	37.1		ug/L		116	68 - 129	4	20
Dibenz(a,h)anthracene			32.0	34.2		ug/L		107	70 - 134	4	20
Fluoranthene			32.0	39.2		ug/L		122	68 - 126	0	20
Fluorene			32.0	25.7		ug/L		80	53 - 120	2	20
Indeno[1,2,3-cd]pyrene			32.0	35.4		ug/L		111	65 - 133	3	20
Naphthalene			32.0	16.1		ug/L		50	36 - 110	2	20
Phenanthrene			32.0	32.7		ug/L		102	65 - 120	1	20
Pyrene			32.0	34.8		ug/L		109	70 - 126	3	20

Surrogate	LCSD %Recovery	LCSD Qualifier	Limits
2-Fluorobiphenyl (Surr)	91		34 - 110
Nitrobenzene-d5 (Surr)	95		36 - 120
Terphenyl-d14 (Surr)	120		40 - 145

Lab Sample ID: MB 500-540269/1-A
Matrix: Solid
Analysis Batch: 540348

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 540269

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<8.1		67	8.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
2-Methylnaphthalene	<6.1		67	6.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Acenaphthene	<6.0		33	6.0	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Acenaphthylene	<4.4		33	4.4	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Anthracene	<5.6		33	5.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[a]anthracene	<4.5		33	4.5	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[a]pyrene	<6.4		33	6.4	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[b]fluoranthene	<7.2		33	7.2	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[g,h,i]perylene	<11		33	11	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[k]fluoranthene	<9.8		33	9.8	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Chrysene	<9.1		33	9.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-540269/1-A
Matrix: Solid
Analysis Batch: 540348

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 540269

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dibenz(a,h)anthracene	<6.4		33	6.4	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Fluoranthene	<6.2		33	6.2	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Fluorene	<4.7		33	4.7	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Indeno[1,2,3-cd]pyrene	<8.6		33	8.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Naphthalene	<5.1		33	5.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Phenanthrene	<4.6		33	4.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Pyrene	<6.6		33	6.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*83*		*43 - 145*	*04/29/20 07:52*	*04/29/20 21:01*	*1*
Nitrobenzene-d5 (Surr)	*85*		*37 - 147*	*04/29/20 07:52*	*04/29/20 21:01*	*1*
Terphenyl-d14 (Surr)	*109*		*42 - 157*	*04/29/20 07:52*	*04/29/20 21:01*	*1*

Lab Sample ID: LCS 500-540269/2-A
Matrix: Solid
Analysis Batch: 540348

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 540269

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	1330	1240		ug/Kg		93	68 - 111
2-Methylnaphthalene	1330	1230		ug/Kg		92	69 - 112
Acenaphthene	1330	1270		ug/Kg		96	65 - 124
Acenaphthylene	1330	1140		ug/Kg		86	68 - 120
Anthracene	1330	1160		ug/Kg		87	70 - 114
Benzo[a]anthracene	1330	1320		ug/Kg		99	67 - 122
Benzo[a]pyrene	1330	1370		ug/Kg		103	65 - 133
Benzo[b]fluoranthene	1330	1340		ug/Kg		101	69 - 129
Benzo[g,h,i]perylene	1330	1430		ug/Kg		107	72 - 131
Benzo[k]fluoranthene	1330	1290		ug/Kg		97	68 - 127
Chrysene	1330	1230		ug/Kg		92	63 - 120
Dibenz(a,h)anthracene	1330	1330		ug/Kg		100	64 - 131
Fluoranthene	1330	1310		ug/Kg		98	62 - 120
Fluorene	1330	1250		ug/Kg		94	62 - 120
Indeno[1,2,3-cd]pyrene	1330	1300		ug/Kg		97	68 - 130
Naphthalene	1330	1110		ug/Kg		84	63 - 110
Phenanthrene	1330	1170		ug/Kg		88	62 - 120
Pyrene	1330	1220		ug/Kg		91	61 - 128

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl (Surr)	*85*		*43 - 145*
Nitrobenzene-d5 (Surr)	*91*		*37 - 147*
Terphenyl-d14 (Surr)	*97*		*42 - 157*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 500-539043/1-A
Matrix: Solid
Analysis Batch: 539203

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539043

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.34		1.0	0.34	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Barium	<0.11		1.0	0.11	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Cadmium	<0.036		0.20	0.036	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Chromium	<0.50		1.0	0.50	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Lead	<0.23		0.50	0.23	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Selenium	<0.59		1.0	0.59	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Silver	<0.13		0.50	0.13	mg/Kg		04/21/20 07:24	04/22/20 00:08	1

Lab Sample ID: LCS 500-539043/2-A
Matrix: Solid
Analysis Batch: 539203

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539043

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	10.0	9.55		mg/Kg		95	80 - 120
Barium	200	194		mg/Kg		97	80 - 120
Cadmium	5.00	4.82		mg/Kg		96	80 - 120
Chromium	20.0	19.5		mg/Kg		98	80 - 120
Lead	10.0	9.53		mg/Kg		95	80 - 120
Selenium	10.0	9.35		mg/Kg		94	80 - 120
Silver	5.00	4.75		mg/Kg		95	80 - 120

Lab Sample ID: LCS 500-540208/2-A
Matrix: Solid
Analysis Batch: 540392

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 540208

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	0.100	0.103		mg/L		103	80 - 120
Lead	0.100	0.0950		mg/L		95	80 - 120

Lab Sample ID: LB 500-539901/1-B
Matrix: Solid
Analysis Batch: 540392

Client Sample ID: Method Blank
Prep Type: TCLP
Prep Batch: 540208

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.010		0.050	0.010	mg/L		04/29/20 06:08	04/29/20 17:21	1
Lead	<0.0075		0.050	0.0075	mg/L		04/29/20 06:08	04/29/20 17:21	1

Method: 6020A - Metals (ICP/MS)

Lab Sample ID: MB 500-539129/1-A
Matrix: Water
Analysis Batch: 539487

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.23		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 16:49	1
Barium	<0.73		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 16:49	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 16:49	1
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 16:49	1

Method: 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 500-539129/1-A
Matrix: Water
Analysis Batch: 539529

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:25	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:25	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:25	1

Lab Sample ID: LCS 500-539129/2-A
Matrix: Water
Analysis Batch: 539487

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	100	104		ug/L		104	80 - 120
Barium	500	563		ug/L		113	80 - 120
Cadmium	50.0	55.2		ug/L		110	80 - 120
Selenium	100	107		ug/L		107	80 - 120

Lab Sample ID: LCS 500-539129/2-A
Matrix: Water
Analysis Batch: 539529

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chromium	200	203		ug/L		102	80 - 120
Lead	100	103		ug/L		103	80 - 120
Silver	50.0	51.6		ug/L		103	80 - 120

Method: 7470A - Mercury (CVAA)

Lab Sample ID: MB 500-539655/12-A
Matrix: Water
Analysis Batch: 539879

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539655

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:22	1

Lab Sample ID: LCS 500-539655/13-A
Matrix: Water
Analysis Batch: 539879

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539655

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	2.00	2.07		ug/L		103	80 - 120

Lab Sample ID: MB 500-540294/12-A
Matrix: Solid
Analysis Batch: 540518

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 540294

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.00020		0.00020	0.00020	mg/L		04/29/20 09:35	04/30/20 09:41	1

Method: 7470A - Mercury (CVAA) (Continued)

Lab Sample ID: LCS 500-540294/14-A
Matrix: Solid
Analysis Batch: 540518

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 540294

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury			0.00200	0.00206		mg/L		103	80 - 120		

Lab Sample ID: 500-180867-15 MS
Matrix: Water
Analysis Batch: 539879

Client Sample ID: TW-11
Prep Type: Dissolved
Prep Batch: 539655

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury	<0.098		1.00	1.15		ug/L		115	75 - 125		

Lab Sample ID: 500-180867-15 MSD
Matrix: Water
Analysis Batch: 539879

Client Sample ID: TW-11
Prep Type: Dissolved
Prep Batch: 539655

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury	<0.098		1.00	1.15		ug/L		115	75 - 125	0	20

Lab Sample ID: 500-180867-15 DU
Matrix: Water
Analysis Batch: 539879

Client Sample ID: TW-11
Prep Type: Dissolved
Prep Batch: 539655

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Mercury	<0.098		<0.098		ug/L		NC	20

Lab Sample ID: LB 500-539901/1-D
Matrix: Solid
Analysis Batch: 540518

Client Sample ID: Method Blank
Prep Type: TCLP
Prep Batch: 540294

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.00020		0.00020	0.00020	mg/L		04/29/20 09:35	04/30/20 10:20	1

Method: 7471B - Mercury (CVAA)

Lab Sample ID: MB 500-539663/12-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539663

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.0056		0.017	0.0056	mg/Kg		04/24/20 14:15	04/27/20 09:15	1

Lab Sample ID: LCS 500-539663/13-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539663

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury			0.167	0.160		mg/Kg		96	80 - 120		

Method: 7471B - Mercury (CVAA) (Continued)

Lab Sample ID: 500-180867-1 MS
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: HA-1
Prep Type: Total/NA
Prep Batch: 539663

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.070		0.0963	0.160		mg/Kg	☼	93	75 - 125

Lab Sample ID: 500-180867-1 MSD
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: HA-1
Prep Type: Total/NA
Prep Batch: 539663

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury	0.070		0.0963	0.174		mg/Kg	☼	108	75 - 125	8	20

Lab Sample ID: 500-180867-1 DU
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: HA-1
Prep Type: Total/NA
Prep Batch: 539663

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Mercury	0.070		0.0770		mg/Kg	☼	9	20

Lab Sample ID: MB 500-539665/12-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539665

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.0056		0.017	0.0056	mg/Kg		04/24/20 14:15	04/27/20 08:22	1

Lab Sample ID: LCS 500-539665/13-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539665

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.167	0.163		mg/Kg		98	80 - 120

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 08:45	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 11:22	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/29/20 23:26	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:46	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:10	MJG	TAL CHI

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid
Percent Solids: 81.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 09:10	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 11:46	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 01:18	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:51	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:18	MJG	TAL CHI

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid
Percent Solids: 82.9

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 09:25	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 12:10	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/29/20 23:54	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:55	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:20	MJG	TAL CHI

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 09:50	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 12:35	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 01:46	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:59	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:26	MJG	TAL CHI

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:05	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 12:59	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 02:14	NRJ	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:03	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:29	MJG	TAL CHI

Client Sample ID: HA-6
Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-6
Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6
Matrix: Solid
Percent Solids: 85.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:25	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 13:23	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 02:42	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:08	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:31	MJG	TAL CHI

Client Sample ID: HA-7
Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-7
Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7
Matrix: Solid
Percent Solids: 85.1

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:40	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 13:47	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/30/20 00:22	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:12	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:33	MJG	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:55	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 14:11	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/30/20 00:50	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:16	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:35	MJG	TAL CHI

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid
Percent Solids: 87.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 11:15	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 14:35	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/29/20 22:59	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:20	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:37	MJG	TAL CHI

Client Sample ID: HA-10
Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-10

Lab Sample ID: 500-180867-10
Date Collected: 04/15/20 11:30
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 86.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 11:30	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 14:59	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 03:10	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539324	04/22/20 11:05	JEF	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:33	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:39	MJG	TAL CHI

Client Sample ID: HA-11

Lab Sample ID: 500-180867-11
Date Collected: 04/15/20 11:50
Matrix: Solid
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-11

Lab Sample ID: 500-180867-11
Date Collected: 04/15/20 11:50
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 81.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 11:50	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 15:23	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540575	05/01/20 04:47	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:37	JEF	TAL CHI
Total/NA	Prep	7471B			539665	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 08:26	MJG	TAL CHI

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12
Date Collected: 04/15/20 12:10
Matrix: Solid
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12
Date Collected: 04/15/20 12:10
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 86.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 12:10	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 15:47	JDD	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12
Date Collected: 04/15/20 12:10
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 86.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/29/20 22:31	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:42	JEF	TAL CHI
Total/NA	Prep	7471B			539665	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 08:28	MJG	TAL CHI

Client Sample ID: Soil-Composite-1

Lab Sample ID: 500-180867-13
Date Collected: 04/15/20 12:40
Matrix: Solid
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
TCLP	Leach	1311			539901	04/27/20 11:55	BEC	TAL CHI
TCLP	Prep	3010A			540208	04/29/20 06:08	LMN	TAL CHI
TCLP	Analysis	6010C		1	540392	04/29/20 17:37	EEN	TAL CHI
TCLP	Leach	1311			539901	04/27/20 11:55	BEC	TAL CHI
TCLP	Prep	7470A			540294	04/29/20 09:35	MJG	TAL CHI
TCLP	Analysis	7470A		1	540518	04/30/20 10:23	MJG	TAL CHI

Client Sample ID: TW-10

Lab Sample ID: 500-180867-14
Date Collected: 04/16/20 08:50
Matrix: Water
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 16:11	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 00:53	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 17:59	FXG	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:36	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:29	MJG	TAL CHI

Client Sample ID: TW-11

Lab Sample ID: 500-180867-15
Date Collected: 04/16/20 11:15
Matrix: Water
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 16:35	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 01:21	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:03	FXG	TAL CHI

Client Sample ID: TW-11

Lab Sample ID: 500-180867-15

Date Collected: 04/16/20 11:15

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:41	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:31	MJG	TAL CHI

Client Sample ID: TW-13

Lab Sample ID: 500-180867-16

Date Collected: 04/16/20 09:40

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 16:59	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 01:49	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:07	FXG	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:45	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:53	MJG	TAL CHI

Client Sample ID: TW-15

Lab Sample ID: 500-180867-17

Date Collected: 04/16/20 10:20

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 17:23	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 02:17	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:18	FXG	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:48	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:55	MJG	TAL CHI

Client Sample ID: TW-17

Lab Sample ID: 500-180867-18

Date Collected: 04/16/20 12:00

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 17:47	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 02:45	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:22	FXG	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-17

Lab Sample ID: 500-180867-18

Date Collected: 04/16/20 12:00

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:52	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:57	MJG	TAL CHI

Client Sample ID: Trip Blank

Lab Sample ID: 500-180867-19

Date Collected: 04/16/20 00:00

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 18:11	JDD	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Stantec Consulting Corp. Job ID: 500-180867-1
Project/Site: Fox Shores Kaukauna - 193706620

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State	999580010	08-31-20

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins Environment Testing TestAmerica

COOLER 2 of 2

Client Information	Sampler: TYLER HISCHKE	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-80927-37067.1
Client Contact: Tyler Hischke	Phone: 920-278-3192	E-Mail: sandie.fredrick@testamericainc.com		Page: Page 1 of 2
Company: Stantec Consulting Corp.				Job #: 500-180867
Address: 1165 Scheuring Road	Due Date Requested:			
City: De Pere	TAT Requested (days): 10			
State, Zip: WI, 54115	PO #: 193706620			
Phone: 920-278-3192	WO #:			
Email: tyler.hischke@stantec.com	Project #: 50009659			
Project Name: Soils/Waters 193706620	SSOW#:			
Site: FOX SHORES KAJKAUNA				

500-180867 COC

Analysis Requested

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

	Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 7470A TCLP As, Pb, Hg	6010C, 7471B, 8270D RCRA/PAH	8260B - VOC	8270D - PAH	6020A, 7470A RCRA Dissolved	8260B - VOC	Total Number of containers	Special Instructions/Note:
				Preservation Code:				N	N	N	N	D	A		
1	HA-1	4/15/20	0845	G	Solid				X	X				3	
2	HA-2	4/15/20	0910	G	Solid				X	X				3	
3	HA-3	4/15/20	0925	G	Solid				X	X				3	
4	HA-4	4/15/20	0950	G	Solid				X	X				3	
5	HA-5	4/15/20	1005	G	Solid				X	X				3	
6	HA-6	4/15/20	1025	G	Solid				X	X				3	
7	HA-7	4/15/20	1040	G	Solid				X	X				3	
8	HA-8	4/15/20	1055	G	Solid				X	X				3	
9	HA-9	4/15/20	1115	G	Solid				X	X				3	
10	HA-10	4/15/20	1130	G	Solid				X	X				3	
11	HA-11	4/15/20	1150	G	Solid				X	X				3	

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time	Company	Received by:	Date/Time:	Company
TYLER HISCHKE	4/16/20 1500	STANTEC		4/17/20 0945	DA-CHI
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 0.5, 2.6

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins | Environment Testing TestAmerica

COOLER 2 of 2

Client Information	Sampler: TYLER HISCHKE	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-80927-37067.2
Client Contact: Tyler Hischke	Phone: 920-278-3192	E-Mail: sandie.fredrick@testamericainc.com		Page: Page 2 of 2
Company: Stantec Consulting Corp.		Analysis Requested		Job #: 500-180867
Address: 1165 Scheuring Road	Due Date Requested:			Preservation Codes: A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
City: De Pere	TAT Requested (days): 10			
State, Zip: WI, 54115				
Phone: 920-278-3192	PO #: 193706620			Other:
Email: tyler.hischke@stantec.com	WO #:			
Project Name: Soils/Waters 193706620	Project #: 50009659			
Site: FOX SHORES KAUKAUNA	SSOW#:			

	Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 7470A TCLP As, Pb, Hg	6010C, 7471B, 8270D RCRA/PAH	8260B - VOC	8270D - PAH RCRA Dissolved	6020A, 7470A	8260B - VOC	Total Number of containers	Special Instructions/Note:
				Preservation Code:				N	N	N	N	D	A		
12	HA-12	4/15/20	1210	G	Solid				X	X				3	
13	SOIL-COMPOSITE-1	4/15/20	1240	C	Solid			X						1	
14	TW-10	4/16/20	0850	G	Water	Y					X	X	X	6	
15	TW-11	4/16/20	1115	G	Water	Y					X	X	X	6	
16	TW-13	4/16/20	0940	G	Water	Y					X	X	X	6	
17	TW-15	4/16/20	1020	G	Water	Y					X	X	X	6	
18	TW-17	4/16/20	1200	G	Water	Y					X	X	X	6	
19	Trip Blank				Water										Added by TA
					Water										

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by: TYLER HISCHKE	Date/Time: 4/16/20	Company: STANTEC	Received by:	Date/Time: 4/17/20 0945	Company: TA-CHI
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks:		

Login Sample Receipt Checklist

Client: Stantec Consulting Corp. Job Number: 500-180867-1

Login Number: 180867 **List Source: Eurofins TestAmerica, Chicago**
List Number: 1
Creator: Scott, Sherri L

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	0.5,2.6
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	False	Received Trip Blank(s) not listed on COC.
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Appendix E

Groundwater Laboratory Analytical Reports and Chain-of-Custody Forms

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ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-169224-1
Client Project/Site: Fox Shores Apt. Kaukauna - 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Mr. Jeff Brand

Authorized for release by:
9/10/2019 5:02:55 PM

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Detection Summary 4
Method Summary 5
Sample Summary 6
Client Sample Results 7
Definitions 22
QC Association 23
Surrogate Summary 25
QC Sample Results 26
Chronicle 32
Certification Summary 34
Chain of Custody 35
Receipt Checklists 36

Job ID: 500-169224-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-169224-1

Comments
No additional comments.

Receipt
The samples were received on 8/29/2019 9:30 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 5.1° C.

GC/MS VOA
The following sample was collected in properly preserved vials for analysis of volatile organic compounds (VOCs). However, the pH was outside the required criteria when verified by the laboratory, and corrective action was not possible: TW15 (500-169224-4).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method(s) 8270D: The following sample was diluted due to the nature of the sample matrix: TW15 (500-169224-4). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Field Service / Mobile Lab
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW10 — Lab Sample ID: 500-169224-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	0.49	J	1.0	0.23	ug/L	1		6020A	Dissolved
Barium	45		2.5	0.73	ug/L	1		6020A	Dissolved
Selenium	1.3	J	2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW11 — Lab Sample ID: 500-169224-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	8.5		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	420		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: TW13 — Lab Sample ID: 500-169224-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	0.82	J	1.0	0.23	ug/L	1		6020A	Dissolved
Barium	190		2.5	0.73	ug/L	1		6020A	Dissolved
Selenium	1.1	J	2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW15 — Lab Sample ID: 500-169224-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	2.2		1.0	0.36	ug/L	1		8260B	Total/NA
1,3,5-Trimethylbenzene	1.3		1.0	0.25	ug/L	1		8260B	Total/NA
Isopropylbenzene	1.6		1.0	0.39	ug/L	1		8260B	Total/NA
Naphthalene	0.76	J	1.0	0.34	ug/L	1		8260B	Total/NA
N-Propylbenzene	2.0		1.0	0.41	ug/L	1		8260B	Total/NA
p-Isopropyltoluene	1.1		1.0	0.36	ug/L	1		8260B	Total/NA
sec-Butylbenzene	0.63	J	1.0	0.40	ug/L	1		8260B	Total/NA
Xylenes, Total	1.3		1.0	0.22	ug/L	1		8260B	Total/NA
1-Methylnaphthalene	4.0	J	16	2.4	ug/L	10		8270D	Total/NA
Chrysene	1.5	J	1.6	0.54	ug/L	10		8270D	Total/NA
Phenanthrene	2.8	J	7.9	2.4	ug/L	10		8270D	Total/NA
Arsenic	17		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	240		2.5	0.73	ug/L	1		6020A	Dissolved
Chromium	1.3	J	5.0	1.1	ug/L	1		6020A	Dissolved
Lead	0.31	J	0.50	0.19	ug/L	1		6020A	Dissolved
Selenium	1.8	J	2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW17 — Lab Sample ID: 500-169224-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	1.6		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	100		2.5	0.73	ug/L	1		6020A	Dissolved

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Stantec Consulting Corp.
Job ID: 500-169224-1
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL CHI
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL CHI
6020A	Metals (ICP/MS)	SW846	TAL CHI
7470A	Mercury (CVAA)	SW846	TAL CHI
3005A	Preparation, Total Recoverable or Dissolved Metals	SW846	TAL CHI
3510C	Liquid-Liquid Extraction (Separatory Funnel)	SW846	TAL CHI
5030B	Purge and Trap	SW846	TAL CHI
7470A	Preparation, Mercury	SW846	TAL CHI

Protocol References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
500-169224-1	TW10	Water	08/28/19 11:45	08/29/19 09:30	
500-169224-2	TW11	Water	08/28/19 12:26	08/29/19 09:30	
500-169224-3	TW13	Water	08/28/19 11:00	08/29/19 09:30	
500-169224-4	TW15	Water	08/28/19 10:23	08/29/19 09:30	
500-169224-5	TW17	Water	08/28/19 09:40	08/29/19 09:30	

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW10
Date Collected: 08/28/19 11:45
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-1
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			09/04/19 04:23	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			09/04/19 04:23	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			09/04/19 04:23	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			09/04/19 04:23	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			09/04/19 04:23	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			09/04/19 04:23	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			09/04/19 04:23	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			09/04/19 04:23	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			09/04/19 04:23	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			09/04/19 04:23	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			09/04/19 04:23	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			09/04/19 04:23	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			09/04/19 04:23	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			09/04/19 04:23	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			09/04/19 04:23	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			09/04/19 04:23	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			09/04/19 04:23	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			09/04/19 04:23	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			09/04/19 04:23	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			09/04/19 04:23	1
Benzene	<0.15		0.50	0.15	ug/L			09/04/19 04:23	1
Bromobenzene	<0.36		1.0	0.36	ug/L			09/04/19 04:23	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			09/04/19 04:23	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			09/04/19 04:23	1
Bromoform	<0.48		1.0	0.48	ug/L			09/04/19 04:23	1
Bromomethane	<0.80		3.0	0.80	ug/L			09/04/19 04:23	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			09/04/19 04:23	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
Chloroethane	<0.51		1.0	0.51	ug/L			09/04/19 04:23	1
Chloroform	<0.37		2.0	0.37	ug/L			09/04/19 04:23	1
Chloromethane	<0.32		1.0	0.32	ug/L			09/04/19 04:23	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			09/04/19 04:23	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			09/04/19 04:23	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			09/04/19 04:23	1
Dibromomethane	<0.27		1.0	0.27	ug/L			09/04/19 04:23	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			09/04/19 04:23	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			09/04/19 04:23	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			09/04/19 04:23	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			09/04/19 04:23	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			09/04/19 04:23	1
Naphthalene	<0.34		1.0	0.34	ug/L			09/04/19 04:23	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			09/04/19 04:23	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			09/04/19 04:23	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW10
Date Collected: 08/28/19 11:45
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-1
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 04:23	1
Styrene	<0.39		1.0	0.39	ug/L			09/04/19 04:23	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 04:23	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			09/04/19 04:23	1
Toluene	<0.15		0.50	0.15	ug/L			09/04/19 04:23	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			09/04/19 04:23	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			09/04/19 04:23	1
Trichloroethene	<0.16		0.50	0.16	ug/L			09/04/19 04:23	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			09/04/19 04:23	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			09/04/19 04:23	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			09/04/19 04:23	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*		*09/04/19 04:23*	*1*
4-Bromofluorobenzene (Surr)	*106*		*72 - 124*		*09/04/19 04:23*	*1*
Dibromofluoromethane	*101*		*75 - 120*		*09/04/19 04:23*	*1*
Toluene-d8 (Surr)	*105*		*75 - 120*		*09/04/19 04:23*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.23		1.5	0.23	ug/L		09/03/19 08:33	09/03/19 16:21	1
2-Methylnaphthalene	<0.050		1.5	0.050	ug/L		09/03/19 08:33	09/03/19 16:21	1
Acenaphthene	<0.23		0.76	0.23	ug/L		09/03/19 08:33	09/03/19 16:21	1
Acenaphthylene	<0.20		0.76	0.20	ug/L		09/03/19 08:33	09/03/19 16:21	1
Anthracene	<0.25		0.76	0.25	ug/L		09/03/19 08:33	09/03/19 16:21	1
Benzo[a]anthracene	<0.043		0.15	0.043	ug/L		09/03/19 08:33	09/03/19 16:21	1
Benzo[a]pyrene	<0.075		0.15	0.075	ug/L		09/03/19 08:33	09/03/19 16:21	1
Benzo[b]fluoranthene	<0.061		0.15	0.061	ug/L		09/03/19 08:33	09/03/19 16:21	1
Benzo[g,h,i]perylene	<0.29		0.76	0.29	ug/L		09/03/19 08:33	09/03/19 16:21	1
Benzo[k]fluoranthene	<0.049		0.15	0.049	ug/L		09/03/19 08:33	09/03/19 16:21	1
Chrysene	<0.052		0.15	0.052	ug/L		09/03/19 08:33	09/03/19 16:21	1
Dibenz(a,h)anthracene	<0.039		0.23	0.039	ug/L		09/03/19 08:33	09/03/19 16:21	1
Fluoranthene	<0.35		0.76	0.35	ug/L		09/03/19 08:33	09/03/19 16:21	1
Fluorene	<0.19		0.76	0.19	ug/L		09/03/19 08:33	09/03/19 16:21	1
Indeno[1,2,3-cd]pyrene	<0.057		0.15	0.057	ug/L		09/03/19 08:33	09/03/19 16:21	1
Naphthalene	<0.23		0.76	0.23	ug/L		09/03/19 08:33	09/03/19 16:21	1
Phenanthrene	<0.23		0.76	0.23	ug/L		09/03/19 08:33	09/03/19 16:21	1
Pyrene	<0.32		0.76	0.32	ug/L		09/03/19 08:33	09/03/19 16:21	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*90*		*34 - 110*	*09/03/19 08:33*	*09/03/19 16:21*	*1*
Nitrobenzene-d5 (Surr)	*82*		*36 - 120*	*09/03/19 08:33*	*09/03/19 16:21*	*1*
Terphenyl-d14 (Surr)	*111*		*40 - 145*	*09/03/19 08:33*	*09/03/19 16:21*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.49**	**J**	1.0	0.23	ug/L		08/29/19 16:25	08/30/19 13:59	1
Barium	**45**		2.5	0.73	ug/L		08/29/19 16:25	08/30/19 13:59	1
Cadmium	<0.17		0.50	0.17	ug/L		08/29/19 16:25	08/30/19 13:59	1
Chromium	<1.1		5.0	1.1	ug/L		08/29/19 16:25	08/30/19 13:59	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW10
Date Collected: 08/28/19 11:45
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-1
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	<0.19		0.50	0.19	ug/L		08/29/19 16:25	08/30/19 13:59	1
Selenium	**1.3**	**J**	2.5	0.98	ug/L		08/29/19 16:25	08/30/19 13:59	1
Silver	<0.12		0.50	0.12	ug/L		08/29/19 16:25	08/30/19 13:59	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		09/04/19 13:40	09/05/19 09:35	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW11
Date Collected: 08/28/19 12:26
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-2
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			09/04/19 04:49	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			09/04/19 04:49	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			09/04/19 04:49	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			09/04/19 04:49	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			09/04/19 04:49	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			09/04/19 04:49	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			09/04/19 04:49	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			09/04/19 04:49	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			09/04/19 04:49	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			09/04/19 04:49	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			09/04/19 04:49	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			09/04/19 04:49	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			09/04/19 04:49	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			09/04/19 04:49	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			09/04/19 04:49	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			09/04/19 04:49	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			09/04/19 04:49	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			09/04/19 04:49	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			09/04/19 04:49	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			09/04/19 04:49	1
Benzene	<0.15		0.50	0.15	ug/L			09/04/19 04:49	1
Bromobenzene	<0.36		1.0	0.36	ug/L			09/04/19 04:49	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			09/04/19 04:49	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			09/04/19 04:49	1
Bromoform	<0.48		1.0	0.48	ug/L			09/04/19 04:49	1
Bromomethane	<0.80		3.0	0.80	ug/L			09/04/19 04:49	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			09/04/19 04:49	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
Chloroethane	<0.51		1.0	0.51	ug/L			09/04/19 04:49	1
Chloroform	<0.37		2.0	0.37	ug/L			09/04/19 04:49	1
Chloromethane	<0.32		1.0	0.32	ug/L			09/04/19 04:49	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			09/04/19 04:49	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			09/04/19 04:49	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			09/04/19 04:49	1
Dibromomethane	<0.27		1.0	0.27	ug/L			09/04/19 04:49	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			09/04/19 04:49	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			09/04/19 04:49	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			09/04/19 04:49	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			09/04/19 04:49	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			09/04/19 04:49	1
Naphthalene	<0.34		1.0	0.34	ug/L			09/04/19 04:49	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			09/04/19 04:49	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			09/04/19 04:49	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW11
Date Collected: 08/28/19 12:26
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-2
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 04:49	1
Styrene	<0.39		1.0	0.39	ug/L			09/04/19 04:49	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 04:49	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			09/04/19 04:49	1
Toluene	<0.15		0.50	0.15	ug/L			09/04/19 04:49	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			09/04/19 04:49	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			09/04/19 04:49	1
Trichloroethene	<0.16		0.50	0.16	ug/L			09/04/19 04:49	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			09/04/19 04:49	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			09/04/19 04:49	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			09/04/19 04:49	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*		*09/04/19 04:49*	*1*
4-Bromofluorobenzene (Surr)	*104*		*72 - 124*		*09/04/19 04:49*	*1*
Dibromofluoromethane	*102*		*75 - 120*		*09/04/19 04:49*	*1*
Toluene-d8 (Surr)	*108*		*75 - 120*		*09/04/19 04:49*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.25		1.6	0.25	ug/L		09/03/19 08:33	09/03/19 16:50	1
2-Methylnaphthalene	<0.054		1.6	0.054	ug/L		09/03/19 08:33	09/03/19 16:50	1
Acenaphthene	<0.25		0.82	0.25	ug/L		09/03/19 08:33	09/03/19 16:50	1
Acenaphthylene	<0.22		0.82	0.22	ug/L		09/03/19 08:33	09/03/19 16:50	1
Anthracene	<0.27		0.82	0.27	ug/L		09/03/19 08:33	09/03/19 16:50	1
Benzo[a]anthracene	<0.047		0.16	0.047	ug/L		09/03/19 08:33	09/03/19 16:50	1
Benzo[a]pyrene	<0.081		0.16	0.081	ug/L		09/03/19 08:33	09/03/19 16:50	1
Benzo[b]fluoranthene	<0.066		0.16	0.066	ug/L		09/03/19 08:33	09/03/19 16:50	1
Benzo[g,h,i]perylene	<0.31		0.82	0.31	ug/L		09/03/19 08:33	09/03/19 16:50	1
Benzo[k]fluoranthene	<0.053		0.16	0.053	ug/L		09/03/19 08:33	09/03/19 16:50	1
Chrysene	<0.056		0.16	0.056	ug/L		09/03/19 08:33	09/03/19 16:50	1
Dibenz(a,h)anthracene	<0.042		0.25	0.042	ug/L		09/03/19 08:33	09/03/19 16:50	1
Fluoranthene	<0.37		0.82	0.37	ug/L		09/03/19 08:33	09/03/19 16:50	1
Fluorene	<0.20		0.82	0.20	ug/L		09/03/19 08:33	09/03/19 16:50	1
Indeno[1,2,3-cd]pyrene	<0.062		0.16	0.062	ug/L		09/03/19 08:33	09/03/19 16:50	1
Naphthalene	<0.25		0.82	0.25	ug/L		09/03/19 08:33	09/03/19 16:50	1
Phenanthrene	<0.25		0.82	0.25	ug/L		09/03/19 08:33	09/03/19 16:50	1
Pyrene	<0.35		0.82	0.35	ug/L		09/03/19 08:33	09/03/19 16:50	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*84*		*34 - 110*	*09/03/19 08:33*	*09/03/19 16:50*	*1*
Nitrobenzene-d5 (Surr)	*80*		*36 - 120*	*09/03/19 08:33*	*09/03/19 16:50*	*1*
Terphenyl-d14 (Surr)	*110*		*40 - 145*	*09/03/19 08:33*	*09/03/19 16:50*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**8.5**		1.0	0.23	ug/L		08/29/19 16:25	08/30/19 14:18	1
Barium	**420**		2.5	0.73	ug/L		08/29/19 16:25	08/30/19 14:18	1
Cadmium	<0.17		0.50	0.17	ug/L		08/29/19 16:25	08/30/19 14:18	1
Chromium	<1.1		5.0	1.1	ug/L		08/29/19 16:25	08/30/19 14:18	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW11
Date Collected: 08/28/19 12:26
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-2
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	<0.19		0.50	0.19	ug/L		08/29/19 16:25	08/30/19 14:18	1
Selenium	<0.98		2.5	0.98	ug/L		08/29/19 16:25	08/30/19 14:18	1
Silver	<0.12		0.50	0.12	ug/L		08/29/19 16:25	08/30/19 14:18	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		09/04/19 13:40	09/05/19 09:36	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW13
Date Collected: 08/28/19 11:00
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-3
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			09/04/19 05:14	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			09/04/19 05:14	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			09/04/19 05:14	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			09/04/19 05:14	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			09/04/19 05:14	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			09/04/19 05:14	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			09/04/19 05:14	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			09/04/19 05:14	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			09/04/19 05:14	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			09/04/19 05:14	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			09/04/19 05:14	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			09/04/19 05:14	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			09/04/19 05:14	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			09/04/19 05:14	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			09/04/19 05:14	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			09/04/19 05:14	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			09/04/19 05:14	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			09/04/19 05:14	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			09/04/19 05:14	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			09/04/19 05:14	1
Benzene	<0.15		0.50	0.15	ug/L			09/04/19 05:14	1
Bromobenzene	<0.36		1.0	0.36	ug/L			09/04/19 05:14	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			09/04/19 05:14	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			09/04/19 05:14	1
Bromoform	<0.48		1.0	0.48	ug/L			09/04/19 05:14	1
Bromomethane	<0.80		3.0	0.80	ug/L			09/04/19 05:14	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			09/04/19 05:14	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
Chloroethane	<0.51		1.0	0.51	ug/L			09/04/19 05:14	1
Chloroform	<0.37		2.0	0.37	ug/L			09/04/19 05:14	1
Chloromethane	<0.32		1.0	0.32	ug/L			09/04/19 05:14	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			09/04/19 05:14	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			09/04/19 05:14	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			09/04/19 05:14	1
Dibromomethane	<0.27		1.0	0.27	ug/L			09/04/19 05:14	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			09/04/19 05:14	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			09/04/19 05:14	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			09/04/19 05:14	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			09/04/19 05:14	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			09/04/19 05:14	1
Naphthalene	<0.34		1.0	0.34	ug/L			09/04/19 05:14	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			09/04/19 05:14	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			09/04/19 05:14	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW13

Date Collected: 08/28/19 11:00
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-3

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 05:14	1
Styrene	<0.39		1.0	0.39	ug/L			09/04/19 05:14	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 05:14	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			09/04/19 05:14	1
Toluene	<0.15		0.50	0.15	ug/L			09/04/19 05:14	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			09/04/19 05:14	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			09/04/19 05:14	1
Trichloroethene	<0.16		0.50	0.16	ug/L			09/04/19 05:14	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			09/04/19 05:14	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			09/04/19 05:14	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			09/04/19 05:14	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*		*09/04/19 05:14*	*1*
4-Bromofluorobenzene (Surr)	*106*		*72 - 124*		*09/04/19 05:14*	*1*
Dibromofluoromethane	*101*		*75 - 120*		*09/04/19 05:14*	*1*
Toluene-d8 (Surr)	*108*		*75 - 120*		*09/04/19 05:14*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.25		1.6	0.25	ug/L		09/03/19 08:33	09/03/19 17:19	1
2-Methylnaphthalene	<0.054		1.6	0.054	ug/L		09/03/19 08:33	09/03/19 17:19	1
Acenaphthene	<0.25		0.82	0.25	ug/L		09/03/19 08:33	09/03/19 17:19	1
Acenaphthylene	<0.22		0.82	0.22	ug/L		09/03/19 08:33	09/03/19 17:19	1
Anthracene	<0.27		0.82	0.27	ug/L		09/03/19 08:33	09/03/19 17:19	1
Benzo[a]anthracene	<0.047		0.16	0.047	ug/L		09/03/19 08:33	09/03/19 17:19	1
Benzo[a]pyrene	<0.081		0.16	0.081	ug/L		09/03/19 08:33	09/03/19 17:19	1
Benzo[b]fluoranthene	<0.066		0.16	0.066	ug/L		09/03/19 08:33	09/03/19 17:19	1
Benzo[g,h,i]perylene	<0.31		0.82	0.31	ug/L		09/03/19 08:33	09/03/19 17:19	1
Benzo[k]fluoranthene	<0.053		0.16	0.053	ug/L		09/03/19 08:33	09/03/19 17:19	1
Chrysene	<0.056		0.16	0.056	ug/L		09/03/19 08:33	09/03/19 17:19	1
Dibenz(a,h)anthracene	<0.042		0.25	0.042	ug/L		09/03/19 08:33	09/03/19 17:19	1
Fluoranthene	<0.37		0.82	0.37	ug/L		09/03/19 08:33	09/03/19 17:19	1
Fluorene	<0.20		0.82	0.20	ug/L		09/03/19 08:33	09/03/19 17:19	1
Indeno[1,2,3-cd]pyrene	<0.061		0.16	0.061	ug/L		09/03/19 08:33	09/03/19 17:19	1
Naphthalene	<0.25		0.82	0.25	ug/L		09/03/19 08:33	09/03/19 17:19	1
Phenanthrene	<0.25		0.82	0.25	ug/L		09/03/19 08:33	09/03/19 17:19	1
Pyrene	<0.35		0.82	0.35	ug/L		09/03/19 08:33	09/03/19 17:19	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*91*		*34 - 110*	*09/03/19 08:33*	*09/03/19 17:19*	*1*
Nitrobenzene-d5 (Surr)	*86*		*36 - 120*	*09/03/19 08:33*	*09/03/19 17:19*	*1*
Terphenyl-d14 (Surr)	*120*		*40 - 145*	*09/03/19 08:33*	*09/03/19 17:19*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.82**	**J**	1.0	0.23	ug/L		08/29/19 16:25	08/30/19 14:22	1
Barium	**190**		2.5	0.73	ug/L		08/29/19 16:25	08/30/19 14:22	1
Cadmium	<0.17		0.50	0.17	ug/L		08/29/19 16:25	08/30/19 14:22	1
Chromium	<1.1		5.0	1.1	ug/L		08/29/19 16:25	08/30/19 14:22	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW13
Date Collected: 08/28/19 11:00
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-3
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	<0.19		0.50	0.19	ug/L		08/29/19 16:25	08/30/19 14:22	1
Selenium	**1.1**	**J**	2.5	0.98	ug/L		08/29/19 16:25	08/30/19 14:22	1
Silver	<0.12		0.50	0.12	ug/L		08/29/19 16:25	08/30/19 14:22	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		09/04/19 13:40	09/05/19 09:38	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW15
Date Collected: 08/28/19 10:23
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-4
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			09/04/19 05:40	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			09/04/19 05:40	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			09/04/19 05:40	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			09/04/19 05:40	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			09/04/19 05:40	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			09/04/19 05:40	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			09/04/19 05:40	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			09/04/19 05:40	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			09/04/19 05:40	1
1,2,4-Trimethylbenzene	**2.2**		1.0	0.36	ug/L			09/04/19 05:40	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			09/04/19 05:40	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			09/04/19 05:40	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			09/04/19 05:40	1
1,3,5-Trimethylbenzene	**1.3**		1.0	0.25	ug/L			09/04/19 05:40	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			09/04/19 05:40	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			09/04/19 05:40	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			09/04/19 05:40	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			09/04/19 05:40	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			09/04/19 05:40	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			09/04/19 05:40	1
Benzene	<0.15		0.50	0.15	ug/L			09/04/19 05:40	1
Bromobenzene	<0.36		1.0	0.36	ug/L			09/04/19 05:40	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			09/04/19 05:40	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			09/04/19 05:40	1
Bromoform	<0.48		1.0	0.48	ug/L			09/04/19 05:40	1
Bromomethane	<0.80		3.0	0.80	ug/L			09/04/19 05:40	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			09/04/19 05:40	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
Chloroethane	<0.51		1.0	0.51	ug/L			09/04/19 05:40	1
Chloroform	<0.37		2.0	0.37	ug/L			09/04/19 05:40	1
Chloromethane	<0.32		1.0	0.32	ug/L			09/04/19 05:40	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			09/04/19 05:40	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			09/04/19 05:40	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			09/04/19 05:40	1
Dibromomethane	<0.27		1.0	0.27	ug/L			09/04/19 05:40	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			09/04/19 05:40	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			09/04/19 05:40	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			09/04/19 05:40	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			09/04/19 05:40	1
Isopropylbenzene	**1.6**		1.0	0.39	ug/L			09/04/19 05:40	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			09/04/19 05:40	1
Naphthalene	**0.76**	**J**	1.0	0.34	ug/L			09/04/19 05:40	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
N-Propylbenzene	**2.0**		1.0	0.41	ug/L			09/04/19 05:40	1
p-Isopropyltoluene	**1.1**		1.0	0.36	ug/L			09/04/19 05:40	1

Client Sample ID: TW15 — Lab Sample ID: 500-169224-4

Date Collected: 08/28/19 10:23 — **Matrix: Water**
Date Received: 08/29/19 09:30

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	**0.63**	**J**	1.0	0.40	ug/L			09/04/19 05:40	1
Styrene	<0.39		1.0	0.39	ug/L			09/04/19 05:40	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 05:40	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			09/04/19 05:40	1
Toluene	<0.15		0.50	0.15	ug/L			09/04/19 05:40	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			09/04/19 05:40	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			09/04/19 05:40	1
Trichloroethene	<0.16		0.50	0.16	ug/L			09/04/19 05:40	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			09/04/19 05:40	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			09/04/19 05:40	1
Xylenes, Total	**1.3**		1.0	0.22	ug/L			09/04/19 05:40	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*		*09/04/19 05:40*	*1*
4-Bromofluorobenzene (Surr)	*106*		*72 - 124*		*09/04/19 05:40*	*1*
Dibromofluoromethane	*99*		*75 - 120*		*09/04/19 05:40*	*1*
Toluene-d8 (Surr)	*106*		*75 - 120*		*09/04/19 05:40*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**4.0**	**J**	16	2.4	ug/L		09/03/19 08:33	09/04/19 19:26	10
2-Methylnaphthalene	<0.52		16	0.52	ug/L		09/03/19 08:33	09/04/19 19:26	10
Acenaphthene	<2.4		7.9	2.4	ug/L		09/03/19 08:33	09/04/19 19:26	10
Acenaphthylene	<2.1		7.9	2.1	ug/L		09/03/19 08:33	09/04/19 19:26	10
Anthracene	<2.6		7.9	2.6	ug/L		09/03/19 08:33	09/04/19 19:26	10
Benzo[a]anthracene	<0.45		1.6	0.45	ug/L		09/03/19 08:33	09/04/19 19:26	10
Benzo[a]pyrene	<0.78		1.6	0.78	ug/L		09/03/19 08:33	09/04/19 19:26	10
Benzo[b]fluoranthene	<0.64		1.6	0.64	ug/L		09/03/19 08:33	09/04/19 19:26	10
Benzo[g,h,i]perylene	<3.0		7.9	3.0	ug/L		09/03/19 08:33	09/04/19 19:26	10
Benzo[k]fluoranthene	<0.51		1.6	0.51	ug/L		09/03/19 08:33	09/04/19 19:26	10
Chrysene	**1.5**	**J**	1.6	0.54	ug/L		09/03/19 08:33	09/04/19 19:26	10
Dibenz(a,h)anthracene	<0.40		2.4	0.40	ug/L		09/03/19 08:33	09/04/19 19:26	10
Fluoranthene	<3.6		7.9	3.6	ug/L		09/03/19 08:33	09/04/19 19:26	10
Fluorene	<1.9		7.9	1.9	ug/L		09/03/19 08:33	09/04/19 19:26	10
Indeno[1,2,3-cd]pyrene	<0.59		1.6	0.59	ug/L		09/03/19 08:33	09/04/19 19:26	10
Naphthalene	<2.4		7.9	2.4	ug/L		09/03/19 08:33	09/04/19 19:26	10
Phenanthrene	**2.8**	**J**	7.9	2.4	ug/L		09/03/19 08:33	09/04/19 19:26	10
Pyrene	<3.4		7.9	3.4	ug/L		09/03/19 08:33	09/04/19 19:26	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*54*		*34 - 110*	*09/03/19 08:33*	*09/04/19 19:26*	*10*
Nitrobenzene-d5 (Surr)	*92*		*36 - 120*	*09/03/19 08:33*	*09/04/19 19:26*	*10*
Terphenyl-d14 (Surr)	*137*		*40 - 145*	*09/03/19 08:33*	*09/04/19 19:26*	*10*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**17**		1.0	0.23	ug/L		08/29/19 16:25	08/30/19 14:33	1
Barium	**240**		2.5	0.73	ug/L		08/29/19 16:25	08/30/19 14:33	1
Cadmium	<0.17		0.50	0.17	ug/L		08/29/19 16:25	08/30/19 14:33	1
Chromium	**1.3**	**J**	5.0	1.1	ug/L		08/29/19 16:25	08/30/19 14:33	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW15
Date Collected: 08/28/19 10:23
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-4
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	**0.31**	**J**	0.50	0.19	ug/L		08/29/19 16:25	08/30/19 14:33	1
Selenium	**1.8**	**J**	2.5	0.98	ug/L		08/29/19 16:25	08/30/19 14:33	1
Silver	<0.12		0.50	0.12	ug/L		08/29/19 16:25	08/30/19 14:33	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		09/04/19 13:40	09/05/19 09:43	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW17
Date Collected: 08/28/19 09:40
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-5
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			09/04/19 06:06	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			09/04/19 06:06	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			09/04/19 06:06	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			09/04/19 06:06	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			09/04/19 06:06	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			09/04/19 06:06	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			09/04/19 06:06	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			09/04/19 06:06	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			09/04/19 06:06	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			09/04/19 06:06	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			09/04/19 06:06	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			09/04/19 06:06	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			09/04/19 06:06	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			09/04/19 06:06	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			09/04/19 06:06	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			09/04/19 06:06	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			09/04/19 06:06	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			09/04/19 06:06	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			09/04/19 06:06	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			09/04/19 06:06	1
Benzene	<0.15		0.50	0.15	ug/L			09/04/19 06:06	1
Bromobenzene	<0.36		1.0	0.36	ug/L			09/04/19 06:06	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			09/04/19 06:06	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			09/04/19 06:06	1
Bromoform	<0.48		1.0	0.48	ug/L			09/04/19 06:06	1
Bromomethane	<0.80		3.0	0.80	ug/L			09/04/19 06:06	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			09/04/19 06:06	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
Chloroethane	<0.51		1.0	0.51	ug/L			09/04/19 06:06	1
Chloroform	<0.37		2.0	0.37	ug/L			09/04/19 06:06	1
Chloromethane	<0.32		1.0	0.32	ug/L			09/04/19 06:06	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			09/04/19 06:06	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			09/04/19 06:06	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			09/04/19 06:06	1
Dibromomethane	<0.27		1.0	0.27	ug/L			09/04/19 06:06	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			09/04/19 06:06	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			09/04/19 06:06	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			09/04/19 06:06	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			09/04/19 06:06	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			09/04/19 06:06	1
Naphthalene	<0.34		1.0	0.34	ug/L			09/04/19 06:06	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			09/04/19 06:06	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			09/04/19 06:06	1

Client Sample ID: TW17
Date Collected: 08/28/19 09:40
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-5
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 06:06	1
Styrene	<0.39		1.0	0.39	ug/L			09/04/19 06:06	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			09/04/19 06:06	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			09/04/19 06:06	1
Toluene	<0.15		0.50	0.15	ug/L			09/04/19 06:06	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			09/04/19 06:06	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			09/04/19 06:06	1
Trichloroethene	<0.16		0.50	0.16	ug/L			09/04/19 06:06	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			09/04/19 06:06	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			09/04/19 06:06	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			09/04/19 06:06	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*		*09/04/19 06:06*	*1*
4-Bromofluorobenzene (Surr)	*105*		*72 - 124*		*09/04/19 06:06*	*1*
Dibromofluoromethane	*103*		*75 - 120*		*09/04/19 06:06*	*1*
Toluene-d8 (Surr)	*108*		*75 - 120*		*09/04/19 06:06*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.24		1.6	0.24	ug/L		09/03/19 08:33	09/03/19 17:48	1
2-Methylnaphthalene	<0.052		1.6	0.052	ug/L		09/03/19 08:33	09/03/19 17:48	1
Acenaphthene	<0.24		0.79	0.24	ug/L		09/03/19 08:33	09/03/19 17:48	1
Acenaphthylene	<0.21		0.79	0.21	ug/L		09/03/19 08:33	09/03/19 17:48	1
Anthracene	<0.26		0.79	0.26	ug/L		09/03/19 08:33	09/03/19 17:48	1
Benzo[a]anthracene	<0.045		0.16	0.045	ug/L		09/03/19 08:33	09/03/19 17:48	1
Benzo[a]pyrene	<0.078		0.16	0.078	ug/L		09/03/19 08:33	09/03/19 17:48	1
Benzo[b]fluoranthene	<0.064		0.16	0.064	ug/L		09/03/19 08:33	09/03/19 17:48	1
Benzo[g,h,i]perylene	<0.30		0.79	0.30	ug/L		09/03/19 08:33	09/03/19 17:48	1
Benzo[k]fluoranthene	<0.051		0.16	0.051	ug/L		09/03/19 08:33	09/03/19 17:48	1
Chrysene	<0.054		0.16	0.054	ug/L		09/03/19 08:33	09/03/19 17:48	1
Dibenz(a,h)anthracene	<0.040		0.24	0.040	ug/L		09/03/19 08:33	09/03/19 17:48	1
Fluoranthene	<0.36		0.79	0.36	ug/L		09/03/19 08:33	09/03/19 17:48	1
Fluorene	<0.19		0.79	0.19	ug/L		09/03/19 08:33	09/03/19 17:48	1
Indeno[1,2,3-cd]pyrene	<0.059		0.16	0.059	ug/L		09/03/19 08:33	09/03/19 17:48	1
Naphthalene	<0.24		0.79	0.24	ug/L		09/03/19 08:33	09/03/19 17:48	1
Phenanthrene	<0.24		0.79	0.24	ug/L		09/03/19 08:33	09/03/19 17:48	1
Pyrene	<0.34		0.79	0.34	ug/L		09/03/19 08:33	09/03/19 17:48	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*86*		*34 - 110*	*09/03/19 08:33*	*09/03/19 17:48*	*1*
Nitrobenzene-d5 (Surr)	*75*		*36 - 120*	*09/03/19 08:33*	*09/03/19 17:48*	*1*
Terphenyl-d14 (Surr)	*113*		*40 - 145*	*09/03/19 08:33*	*09/03/19 17:48*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.6**		1.0	0.23	ug/L		08/29/19 16:25	08/30/19 14:37	1
Barium	**100**		2.5	0.73	ug/L		08/29/19 16:25	08/30/19 14:37	1
Cadmium	<0.17		0.50	0.17	ug/L		08/29/19 16:25	08/30/19 14:37	1
Chromium	<1.1		5.0	1.1	ug/L		08/29/19 16:25	08/30/19 14:37	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Client Sample ID: TW17
Date Collected: 08/28/19 09:40
Date Received: 08/29/19 09:30

Lab Sample ID: 500-169224-5
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	<0.19		0.50	0.19	ug/L		08/29/19 16:25	08/30/19 14:37	1
Selenium	<0.98		2.5	0.98	ug/L		08/29/19 16:25	08/30/19 14:37	1
Silver	<0.12		0.50	0.12	ug/L		08/29/19 16:25	08/30/19 14:37	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		09/04/19 13:40	09/05/19 09:45	1

Definitions/Glossary

Client: Stantec Consulting Corp. Job ID: 500-169224-1
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

GC/MS VOA

Analysis Batch: 502975

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Total/NA	Water	8260B	
500-169224-2	TW11	Total/NA	Water	8260B	
500-169224-3	TW13	Total/NA	Water	8260B	
500-169224-4	TW15	Total/NA	Water	8260B	
500-169224-5	TW17	Total/NA	Water	8260B	
MB 500-502975/6	Method Blank	Total/NA	Water	8260B	
LCS 500-502975/4	Lab Control Sample	Total/NA	Water	8260B	

GC/MS Semi VOA

Prep Batch: 502819

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Total/NA	Water	3510C	
500-169224-2	TW11	Total/NA	Water	3510C	
500-169224-3	TW13	Total/NA	Water	3510C	
500-169224-4	TW15	Total/NA	Water	3510C	
500-169224-5	TW17	Total/NA	Water	3510C	
MB 500-502819/1-A	Method Blank	Total/NA	Water	3510C	
LCS 500-502819/2-A	Lab Control Sample	Total/NA	Water	3510C	

Analysis Batch: 502871

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Total/NA	Water	8270D	502819
500-169224-2	TW11	Total/NA	Water	8270D	502819
500-169224-3	TW13	Total/NA	Water	8270D	502819
500-169224-5	TW17	Total/NA	Water	8270D	502819
MB 500-502819/1-A	Method Blank	Total/NA	Water	8270D	502819
LCS 500-502819/2-A	Lab Control Sample	Total/NA	Water	8270D	502819

Analysis Batch: 503083

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-4	TW15	Total/NA	Water	8270D	502819

Metals

Prep Batch: 502400

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Dissolved	Water	3005A	
500-169224-2	TW11	Dissolved	Water	3005A	
500-169224-3	TW13	Dissolved	Water	3005A	
500-169224-4	TW15	Dissolved	Water	3005A	
500-169224-5	TW17	Dissolved	Water	3005A	
MB 500-502400/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 500-502400/2-A	Lab Control Sample	Total Recoverable	Water	3005A	
500-169224-1 MS	TW10	Dissolved	Water	3005A	
500-169224-1 MSD	TW10	Dissolved	Water	3005A	
500-169224-1 DU	TW10	Dissolved	Water	3005A	

Analysis Batch: 502616

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Dissolved	Water	6020A	502400
500-169224-2	TW11	Dissolved	Water	6020A	502400

Metals (Continued)

Analysis Batch: 502616 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-3	TW13	Dissolved	Water	6020A	502400
500-169224-4	TW15	Dissolved	Water	6020A	502400
500-169224-5	TW17	Dissolved	Water	6020A	502400
MB 500-502400/1-A	Method Blank	Total Recoverable	Water	6020A	502400
LCS 500-502400/2-A	Lab Control Sample	Total Recoverable	Water	6020A	502400
500-169224-1 MS	TW10	Dissolved	Water	6020A	502400
500-169224-1 MSD	TW10	Dissolved	Water	6020A	502400
500-169224-1 DU	TW10	Dissolved	Water	6020A	502400

Prep Batch: 503120

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Dissolved	Water	7470A	
500-169224-2	TW11	Dissolved	Water	7470A	
500-169224-3	TW13	Dissolved	Water	7470A	
500-169224-4	TW15	Dissolved	Water	7470A	
500-169224-5	TW17	Dissolved	Water	7470A	
MB 500-503120/12-A	Method Blank	Total/NA	Water	7470A	
LCS 500-503120/13-A	Lab Control Sample	Total/NA	Water	7470A	

Analysis Batch: 503365

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-169224-1	TW10	Dissolved	Water	7470A	503120
500-169224-2	TW11	Dissolved	Water	7470A	503120
500-169224-3	TW13	Dissolved	Water	7470A	503120
500-169224-4	TW15	Dissolved	Water	7470A	503120
500-169224-5	TW17	Dissolved	Water	7470A	503120
MB 500-503120/12-A	Method Blank	Total/NA	Water	7470A	503120
LCS 500-503120/13-A	Lab Control Sample	Total/NA	Water	7470A	503120

Surrogate Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Water

Prep Type: Total/NA

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(75-126)	(72-124)	(75-120)	(75-120)
500-169224-1	TW10	102	106	101	105
500-169224-2	TW11	99	104	102	108
500-169224-3	TW13	101	106	101	108
500-169224-4	TW15	99	106	99	106
500-169224-5	TW17	102	105	103	108
LCS 500-502975/4	Lab Control Sample	99	108	99	108
MB 500-502975/6	Method Blank	104	106	100	107

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane
TOL = Toluene-d8 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Water

Prep Type: Total/NA

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(34-110)	(36-120)	(40-145)
500-169224-1	TW10	90	82	111
500-169224-2	TW11	84	80	110
500-169224-3	TW13	91	86	120
500-169224-4	TW15	54	92	137
500-169224-5	TW17	86	75	113
LCS 500-502819/2-A	Lab Control Sample	86	83	97
MB 500-502819/1-A	Method Blank	84	82	104

Surrogate Legend

FBP = 2-Fluorobiphenyl
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Job ID: 500-169224-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-502975/6
Matrix: Water
Analysis Batch: 502975

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			09/03/19 21:54	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			09/03/19 21:54	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			09/03/19 21:54	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			09/03/19 21:54	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			09/03/19 21:54	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			09/03/19 21:54	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			09/03/19 21:54	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			09/03/19 21:54	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			09/03/19 21:54	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			09/03/19 21:54	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			09/03/19 21:54	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			09/03/19 21:54	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			09/03/19 21:54	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			09/03/19 21:54	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			09/03/19 21:54	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			09/03/19 21:54	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			09/03/19 21:54	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			09/03/19 21:54	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			09/03/19 21:54	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			09/03/19 21:54	1
Benzene	<0.15		0.50	0.15	ug/L			09/03/19 21:54	1
Bromobenzene	<0.36		1.0	0.36	ug/L			09/03/19 21:54	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			09/03/19 21:54	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			09/03/19 21:54	1
Bromoform	<0.48		1.0	0.48	ug/L			09/03/19 21:54	1
Bromomethane	<0.80		3.0	0.80	ug/L			09/03/19 21:54	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			09/03/19 21:54	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
Chloroethane	<0.51		1.0	0.51	ug/L			09/03/19 21:54	1
Chloroform	<0.37		2.0	0.37	ug/L			09/03/19 21:54	1
Chloromethane	<0.32		1.0	0.32	ug/L			09/03/19 21:54	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			09/03/19 21:54	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			09/03/19 21:54	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			09/03/19 21:54	1
Dibromomethane	<0.27		1.0	0.27	ug/L			09/03/19 21:54	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			09/03/19 21:54	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			09/03/19 21:54	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			09/03/19 21:54	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			09/03/19 21:54	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			09/03/19 21:54	1
Naphthalene	<0.34		1.0	0.34	ug/L			09/03/19 21:54	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			09/03/19 21:54	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-502975/6
Matrix: Water
Analysis Batch: 502975

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			09/03/19 21:54	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			09/03/19 21:54	1
Styrene	<0.39		1.0	0.39	ug/L			09/03/19 21:54	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			09/03/19 21:54	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			09/03/19 21:54	1
Toluene	<0.15		0.50	0.15	ug/L			09/03/19 21:54	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			09/03/19 21:54	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			09/03/19 21:54	1
Trichloroethene	<0.16		0.50	0.16	ug/L			09/03/19 21:54	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			09/03/19 21:54	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			09/03/19 21:54	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			09/03/19 21:54	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*104*		*75 - 126*		*09/03/19 21:54*	*1*
4-Bromofluorobenzene (Surr)	*106*		*72 - 124*		*09/03/19 21:54*	*1*
Dibromofluoromethane	*100*		*75 - 120*		*09/03/19 21:54*	*1*
Toluene-d8 (Surr)	*107*		*75 - 120*		*09/03/19 21:54*	*1*

Lab Sample ID: LCS 500-502975/4
Matrix: Water
Analysis Batch: 502975

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	45.3		ug/L		91	70 - 125
1,1,1-Trichloroethane	50.0	47.5		ug/L		95	70 - 125
1,1,2,2-Tetrachloroethane	50.0	46.8		ug/L		94	62 - 140
1,1,2-Trichloroethane	50.0	45.6		ug/L		91	71 - 130
1,1-Dichloroethane	50.0	44.2		ug/L		88	70 - 125
1,1-Dichloroethene	50.0	45.9		ug/L		92	67 - 122
1,1-Dichloropropene	50.0	47.9		ug/L		96	70 - 121
1,2,3-Trichlorobenzene	50.0	43.1		ug/L		86	51 - 145
1,2,3-Trichloropropane	50.0	49.9		ug/L		100	50 - 133
1,2,4-Trichlorobenzene	50.0	43.3		ug/L		87	57 - 137
1,2,4-Trimethylbenzene	50.0	50.2		ug/L		100	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	48.0		ug/L		96	56 - 123
1,2-Dibromoethane	50.0	44.0		ug/L		88	70 - 125
1,2-Dichlorobenzene	50.0	46.5		ug/L		93	70 - 125
1,2-Dichloroethane	50.0	45.9		ug/L		92	68 - 127
1,2-Dichloropropane	50.0	43.4		ug/L		87	67 - 130
1,3,5-Trimethylbenzene	50.0	52.0		ug/L		104	70 - 123
1,3-Dichlorobenzene	50.0	46.8		ug/L		94	70 - 125
1,3-Dichloropropane	50.0	45.4		ug/L		91	62 - 136
1,4-Dichlorobenzene	50.0	45.5		ug/L		91	70 - 120
2,2-Dichloropropane	50.0	44.9		ug/L		90	58 - 139
2-Chlorotoluene	50.0	50.0		ug/L		100	70 - 125
4-Chlorotoluene	50.0	49.4		ug/L		99	68 - 124
Benzene	50.0	44.6		ug/L		89	70 - 120

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-502975/4
Matrix: Water
Analysis Batch: 502975

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromobenzene	50.0	45.7		ug/L		91	70 - 122
Bromochloromethane	50.0	43.1		ug/L		86	65 - 122
Bromodichloromethane	50.0	44.2		ug/L		88	69 - 120
Bromoform	50.0	39.0		ug/L		78	56 - 132
Bromomethane	50.0	45.7		ug/L		91	40 - 152
Carbon tetrachloride	50.0	47.6		ug/L		95	59 - 133
Chlorobenzene	50.0	46.5		ug/L		93	70 - 120
Chloroethane	50.0	58.7		ug/L		117	48 - 136
Chloroform	50.0	44.9		ug/L		90	70 - 120
Chloromethane	50.0	44.4		ug/L		89	56 - 152
cis-1,2-Dichloroethene	50.0	44.6		ug/L		89	70 - 125
cis-1,3-Dichloropropene	50.0	44.6		ug/L		89	64 - 127
Dibromochloromethane	50.0	44.9		ug/L		90	68 - 125
Dibromomethane	50.0	42.6		ug/L		85	70 - 120
Dichlorodifluoromethane	50.0	51.6		ug/L		103	40 - 159
Ethylbenzene	50.0	47.5		ug/L		95	70 - 123
Hexachlorobutadiene	50.0	44.1		ug/L		88	51 - 150
Isopropylbenzene	50.0	52.2		ug/L		104	70 - 126
Methyl tert-butyl ether	50.0	41.1		ug/L		82	55 - 123
Methylene Chloride	50.0	41.9		ug/L		84	69 - 125
Naphthalene	50.0	45.3		ug/L		91	53 - 144
n-Butylbenzene	50.0	50.4		ug/L		101	68 - 125
N-Propylbenzene	50.0	50.6		ug/L		101	69 - 127
p-Isopropyltoluene	50.0	51.8		ug/L		104	70 - 125
sec-Butylbenzene	50.0	51.5		ug/L		103	70 - 123
Styrene	50.0	46.7		ug/L		93	70 - 120
tert-Butylbenzene	50.0	52.2		ug/L		104	70 - 121
Tetrachloroethene	50.0	46.6		ug/L		93	70 - 128
Toluene	50.0	47.2		ug/L		94	70 - 125
trans-1,2-Dichloroethene	50.0	45.4		ug/L		91	70 - 125
trans-1,3-Dichloropropene	50.0	43.8		ug/L		88	62 - 128
Trichloroethene	50.0	48.6		ug/L		97	70 - 125
Trichlorofluoromethane	50.0	50.4		ug/L		101	55 - 128
Vinyl chloride	50.0	48.7		ug/L		97	64 - 126
Xylenes, Total	100	92.8		ug/L		93	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*
4-Bromofluorobenzene (Surr)	*108*		*72 - 124*
Dibromofluoromethane	*99*		*75 - 120*
Toluene-d8 (Surr)	*108*		*75 - 120*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-502819/1-A
Matrix: Water
Analysis Batch: 502871

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 502819

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.24		1.6	0.24	ug/L		09/03/19 08:33	09/03/19 14:56	1
2-Methylnaphthalene	<0.052		1.6	0.052	ug/L		09/03/19 08:33	09/03/19 14:56	1
Acenaphthene	<0.25		0.80	0.25	ug/L		09/03/19 08:33	09/03/19 14:56	1
Acenaphthylene	<0.21		0.80	0.21	ug/L		09/03/19 08:33	09/03/19 14:56	1
Anthracene	<0.27		0.80	0.27	ug/L		09/03/19 08:33	09/03/19 14:56	1
Benzo[a]anthracene	<0.045		0.16	0.045	ug/L		09/03/19 08:33	09/03/19 14:56	1
Benzo[a]pyrene	<0.079		0.16	0.079	ug/L		09/03/19 08:33	09/03/19 14:56	1
Benzo[b]fluoranthene	<0.065		0.16	0.065	ug/L		09/03/19 08:33	09/03/19 14:56	1
Benzo[g,h,i]perylene	<0.30		0.80	0.30	ug/L		09/03/19 08:33	09/03/19 14:56	1
Benzo[k]fluoranthene	<0.051		0.16	0.051	ug/L		09/03/19 08:33	09/03/19 14:56	1
Chrysene	<0.055		0.16	0.055	ug/L		09/03/19 08:33	09/03/19 14:56	1
Dibenz(a,h)anthracene	<0.041		0.24	0.041	ug/L		09/03/19 08:33	09/03/19 14:56	1
Fluoranthene	<0.36		0.80	0.36	ug/L		09/03/19 08:33	09/03/19 14:56	1
Fluorene	<0.20		0.80	0.20	ug/L		09/03/19 08:33	09/03/19 14:56	1
Indeno[1,2,3-cd]pyrene	<0.060		0.16	0.060	ug/L		09/03/19 08:33	09/03/19 14:56	1
Naphthalene	<0.25		0.80	0.25	ug/L		09/03/19 08:33	09/03/19 14:56	1
Phenanthrene	<0.24		0.80	0.24	ug/L		09/03/19 08:33	09/03/19 14:56	1
Pyrene	<0.34		0.80	0.34	ug/L		09/03/19 08:33	09/03/19 14:56	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*84*		*34 - 110*	*09/03/19 08:33*	*09/03/19 14:56*	*1*
Nitrobenzene-d5 (Surr)	*82*		*36 - 120*	*09/03/19 08:33*	*09/03/19 14:56*	*1*
Terphenyl-d14 (Surr)	*104*		*40 - 145*	*09/03/19 08:33*	*09/03/19 14:56*	*1*

Lab Sample ID: LCS 500-502819/2-A
Matrix: Water
Analysis Batch: 502871

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 502819

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	32.0	26.0		ug/L		81	38 - 110
2-Methylnaphthalene	32.0	25.9		ug/L		81	34 - 110
Acenaphthene	32.0	28.2		ug/L		88	46 - 110
Acenaphthylene	32.0	27.0		ug/L		84	47 - 113
Anthracene	32.0	31.2		ug/L		97	67 - 118
Benzo[a]anthracene	32.0	28.8		ug/L		90	70 - 126
Benzo[a]pyrene	32.0	29.5		ug/L		92	70 - 135
Benzo[b]fluoranthene	32.0	30.2		ug/L		94	69 - 136
Benzo[g,h,i]perylene	32.0	32.0		ug/L		100	70 - 135
Benzo[k]fluoranthene	32.0	31.9		ug/L		100	70 - 133
Chrysene	32.0	27.8		ug/L		87	68 - 129
Dibenz(a,h)anthracene	32.0	28.6		ug/L		89	70 - 134
Fluoranthene	32.0	33.0		ug/L		103	68 - 126
Fluorene	32.0	28.4		ug/L		89	53 - 120
Indeno[1,2,3-cd]pyrene	32.0	29.6		ug/L		93	65 - 133
Naphthalene	32.0	25.8		ug/L		81	36 - 110
Phenanthrene	32.0	30.7		ug/L		96	65 - 120
Pyrene	32.0	28.5		ug/L		89	70 - 126

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-502819/2-A
Matrix: Water
Analysis Batch: 502871

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 502819

Surrogate	LCS %Recovery	LCS Qualifier	Limits
2-Fluorobiphenyl	*86*		*34 - 110*
Nitrobenzene-d5 (Surr)	*83*		*36 - 120*
Terphenyl-d14 (Surr)	*97*		*40 - 145*

Method: 6020A - Metals (ICP/MS)

Lab Sample ID: MB 500-502400/1-A
Matrix: Water
Analysis Batch: 502616

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 502400

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.23		1.0	0.23	ug/L		08/29/19 16:25	08/30/19 13:52	1
Barium	<0.73		2.5	0.73	ug/L		08/29/19 16:25	08/30/19 13:52	1
Cadmium	<0.17		0.50	0.17	ug/L		08/29/19 16:25	08/30/19 13:52	1
Chromium	<1.1		5.0	1.1	ug/L		08/29/19 16:25	08/30/19 13:52	1
Lead	<0.19		0.50	0.19	ug/L		08/29/19 16:25	08/30/19 13:52	1
Selenium	<0.98		2.5	0.98	ug/L		08/29/19 16:25	08/30/19 13:52	1
Silver	<0.12		0.50	0.12	ug/L		08/29/19 16:25	08/30/19 13:52	1

Lab Sample ID: LCS 500-502400/2-A
Matrix: Water
Analysis Batch: 502616

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 502400

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	100	93.5		ug/L		94	80 - 120
Barium	500	480		ug/L		96	80 - 120
Cadmium	50.0	48.1		ug/L		96	80 - 120
Chromium	200	197		ug/L		99	80 - 120
Lead	100	104		ug/L		104	80 - 120
Selenium	100	98.4		ug/L		98	80 - 120
Silver	50.0	52.4		ug/L		105	80 - 120

Lab Sample ID: 500-169224-1 MS
Matrix: Water
Analysis Batch: 502616

Client Sample ID: TW10
Prep Type: Dissolved
Prep Batch: 502400

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	0.49	J	100	98.8		ug/L		98	75 - 125
Barium	45		500	534		ug/L		98	75 - 125
Cadmium	<0.17		50.0	49.6		ug/L		99	75 - 125
Chromium	<1.1		200	198		ug/L		99	75 - 125
Lead	<0.19		100	105		ug/L		105	75 - 125
Selenium	1.3	J	100	100		ug/L		99	75 - 125
Silver	<0.12		50.0	54.1		ug/L		108	75 - 125

Method: 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: 500-169224-1 MSD
Matrix: Water
Analysis Batch: 502616

Client Sample ID: TW10
Prep Type: Dissolved
Prep Batch: 502400

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	0.49	J	100	93.4		ug/L		93	75 - 125	6	20
Barium	45		500	490		ug/L		89	75 - 125	9	20
Cadmium	<0.17		50.0	47.0		ug/L		94	75 - 125	5	20
Chromium	<1.1		200	188		ug/L		94	75 - 125	5	20
Lead	<0.19		100	97.8		ug/L		98	75 - 125	7	20
Selenium	1.3	J	100	94.7		ug/L		93	75 - 125	6	20
Silver	<0.12		50.0	50.4		ug/L		101	75 - 125	7	20

Lab Sample ID: 500-169224-1 DU
Matrix: Water
Analysis Batch: 502616

Client Sample ID: TW10
Prep Type: Dissolved
Prep Batch: 502400

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Arsenic	0.49	J	0.493	J	ug/L		0.8	20
Barium	45		45.4		ug/L		1	20
Cadmium	<0.17		<0.17		ug/L		NC	20
Chromium	<1.1		<1.1		ug/L		NC	20
Lead	<0.19		<0.19		ug/L		NC	20
Selenium	1.3	J	1.34	J	ug/L		4	20
Silver	<0.12		<0.12		ug/L		NC	20

Method: 7470A - Mercury (CVAA)

Lab Sample ID: MB 500-503120/12-A
Matrix: Water
Analysis Batch: 503365

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 503120

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		09/04/19 13:40	09/05/19 09:33	1

Lab Sample ID: LCS 500-503120/13-A
Matrix: Water
Analysis Batch: 503365

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 503120

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	2.00	1.97		ug/L		98	80 - 120

Lab Chronicle

Client: Stantec Consulting Corp.
Job ID: 500-169224-1
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Client Sample ID: TW10
Lab Sample ID: 500-169224-1
Date Collected: 08/28/19 11:45
Matrix: Water
Date Received: 08/29/19 09:30

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	502975	09/04/19 04:23	JLC	TAL CHI
Total/NA	Prep	3510C			502819	09/03/19 08:33	JVD	TAL CHI
Total/NA	Analysis	8270D		1	502871	09/03/19 16:21	AJD	TAL CHI
Dissolved	Prep	3005A			502400	08/29/19 16:25	BDE	TAL CHI
Dissolved	Analysis	6020A		1	502616	08/30/19 13:59	FXG	TAL CHI
Dissolved	Prep	7470A			503120	09/04/19 13:40	MJG	TAL CHI
Dissolved	Analysis	7470A		1	503365	09/05/19 09:35	MJG	TAL CHI

Client Sample ID: TW11
Lab Sample ID: 500-169224-2
Date Collected: 08/28/19 12:26
Matrix: Water
Date Received: 08/29/19 09:30

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	502975	09/04/19 04:49	JLC	TAL CHI
Total/NA	Prep	3510C			502819	09/03/19 08:33	JVD	TAL CHI
Total/NA	Analysis	8270D		1	502871	09/03/19 16:50	AJD	TAL CHI
Dissolved	Prep	3005A			502400	08/29/19 16:25	BDE	TAL CHI
Dissolved	Analysis	6020A		1	502616	08/30/19 14:18	FXG	TAL CHI
Dissolved	Prep	7470A			503120	09/04/19 13:40	MJG	TAL CHI
Dissolved	Analysis	7470A		1	503365	09/05/19 09:36	MJG	TAL CHI

Client Sample ID: TW13
Lab Sample ID: 500-169224-3
Date Collected: 08/28/19 11:00
Matrix: Water
Date Received: 08/29/19 09:30

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	502975	09/04/19 05:14	JLC	TAL CHI
Total/NA	Prep	3510C			502819	09/03/19 08:33	JVD	TAL CHI
Total/NA	Analysis	8270D		1	502871	09/03/19 17:19	AJD	TAL CHI
Dissolved	Prep	3005A			502400	08/29/19 16:25	BDE	TAL CHI
Dissolved	Analysis	6020A		1	502616	08/30/19 14:22	FXG	TAL CHI
Dissolved	Prep	7470A			503120	09/04/19 13:40	MJG	TAL CHI
Dissolved	Analysis	7470A		1	503365	09/05/19 09:38	MJG	TAL CHI

Client Sample ID: TW15
Lab Sample ID: 500-169224-4
Date Collected: 08/28/19 10:23
Matrix: Water
Date Received: 08/29/19 09:30

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	502975	09/04/19 05:40	JLC	TAL CHI
Total/NA	Prep	3510C			502819	09/03/19 08:33	JVD	TAL CHI
Total/NA	Analysis	8270D		10	503083	09/04/19 19:26	AJD	TAL CHI
Dissolved	Prep	3005A			502400	08/29/19 16:25	BDE	TAL CHI
Dissolved	Analysis	6020A		1	502616	08/30/19 14:33	FXG	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Job ID: 500-169224-1
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Client Sample ID: TW15
Lab Sample ID: 500-169224-4
Date Collected: 08/28/19 10:23
Matrix: Water
Date Received: 08/29/19 09:30

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	7470A			503120	09/04/19 13:40	MJG	TAL CHI
Dissolved	Analysis	7470A		1	503365	09/05/19 09:43	MJG	TAL CHI

Client Sample ID: TW17
Lab Sample ID: 500-169224-5
Date Collected: 08/28/19 09:40
Matrix: Water
Date Received: 08/29/19 09:30

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	502975	09/04/19 06:06	JLC	TAL CHI
Total/NA	Prep	3510C			502819	09/03/19 08:33	JVD	TAL CHI
Total/NA	Analysis	8270D		1	502871	09/03/19 17:48	AJD	TAL CHI
Dissolved	Prep	3005A			502400	08/29/19 16:25	BDE	TAL CHI
Dissolved	Analysis	6020A		1	502616	08/30/19 14:37	FXG	TAL CHI
Dissolved	Prep	7470A			503120	09/04/19 13:40	MJG	TAL CHI
Dissolved	Analysis	7470A		1	503365	09/05/19 09:45	MJG	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Stantec Consulting Corp. Job ID: 500-169224-1
Project/Site: Fox Shores Apt. Kaukauna - 193706620

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State Program	999580010	08-31-20

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins | Environment Testing TestAmerica

Client Information	Sampler: [signature]	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-74296-34609.2
Client Contact: Mr. Jeff Brand	Phone: 920-883-8501	E-Mail: sandie.fredrick@testamericainc.com		Page: Page ~~2 of 2~~ 1 of 1
Company: Stantec Consulting Corp.				Job #: 500-169224
Address: 1165 Scheuring Road	Due Date Requested:			
City: De Pere	TAT Requested (days):			
State, Zip: WI, 54115				
Phone: 920-592-8400	PO #: 193706620			
Email: Jeff.Brand@stantec.com	WO #:			
Project Name: Fox Shores Apt, Kaukauna 193706620	Project #: 50009659			
Site:	SSOW#:			

Analysis Requested

500-169224 COC

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

8/29/19 PWS

	Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 7471B, 8270D	8260B - VOC	8270D - PAH	6020A, 7470A	8260B - VOC	Dis RCRA Metals	Total Number of containers	Special Instructions/Note:
				Preservation Code:				N	N	N	D	A			
1	TW10	8-28-19	1145	G	Water				X	X			X		
2	TW11	↓	1226	G	Water				X	X			X		
3	TW13	↓	1100	G	Water				X	X			X		
4	TW15	↓	1023	G	Water				X	X			X		
5	TW17	↓	940	G	Water				X	X			X		

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
[signature]	8/28/19 14:00	Stantec	Paula Burnley	8/29/19 0930	TACHI

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 5.1

Ver: 01/16/2019 9/10/2019

Login Sample Receipt Checklist

Client: Stantec Consulting Corp. Job Number: 500-169224-1

Login Number: 169224 **List Source: Eurofins TestAmerica, Chicago**
List Number: 1
Creator: Buckley, Paula M

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	5.1
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

eurofins | Environment Testing TestAmerica



ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-180867-1
Client Project/Site: Fox Shores Kaukauna - 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Tyler Hischke

Authorized for release by:
5/1/2020 12:21:31 PM

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

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The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Detection Summary 4
Method Summary 12
Sample Summary 13
Client Sample Results 14
Definitions 68
QC Association 69
Surrogate Summary 75
QC Sample Results 77
Chronicle 90
Certification Summary 98
Chain of Custody 99
Receipt Checklists 101

Case Narrative

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Job ID: 500-180867-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-180867-1

Comments
No additional comments.

Receipt
The samples were received on 4/17/2020 9:45 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperatures of the 2 coolers at receipt time were 0.5º C and 2.6º C.

Receipt Exceptions
A trip blank was submitted for analysis with these samples; however, it was not listed on the Chain of Custody (COC). Added to COC and logged in.

GC/MS VOA
Method 8260B: The laboratory control sample (LCS) for batches 539816 and 539811 recovered outside control limits for Bromomethane. This analyte was biased high in the LCSs and was not detected in the associated samples; therefore, the data have been reported.HA-1 (500-180867-1), HA-2 (500-180867-2), HA-3 (500-180867-3), HA-4 (500-180867-4), HA-5 (500-180867-5), HA-6 (500-180867-6), HA-7 (500-180867-7), HA-8 (500-180867-8), HA-9 (500-180867-9), HA-10 (500-180867-10), HA-11 (500-180867-11), HA-12 (500-180867-12), TW-10 (500-180867-14), TW-11 (500-180867-15), TW-13 (500-180867-16), TW-15 (500-180867-17), TW-17 (500-180867-18) and Trip Blank (500-180867-19)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method 8270D: The following samples were diluted due to the nature of the sample matrix: HA-2 (500-180867-2), HA-3 (500-180867-3), HA-4 (500-180867-4), HA-5 (500-180867-5), HA-6 (500-180867-6), HA-10 (500-180867-10) and HA-11 (500-180867-11). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Field Service / Mobile Lab
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1

Lab Sample ID: 500-180867-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	24	J	81	9.8	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	30	J	81	7.4	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	9.5	J	40	5.3	ug/Kg	1	☼	8270D	Total/NA
Anthracene	18	J	40	6.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	92		40	5.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	110		40	7.8	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	150		40	8.7	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	74		40	13	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	65		40	12	ug/Kg	1	☼	8270D	Total/NA
Chrysene	130		40	11	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	190		40	7.4	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	63		40	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	17	J	40	6.2	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	100		40	5.6	ug/Kg	1	☼	8270D	Total/NA
Pyrene	190		40	8.0	ug/Kg	1	☼	8270D	Total/NA
Arsenic	3.5		1.1	0.39	mg/Kg	1	☼	6010C	Total/NA
Barium	79		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.24		0.23	0.041	mg/Kg	1	☼	6010C	Total/NA
Chromium	26		1.1	0.57	mg/Kg	1	☼	6010C	Total/NA
Lead	73		0.57	0.26	mg/Kg	1	☼	6010C	Total/NA
Silver	0.45	J	0.57	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.070		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-2

Lab Sample ID: 500-180867-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	28		18	11	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	64		37	16	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	390	J	410	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	410		410	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	52	J	200	36	ug/Kg	5	☼	8270D	Total/NA
Anthracene	160	J	200	34	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	950		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1200		200	39	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	1800		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	460		200	65	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	730		200	59	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1300		200	55	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	120	J	200	39	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2300		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	55	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	420		200	52	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	240		200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1400		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2000		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	11		1.1	0.38	mg/Kg	1	☼	6010C	Total/NA
Barium	61		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	2.6		0.22	0.040	mg/Kg	1	☼	6010C	Total/NA
Chromium	15		1.1	0.55	mg/Kg	1	☼	6010C	Total/NA
Lead	470		0.55	0.26	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.0	J	1.1	0.65	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-2 (Continued)

Lab Sample ID: 500-180867-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Silver	0.97		0.55	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.19		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-3

Lab Sample ID: 500-180867-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	42	J	70	25	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	24		17	13	ug/Kg	50	☼	8260B	Total/NA
Toluene	74		17	10	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	130		35	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	340	J	400	48	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	410		400	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	56	J	200	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	41	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	180	J	200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	1200		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1400		200	38	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	2000		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	820		200	63	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	780		200	58	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1600		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	140	J	200	38	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2500		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	61	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	710		200	51	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	260		200	30	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1500		200	27	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2300		200	39	ug/Kg	5	☼	8270D	Total/NA
Arsenic	11		1.2	0.40	mg/Kg	1	☼	6010C	Total/NA
Barium	56		1.2	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.92		0.24	0.043	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.2	0.59	mg/Kg	1	☼	6010C	Total/NA
Lead	220		0.59	0.27	mg/Kg	1	☼	6010C	Total/NA
Selenium	0.74	J	1.2	0.70	mg/Kg	1	☼	6010C	Total/NA
Silver	0.56	J	0.59	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.32		0.020	0.0065	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-4

Lab Sample ID: 500-180867-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	56	J	65	23	ug/Kg	50	☼	8260B	Total/NA
Benzene	18		16	9.5	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	26		16	12	ug/Kg	50	☼	8260B	Total/NA
Toluene	77		16	9.6	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	160		32	14	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	420		400	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	460		400	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	190	J	200	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	150	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	540		200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	2400		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	2700		200	39	ug/Kg	5	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-4 (Continued)

Lab Sample ID: 500-180867-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[b]fluoranthene	3600		200	43	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	890		200	64	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	1200		200	59	ug/Kg	5	☼	8270D	Total/NA
Chrysene	2800		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	250		200	39	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	4800		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	160	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	870		200	52	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	410		200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	3100		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	4900		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	6.7		1.1	0.39	mg/Kg	1	☼	6010C	Total/NA
Barium	59		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.1		0.23	0.041	mg/Kg	1	☼	6010C	Total/NA
Chromium	13		1.1	0.57	mg/Kg	1	☼	6010C	Total/NA
Lead	140		0.57	0.26	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.1		1.1	0.67	mg/Kg	1	☼	6010C	Total/NA
Silver	0.78		0.57	0.15	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.12		0.019	0.0064	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-5

Lab Sample ID: 500-180867-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	77		68	24	ug/Kg	50	☼	8260B	Total/NA
Benzene	140		17	10	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	49		17	13	ug/Kg	50	☼	8260B	Total/NA
Toluene	260		17	10	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	270		34	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	220	J	400	48	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	300	J	400	36	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	80	J	200	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	64	J	200	26	ug/Kg	5	☼	8270D	Total/NA
Anthracene	200		200	33	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	1100		200	26	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1400		200	38	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	2200		200	42	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	510		200	63	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	730		200	58	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1400		200	54	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	180	J	200	38	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2100		200	36	ug/Kg	5	☼	8270D	Total/NA
Fluorene	51	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	480		200	51	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	290		200	30	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1200		200	27	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2100		200	39	ug/Kg	5	☼	8270D	Total/NA
Arsenic	8.1		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	55		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.64		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	160		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-5 (Continued)

Lab Sample ID: 500-180867-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Silver	0.45	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.15		0.018	0.0061	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-6

Lab Sample ID: 500-180867-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	13	J	17	9.8	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	25	J	33	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	120	J	390	47	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	120	J	390	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	190		190	34	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	39	J	190	25	ug/Kg	5	☼	8270D	Total/NA
Anthracene	400		190	32	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	1300		190	26	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	1400		190	37	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	1900		190	41	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	440		190	62	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	570		190	56	ug/Kg	5	☼	8270D	Total/NA
Chrysene	1300		190	52	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	100	J	190	37	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2400		190	35	ug/Kg	5	☼	8270D	Total/NA
Fluorene	160	J	190	27	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	320		190	50	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	150	J	190	29	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1900		190	27	ug/Kg	5	☼	8270D	Total/NA
Pyrene	2300		190	38	ug/Kg	5	☼	8270D	Total/NA
Arsenic	6.8		1.0	0.35	mg/Kg	1	☼	6010C	Total/NA
Barium	37		1.0	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.36		0.21	0.037	mg/Kg	1	☼	6010C	Total/NA
Chromium	12		1.0	0.51	mg/Kg	1	☼	6010C	Total/NA
Lead	91		0.52	0.24	mg/Kg	1	☼	6010C	Total/NA
Silver	0.27	J	0.52	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.053		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-7

Lab Sample ID: 500-180867-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Xylenes, Total	53		33	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	86		79	9.5	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	100		79	7.2	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	49		39	7.0	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	41		39	5.1	ug/Kg	1	☼	8270D	Total/NA
Anthracene	100		39	6.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	440		39	5.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	450		39	7.5	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	580		39	8.4	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	180		39	13	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	260		39	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	480		39	11	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	41		39	7.5	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	760		39	7.2	ug/Kg	1	☼	8270D	Total/NA
Fluorene	43		39	5.5	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-7 (Continued)

Lab Sample ID: 500-180867-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Indeno[1,2,3-cd]pyrene	170		39	10	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	81		39	6.0	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	630		39	5.4	ug/Kg	1	☼	8270D	Total/NA
Pyrene	800		39	7.7	ug/Kg	1	☼	8270D	Total/NA
Arsenic	5.0		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	44		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.43		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	86		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.53	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.041		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-8

Lab Sample ID: 500-180867-8

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	23	J	65	23	ug/Kg	50	☼	8260B	Total/NA
Benzene	19		16	9.4	ug/Kg	50	☼	8260B	Total/NA
Ethylbenzene	18		16	12	ug/Kg	50	☼	8260B	Total/NA
Toluene	49		16	9.5	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	67		32	14	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	100		75	9.1	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	140		75	6.8	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	100		37	6.7	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	140		37	4.9	ug/Kg	1	☼	8270D	Total/NA
Anthracene	310		37	6.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	1100		37	5.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	1200		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	1600		37	8.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	340		37	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	630		37	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	1200		37	10	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	100		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	2300		37	6.9	ug/Kg	1	☼	8270D	Total/NA
Fluorene	96		37	5.2	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	330		37	9.6	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	160		37	5.7	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	1600		37	5.2	ug/Kg	1	☼	8270D	Total/NA
Pyrene	2600		37	7.4	ug/Kg	1	☼	8270D	Total/NA
Arsenic	6.2		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	54		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.58		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	150		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.51	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.080		0.018	0.0061	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-9

Lab Sample ID: 500-180867-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	21	J	73	8.9	ug/Kg	1	☼	8270D	Total/NA
2-Methylnaphthalene	35	J	73	6.7	ug/Kg	1	☼	8270D	Total/NA
Acenaphthene	14	J	36	6.5	ug/Kg	1	☼	8270D	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-9 (Continued)

Lab Sample ID: 500-180867-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Acenaphthylene	14	J	36	4.8	ug/Kg	1	☼	8270D	Total/NA
Anthracene	48		36	6.1	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	180		36	4.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	170		36	7.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	210		36	7.9	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	100		36	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	55		36	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	190		36	9.9	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	24	J	36	7.0	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	300		36	6.8	ug/Kg	1	☼	8270D	Total/NA
Fluorene	12	J	36	5.1	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	93		36	9.4	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	25	J	36	5.6	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	240		36	5.1	ug/Kg	1	☼	8270D	Total/NA
Pyrene	300		36	7.2	ug/Kg	1	☼	8270D	Total/NA
Arsenic	3.0		1.1	0.38	mg/Kg	1	☼	6010C	Total/NA
Barium	37		1.1	0.13	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.18	J	0.22	0.040	mg/Kg	1	☼	6010C	Total/NA
Chromium	13		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	53		0.55	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.23	J	0.55	0.14	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.16		0.018	0.0059	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-10

Lab Sample ID: 500-180867-10

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	23		17	9.7	ug/Kg	50	☼	8260B	Total/NA
Xylenes, Total	46		33	15	ug/Kg	50	☼	8260B	Total/NA
1-Methylnaphthalene	120	J	380	46	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	160	J	380	35	ug/Kg	5	☼	8270D	Total/NA
Acenaphthene	40	J	190	34	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	44	J	190	25	ug/Kg	5	☼	8270D	Total/NA
Anthracene	150	J	190	31	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	530		190	25	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	620		190	36	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	1000		190	41	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	150	J	190	61	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	250		190	55	ug/Kg	5	☼	8270D	Total/NA
Chrysene	720		190	51	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	980		190	35	ug/Kg	5	☼	8270D	Total/NA
Fluorene	35	J	190	26	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	220		190	49	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	150	J	190	29	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	600		190	26	ug/Kg	5	☼	8270D	Total/NA
Pyrene	970		190	37	ug/Kg	5	☼	8270D	Total/NA
Arsenic	5.0		1.1	0.37	mg/Kg	1	☼	6010C	Total/NA
Barium	41		1.1	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.44		0.22	0.039	mg/Kg	1	☼	6010C	Total/NA
Chromium	16		1.1	0.54	mg/Kg	1	☼	6010C	Total/NA
Lead	190		0.54	0.25	mg/Kg	1	☼	6010C	Total/NA
Silver	0.36	J	0.54	0.14	mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HA-10 (Continued)

Lab Sample ID: 500-180867-10

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Mercury	0.22		0.018	0.0059	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-11

Lab Sample ID: 500-180867-11

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1-Methylnaphthalene	230	J	410	49	ug/Kg	5	☼	8270D	Total/NA
2-Methylnaphthalene	390	J	410	37	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	33	J	200	27	ug/Kg	5	☼	8270D	Total/NA
Anthracene	140	J	200	34	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	350		200	27	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	370		200	39	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	350		200	44	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	120	J	200	60	ug/Kg	5	☼	8270D	Total/NA
Chrysene	460		200	55	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	530		200	37	ug/Kg	5	☼	8270D	Total/NA
Fluorene	59	J	200	28	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	130	J	200	31	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	650		200	28	ug/Kg	5	☼	8270D	Total/NA
Pyrene	690		200	40	ug/Kg	5	☼	8270D	Total/NA
Arsenic	7.9		1.0	0.35	mg/Kg	1	☼	6010C	Total/NA
Barium	70		1.0	0.12	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.83		0.21	0.037	mg/Kg	1	☼	6010C	Total/NA
Chromium	19		1.0	0.51	mg/Kg	1	☼	6010C	Total/NA
Lead	250		0.52	0.24	mg/Kg	1	☼	6010C	Total/NA
Selenium	1.1		1.0	0.61	mg/Kg	1	☼	6010C	Total/NA
Silver	0.82		0.52	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.19		0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[a]anthracene	36	J	37	5.0	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	37		37	7.2	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	46		37	8.1	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	22	J	37	12	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	18	J	37	11	ug/Kg	1	☼	8270D	Total/NA
Chrysene	43		37	10	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	57		37	6.9	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	23	J	37	9.7	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	17	J	37	5.2	ug/Kg	1	☼	8270D	Total/NA
Pyrene	59		37	7.4	ug/Kg	1	☼	8270D	Total/NA
Arsenic	2.0		0.97	0.33	mg/Kg	1	☼	6010C	Total/NA
Barium	31		0.97	0.11	mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.040	J	0.19	0.035	mg/Kg	1	☼	6010C	Total/NA
Chromium	14		0.97	0.48	mg/Kg	1	☼	6010C	Total/NA
Lead	7.2		0.49	0.22	mg/Kg	1	☼	6010C	Total/NA
Silver	0.13	J	0.49	0.13	mg/Kg	1	☼	6010C	Total/NA
Mercury	0.0083	J	0.019	0.0062	mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: Soil-Composite-1

Lab Sample ID: 500-180867-13

No Detections.

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Stantec Consulting Corp.
Job ID: 500-180867-1
Project/Site: Fox Shores Kaukauna - 193706620

Client Sample ID: TW-10
Lab Sample ID: 500-180867-14

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	0.56	J	1.0	0.23	ug/L	1		6020A	Dissolved
Barium	29		2.5	0.73	ug/L	1		6020A	Dissolved
Selenium	1.3	J	2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW-11
Lab Sample ID: 500-180867-15

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	5.2		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	330		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: TW-13
Lab Sample ID: 500-180867-16

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	0.77	J	1.0	0.23	ug/L	1		6020A	Dissolved
Barium	91		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: TW-15
Lab Sample ID: 500-180867-17

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	3.9		1.0	0.36	ug/L	1		8260B	Total/NA
1,3,5-Trimethylbenzene	2.4		1.0	0.25	ug/L	1		8260B	Total/NA
Ethylbenzene	0.21	J	0.50	0.18	ug/L	1		8260B	Total/NA
Isopropylbenzene	2.9		1.0	0.39	ug/L	1		8260B	Total/NA
n-Butylbenzene	9.2		1.0	0.39	ug/L	1		8260B	Total/NA
N-Propylbenzene	4.6		1.0	0.41	ug/L	1		8260B	Total/NA
p-Isopropyltoluene	2.1		1.0	0.36	ug/L	1		8260B	Total/NA
sec-Butylbenzene	3.6		1.0	0.40	ug/L	1		8260B	Total/NA
Xylenes, Total	1.6		1.0	0.22	ug/L	1		8260B	Total/NA
Arsenic	2.0		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	47		2.5	0.73	ug/L	1		6020A	Dissolved
Selenium	7.9		2.5	0.98	ug/L	1		6020A	Dissolved

Client Sample ID: TW-17
Lab Sample ID: 500-180867-18

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[a]anthracene	0.21		0.18	0.050	ug/L	1		8270D	Total/NA
Benzo[a]pyrene	0.36		0.18	0.087	ug/L	1		8270D	Total/NA
Benzo[b]fluoranthene	0.29		0.18	0.071	ug/L	1		8270D	Total/NA
Benzo[k]fluoranthene	0.23		0.18	0.056	ug/L	1		8270D	Total/NA
Chrysene	0.17	J	0.18	0.060	ug/L	1		8270D	Total/NA
Indeno[1,2,3-cd]pyrene	0.23		0.18	0.066	ug/L	1		8270D	Total/NA
Phenanthrene	0.29	J	0.88	0.27	ug/L	1		8270D	Total/NA
Arsenic	1.3		1.0	0.23	ug/L	1		6020A	Dissolved
Barium	67		2.5	0.73	ug/L	1		6020A	Dissolved

Client Sample ID: Trip Blank
Lab Sample ID: 500-180867-19

No Detections.

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL CHI
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL CHI
6010C	Metals (ICP)	SW846	TAL CHI
6020A	Metals (ICP/MS)	SW846	TAL CHI
7470A	Mercury (CVAA)	SW846	TAL CHI
7471B	Mercury (CVAA)	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
1311	TCLP Extraction	SW846	TAL CHI
3005A	Preparation, Total Recoverable or Dissolved Metals	SW846	TAL CHI
3010A	Preparation, Total Metals	SW846	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
3510C	Liquid-Liquid Extraction (Separatory Funnel)	SW846	TAL CHI
3541	Automated Soxhlet Extraction	SW846	TAL CHI
5030B	Purge and Trap	SW846	TAL CHI
5035	Closed System Purge and Trap	SW846	TAL CHI
7470A	Preparation, Mercury	SW846	TAL CHI
7471B	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
500-180867-1	HA-1	Solid	04/15/20 08:45	04/17/20 09:45	
500-180867-2	HA-2	Solid	04/15/20 09:10	04/17/20 09:45	
500-180867-3	HA-3	Solid	04/15/20 09:25	04/17/20 09:45	
500-180867-4	HA-4	Solid	04/15/20 09:50	04/17/20 09:45	
500-180867-5	HA-5	Solid	04/15/20 10:05	04/17/20 09:45	
500-180867-6	HA-6	Solid	04/15/20 10:25	04/17/20 09:45	
500-180867-7	HA-7	Solid	04/15/20 10:40	04/17/20 09:45	
500-180867-8	HA-8	Solid	04/15/20 10:55	04/17/20 09:45	
500-180867-9	HA-9	Solid	04/15/20 11:15	04/17/20 09:45	
500-180867-10	HA-10	Solid	04/15/20 11:30	04/17/20 09:45	
500-180867-11	HA-11	Solid	04/15/20 11:50	04/17/20 09:45	
500-180867-12	HA-12	Solid	04/15/20 12:10	04/17/20 09:45	
500-180867-13	Soil-Composite-1	Solid	04/15/20 12:40	04/17/20 09:45	
500-180867-14	TW-10	Water	04/16/20 08:50	04/17/20 09:45	
500-180867-15	TW-11	Water	04/16/20 11:15	04/17/20 09:45	
500-180867-16	TW-13	Water	04/16/20 09:40	04/17/20 09:45	
500-180867-17	TW-15	Water	04/16/20 10:20	04/17/20 09:45	
500-180867-18	TW-17	Water	04/16/20 12:00	04/17/20 09:45	
500-180867-19	Trip Blank	Water	04/16/20 00:00	04/17/20 09:45	

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<33		72	33	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1,1-Trichloroethane	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1,2,2-Tetrachloroethane	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1,2-Trichloroethane	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1-Dichloroethane	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1-Dichloroethene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,1-Dichloropropene	<22		72	22	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,3-Trichlorobenzene	<33		72	33	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,3-Trichloropropane	<30		140	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,4-Trichlorobenzene	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2,4-Trimethylbenzene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dibromo-3-Chloropropane	<140		360	140	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dibromoethane	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dichlorobenzene	<24		72	24	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dichloroethane	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,2-Dichloropropane	<31		72	31	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,3,5-Trimethylbenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,3-Dichlorobenzene	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,3-Dichloropropane	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
1,4-Dichlorobenzene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
2,2-Dichloropropane	<32		72	32	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
2-Chlorotoluene	<23		72	23	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
4-Chlorotoluene	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Benzene	<11		18	11	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromobenzene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromochloromethane	<31		72	31	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromodichloromethane	<27		72	27	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromoform	<35		72	35	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Bromomethane	<58	*	220	58	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Carbon tetrachloride	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chlorobenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chloroethane	<36		72	36	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chloroform	<27		140	27	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Chloromethane	<23		72	23	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
cis-1,2-Dichloroethene	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
cis-1,3-Dichloropropene	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Dibromochloromethane	<35		72	35	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Dibromomethane	<20		72	20	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Ethylbenzene	<13		18	13	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Hexachlorobutadiene	<32		72	32	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Isopropyl ether	<20		72	20	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Isopropylbenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Methyl tert-butyl ether	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Methylene Chloride	<120		360	120	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
n-Butylbenzene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
N-Propylbenzene	<30		72	30	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
p-Isopropyltoluene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
sec-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28		72	28	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
tert-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Tetrachloroethene	<27		72	27	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Toluene	<11		18	11	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
trans-1,2-Dichloroethene	<25		72	25	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
trans-1,3-Dichloropropene	<26		72	26	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Trichloroethene	<12		36	12	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Trichlorofluoromethane	<31		72	31	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Vinyl chloride	<19		72	19	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50
Xylenes, Total	<16		36	16	ug/Kg	☼	04/15/20 08:45	04/27/20 11:22	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*94*		*75 - 126*	*04/15/20 08:45*	*04/27/20 11:22*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*04/15/20 08:45*	*04/27/20 11:22*	*50*
Dibromofluoromethane (Surr)	*98*		*75 - 120*	*04/15/20 08:45*	*04/27/20 11:22*	*50*
Toluene-d8 (Surr)	*107*		*75 - 120*	*04/15/20 08:45*	*04/27/20 11:22*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**24**	**J**	81	9.8	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
2-Methylnaphthalene	**30**	**J**	81	7.4	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Acenaphthene	<7.2		40	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Acenaphthylene	**9.5**	**J**	40	5.3	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Anthracene	**18**	**J**	40	6.7	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[a]anthracene	**92**		40	5.4	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[a]pyrene	**110**		40	7.8	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[b]fluoranthene	**150**		40	8.7	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[g,h,i]perylene	**74**		40	13	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Benzo[k]fluoranthene	**65**		40	12	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Chrysene	**130**		40	11	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Dibenz(a,h)anthracene	<7.8		40	7.8	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Fluoranthene	**190**		40	7.4	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Fluorene	<5.6		40	5.6	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Indeno[1,2,3-cd]pyrene	**63**		40	10	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Naphthalene	**17**	**J**	40	6.2	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Phenanthrene	**100**		40	5.6	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1
Pyrene	**190**		40	8.0	ug/Kg	☼	04/29/20 07:52	04/29/20 23:26	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*95*		*43 - 145*	*04/29/20 07:52*	*04/29/20 23:26*	*1*
Nitrobenzene-d5 (Surr)	*94*		*37 - 147*	*04/29/20 07:52*	*04/29/20 23:26*	*1*
Terphenyl-d14 (Surr)	*123*		*42 - 157*	*04/29/20 07:52*	*04/29/20 23:26*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.5**		1.1	0.39	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Barium	**79**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Cadmium	**0.24**		0.23	0.041	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Chromium	**26**		1.1	0.57	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Lead	**73**		0.57	0.26	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.67		1.1	0.67	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1
Silver	**0.45**	**J**	0.57	0.15	mg/Kg	☼	04/21/20 07:24	04/22/20 00:46	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.070**		0.019	0.0064	mg/Kg	☼	04/24/20 14:15	04/27/20 10:10	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid
Percent Solids: 81.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<34		73	34	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1,1-Trichloroethane	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1,2,2-Tetrachloroethane	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1,2-Trichloroethane	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1-Dichloroethane	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1-Dichloroethene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,1-Dichloropropene	<22		73	22	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,3-Trichlorobenzene	<34		73	34	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,3-Trichloropropane	<30		150	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,4-Trichlorobenzene	<25		73	25	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2,4-Trimethylbenzene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dibromo-3-Chloropropane	<150		370	150	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dibromoethane	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dichlorobenzene	<24		73	24	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dichloroethane	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,2-Dichloropropane	<31		73	31	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,3,5-Trimethylbenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,3-Dichlorobenzene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,3-Dichloropropane	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
1,4-Dichlorobenzene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
2,2-Dichloropropane	<33		73	33	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
2-Chlorotoluene	<23		73	23	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
4-Chlorotoluene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Benzene	<11		18	11	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromobenzene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromochloromethane	<31		73	31	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromodichloromethane	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromoform	<35		73	35	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Bromomethane	<58	*	220	58	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Carbon tetrachloride	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chlorobenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chloroethane	<37		73	37	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chloroform	<27		150	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Chloromethane	<23		73	23	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
cis-1,2-Dichloroethene	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
cis-1,3-Dichloropropene	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Dibromochloromethane	<36		73	36	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Dibromomethane	<20		73	20	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Ethylbenzene	<13		18	13	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Hexachlorobutadiene	<33		73	33	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Isopropyl ether	<20		73	20	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Isopropylbenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Methyl tert-butyl ether	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Methylene Chloride	<120		370	120	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
n-Butylbenzene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
N-Propylbenzene	<30		73	30	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
p-Isopropyltoluene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
sec-Butylbenzene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid
Percent Solids: 81.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28		73	28	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
tert-Butylbenzene	<29		73	29	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Tetrachloroethene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Toluene	**28**		18	11	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
trans-1,2-Dichloroethene	<26		73	26	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
trans-1,3-Dichloropropene	<27		73	27	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Trichloroethene	<12		37	12	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Trichlorofluoromethane	<31		73	31	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Vinyl chloride	<19		73	19	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50
Xylenes, Total	**64**		37	16	ug/Kg	☼	04/15/20 09:10	04/27/20 11:46	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*94*		*75 - 126*	*04/15/20 09:10*	*04/27/20 11:46*	*50*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*	*04/15/20 09:10*	*04/27/20 11:46*	*50*
Dibromofluoromethane (Surr)	*97*		*75 - 120*	*04/15/20 09:10*	*04/27/20 11:46*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 09:10*	*04/27/20 11:46*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**390**	**J**	410	49	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
2-Methylnaphthalene	**410**		410	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Acenaphthene	**52**	**J**	200	36	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Acenaphthylene	<26		200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Anthracene	**160**	**J**	200	34	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[a]anthracene	**950**		200	27	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[a]pyrene	**1200**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[b]fluoranthene	**1800**		200	43	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[g,h,i]perylene	**460**		200	65	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Benzo[k]fluoranthene	**730**		200	59	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Chrysene	**1300**		200	55	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Dibenz(a,h)anthracene	**120**	**J**	200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Fluoranthene	**2300**		200	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Fluorene	**55**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Indeno[1,2,3-cd]pyrene	**420**		200	52	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Naphthalene	**240**		200	31	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Phenanthrene	**1400**		200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5
Pyrene	**2000**		200	40	ug/Kg	☼	04/29/20 07:52	04/30/20 01:18	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*99*		*43 - 145*	*04/29/20 07:52*	*04/30/20 01:18*	*5*
Nitrobenzene-d5 (Surr)	*98*		*37 - 147*	*04/29/20 07:52*	*04/30/20 01:18*	*5*
Terphenyl-d14 (Surr)	*120*		*42 - 157*	*04/29/20 07:52*	*04/30/20 01:18*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		1.1	0.38	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Barium	**61**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Cadmium	**2.6**		0.22	0.040	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Chromium	**15**		1.1	0.55	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Lead	**470**		0.55	0.26	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-2

Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2

Matrix: Solid
Percent Solids: 81.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.0	J	1.1	0.65	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1
Silver	0.97		0.55	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 00:51	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.19		0.019	0.0064	mg/Kg	☼	04/24/20 14:15	04/27/20 10:18	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid
Percent Solids: 82.9

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		70	32	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1,1-Trichloroethane	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1,2,2-Tetrachloroethane	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1,2-Trichloroethane	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1-Dichloroethane	<29		70	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1-Dichloroethene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,1-Dichloropropene	<21		70	21	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,3-Trichlorobenzene	<32		70	32	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,3-Trichloropropane	<29		140	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,4-Trichlorobenzene	<24		70	24	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2,4-Trimethylbenzene	**42**	**J**	70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dibromo-3-Chloropropane	<140		350	140	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dibromoethane	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dichlorobenzene	<23		70	23	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dichloroethane	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,2-Dichloropropane	<30		70	30	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,3,5-Trimethylbenzene	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,3-Dichlorobenzene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,3-Dichloropropane	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
1,4-Dichlorobenzene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
2,2-Dichloropropane	<31		70	31	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
2-Chlorotoluene	<22		70	22	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
4-Chlorotoluene	<24		70	24	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Benzene	<10		17	10	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromobenzene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromochloromethane	<30		70	30	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromodichloromethane	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromoform	<34		70	34	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Bromomethane	<55	*	210	55	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Carbon tetrachloride	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chlorobenzene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chloroethane	<35		70	35	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chloroform	<26		140	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Chloromethane	<22		70	22	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
cis-1,2-Dichloroethene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
cis-1,3-Dichloropropene	<29		70	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Dibromochloromethane	<34		70	34	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Dibromomethane	<19		70	19	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Dichlorodifluoromethane	<47		210	47	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Ethylbenzene	**24**		17	13	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Hexachlorobutadiene	<31		70	31	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Isopropyl ether	<19		70	19	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Isopropylbenzene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Methyl tert-butyl ether	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Methylene Chloride	<110		350	110	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
n-Butylbenzene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
N-Propylbenzene	<29		70	29	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
p-Isopropyltoluene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
sec-Butylbenzene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid
Percent Solids: 82.9

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<27		70	27	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
tert-Butylbenzene	<28		70	28	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Tetrachloroethene	<26		70	26	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Toluene	**74**		17	10	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
trans-1,2-Dichloroethene	<24		70	24	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
trans-1,3-Dichloropropene	<25		70	25	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Trichloroethene	<11		35	11	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Trichlorofluoromethane	<30		70	30	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Vinyl chloride	<18		70	18	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50
Xylenes, Total	**130**		35	15	ug/Kg	☼	04/15/20 09:25	04/27/20 12:10	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*	*04/15/20 09:25*	*04/27/20 12:10*	*50*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*	*04/15/20 09:25*	*04/27/20 12:10*	*50*
Dibromofluoromethane (Surr)	*101*		*75 - 120*	*04/15/20 09:25*	*04/27/20 12:10*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 09:25*	*04/27/20 12:10*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**340**	**J**	400	48	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
2-Methylnaphthalene	**410**		400	36	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Acenaphthene	**56**	**J**	200	35	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Acenaphthylene	**41**	**J**	200	26	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Anthracene	**180**	**J**	200	33	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[a]anthracene	**1200**		200	27	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[a]pyrene	**1400**		200	38	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[b]fluoranthene	**2000**		200	43	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[g,h,i]perylene	**820**		200	63	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Benzo[k]fluoranthene	**780**		200	58	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Chrysene	**1600**		200	54	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Dibenz(a,h)anthracene	**140**	**J**	200	38	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Fluoranthene	**2500**		200	37	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Fluorene	**61**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Indeno[1,2,3-cd]pyrene	**710**		200	51	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Naphthalene	**260**		200	30	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Phenanthrene	**1500**		200	27	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5
Pyrene	**2300**		200	39	ug/Kg	☼	04/29/20 07:52	04/29/20 23:54	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*106*		*43 - 145*	*04/29/20 07:52*	*04/29/20 23:54*	*5*
Nitrobenzene-d5 (Surr)	*90*		*37 - 147*	*04/29/20 07:52*	*04/29/20 23:54*	*5*
Terphenyl-d14 (Surr)	*117*		*42 - 157*	*04/29/20 07:52*	*04/29/20 23:54*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		1.2	0.40	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Barium	**56**		1.2	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Cadmium	**0.92**		0.24	0.043	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Chromium	**16**		1.2	0.59	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Lead	**220**		0.59	0.27	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-3

Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3

Matrix: Solid
Percent Solids: 82.9

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	0.74	J	1.2	0.70	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1
Silver	0.56	J	0.59	0.15	mg/Kg	☼	04/21/20 07:24	04/22/20 00:55	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.32		0.020	0.0065	mg/Kg	☼	04/24/20 14:15	04/27/20 10:20	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid
Percent Solids: 83.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		65	30	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1,1-Trichloroethane	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1,2,2-Tetrachloroethane	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1,2-Trichloroethane	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1-Dichloroethane	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1-Dichloroethene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,1-Dichloropropene	<19		65	19	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,3-Trichlorobenzene	<30		65	30	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,4-Trichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2,4-Trimethylbenzene	**56**	**J**	65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dibromoethane	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dichloroethane	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,2-Dichloropropane	<28		65	28	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,3,5-Trimethylbenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,3-Dichlorobenzene	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,3-Dichloropropane	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
1,4-Dichlorobenzene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
2,2-Dichloropropane	<29		65	29	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
2-Chlorotoluene	<20		65	20	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
4-Chlorotoluene	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Benzene	**18**		16	9.5	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromobenzene	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromochloromethane	<28		65	28	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromodichloromethane	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromoform	<31		65	31	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Bromomethane	<52	*	190	52	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Carbon tetrachloride	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chlorobenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chloroethane	<33		65	33	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Chloromethane	<21		65	21	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
cis-1,2-Dichloroethene	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
cis-1,3-Dichloropropene	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Dibromochloromethane	<32		65	32	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Dibromomethane	<18		65	18	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Dichlorodifluoromethane	<44		190	44	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Ethylbenzene	**26**		16	12	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Hexachlorobutadiene	<29		65	29	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Isopropyl ether	<18		65	18	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Isopropylbenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Methyl tert-butyl ether	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Methylene Chloride	<110		320	110	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
n-Butylbenzene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
N-Propylbenzene	<27		65	27	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
p-Isopropyltoluene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
sec-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50

Client Sample ID: HA-4

Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4

Matrix: Solid
Percent Solids: 83.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		65	25	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
tert-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Tetrachloroethene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Toluene	**77**		16	9.6	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
trans-1,2-Dichloroethene	<23		65	23	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
trans-1,3-Dichloropropene	<24		65	24	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Trichloroethene	<11		32	11	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Trichlorofluoromethane	<28		65	28	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Vinyl chloride	<17		65	17	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50
Xylenes, Total	**160**		32	14	ug/Kg	☼	04/15/20 09:50	04/27/20 12:35	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*96*		*75 - 126*	*04/15/20 09:50*	*04/27/20 12:35*	*50*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*	*04/15/20 09:50*	*04/27/20 12:35*	*50*
Dibromofluoromethane (Surr)	*99*		*75 - 120*	*04/15/20 09:50*	*04/27/20 12:35*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 09:50*	*04/27/20 12:35*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**420**		400	49	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
2-Methylnaphthalene	**460**		400	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Acenaphthene	**190**	**J**	200	36	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Acenaphthylene	**150**	**J**	200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Anthracene	**540**		200	33	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[a]anthracene	**2400**		200	27	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[a]pyrene	**2700**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[b]fluoranthene	**3600**		200	43	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[g,h,i]perylene	**890**		200	64	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Benzo[k]fluoranthene	**1200**		200	59	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Chrysene	**2800**		200	54	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Dibenz(a,h)anthracene	**250**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Fluoranthene	**4800**		200	37	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Fluorene	**160**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Indeno[1,2,3-cd]pyrene	**870**		200	52	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Naphthalene	**410**		200	31	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Phenanthrene	**3100**		200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5
Pyrene	**4900**		200	40	ug/Kg	☼	04/29/20 07:52	04/30/20 01:46	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*100*		*43 - 145*	*04/29/20 07:52*	*04/30/20 01:46*	*5*
Nitrobenzene-d5 (Surr)	*91*		*37 - 147*	*04/29/20 07:52*	*04/30/20 01:46*	*5*
Terphenyl-d14 (Surr)	*117*		*42 - 157*	*04/29/20 07:52*	*04/30/20 01:46*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**6.7**		1.1	0.39	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Barium	**59**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Cadmium	**1.1**		0.23	0.041	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Chromium	**13**		1.1	0.57	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Lead	**140**		0.57	0.26	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid
Percent Solids: 83.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.1		1.1	0.67	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1
Silver	0.78		0.57	0.15	mg/Kg	☼	04/21/20 07:24	04/22/20 00:59	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.12		0.019	0.0064	mg/Kg	☼	04/24/20 14:15	04/27/20 10:26	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-5

Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5

Matrix: Solid
Percent Solids: 84.4

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<32		68	32	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1,1-Trichloroethane	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1,2,2-Tetrachloroethane	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1,2-Trichloroethane	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1-Dichloroethane	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1-Dichloroethene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,1-Dichloropropene	<20		68	20	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,3-Trichlorobenzene	<31		68	31	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,3-Trichloropropane	<28		140	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,4-Trichlorobenzene	<23		68	23	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2,4-Trimethylbenzene	**77**		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dibromo-3-Chloropropane	<140		340	140	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dibromoethane	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dichlorobenzene	<23		68	23	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dichloroethane	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,2-Dichloropropane	<29		68	29	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,3,5-Trimethylbenzene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,3-Dichlorobenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,3-Dichloropropane	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
1,4-Dichlorobenzene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
2,2-Dichloropropane	<30		68	30	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
2-Chlorotoluene	<21		68	21	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
4-Chlorotoluene	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Benzene	**140**		17	10	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromobenzene	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromochloromethane	<29		68	29	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromodichloromethane	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromoform	<33		68	33	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Bromomethane	<54	*	200	54	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Carbon tetrachloride	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chlorobenzene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chloroethane	<34		68	34	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chloroform	<25		140	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Chloromethane	<22		68	22	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
cis-1,2-Dichloroethene	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
cis-1,3-Dichloropropene	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Dibromochloromethane	<33		68	33	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Dibromomethane	<18		68	18	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Dichlorodifluoromethane	<46		200	46	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Ethylbenzene	**49**		17	13	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Hexachlorobutadiene	<30		68	30	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Isopropyl ether	<19		68	19	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Isopropylbenzene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Methyl tert-butyl ether	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Methylene Chloride	<110		340	110	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
n-Butylbenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
N-Propylbenzene	<28		68	28	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
p-Isopropyltoluene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
sec-Butylbenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		68	26	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
tert-Butylbenzene	<27		68	27	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Tetrachloroethene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Toluene	**260**		17	10	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
trans-1,2-Dichloroethene	<24		68	24	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
trans-1,3-Dichloropropene	<25		68	25	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Trichloroethene	<11		34	11	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Trichlorofluoromethane	<29		68	29	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Vinyl chloride	<18		68	18	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50
Xylenes, Total	**270**		34	15	ug/Kg	☼	04/15/20 10:05	04/27/20 12:59	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*	*04/15/20 10:05*	*04/27/20 12:59*	*50*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*	*04/15/20 10:05*	*04/27/20 12:59*	*50*
Dibromofluoromethane (Surr)	*98*		*75 - 120*	*04/15/20 10:05*	*04/27/20 12:59*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 10:05*	*04/27/20 12:59*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**220**	**J**	400	48	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
2-Methylnaphthalene	**300**	**J**	400	36	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Acenaphthene	**80**	**J**	200	35	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Acenaphthylene	**64**	**J**	200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Anthracene	**200**		200	33	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[a]anthracene	**1100**		200	26	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[a]pyrene	**1400**		200	38	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[b]fluoranthene	**2200**		200	42	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[g,h,i]perylene	**510**		200	63	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Benzo[k]fluoranthene	**730**		200	58	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Chrysene	**1400**		200	54	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Dibenz(a,h)anthracene	**180**	**J**	200	38	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Fluoranthene	**2100**		200	36	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Fluorene	**51**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Indeno[1,2,3-cd]pyrene	**480**		200	51	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Naphthalene	**290**		200	30	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Phenanthrene	**1200**		200	27	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5
Pyrene	**2100**		200	39	ug/Kg	☼	04/29/20 07:52	04/30/20 02:14	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*78*		*43 - 145*	*04/29/20 07:52*	*04/30/20 02:14*	*5*
Nitrobenzene-d5 (Surr)	*79*		*37 - 147*	*04/29/20 07:52*	*04/30/20 02:14*	*5*
Terphenyl-d14 (Surr)	*110*		*42 - 157*	*04/29/20 07:52*	*04/30/20 02:14*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**8.1**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Barium	**55**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Cadmium	**0.64**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Lead	**160**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1
Silver	**0.45**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:03	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.15**		0.018	0.0061	mg/Kg	☼	04/24/20 14:15	04/27/20 10:29	1

Client Sample ID: HA-6

Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6

Matrix: Solid
Percent Solids: 85.3

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		66	31	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1,1-Trichloroethane	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1,2,2-Tetrachloroethane	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1,2-Trichloroethane	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1-Dichloroethane	<27		66	27	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1-Dichloroethene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,1-Dichloropropene	<20		66	20	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,3-Trichlorobenzene	<30		66	30	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,3-Trichloropropane	<28		130	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,4-Trichlorobenzene	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2,4-Trimethylbenzene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dibromo-3-Chloropropane	<130		330	130	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dibromoethane	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dichlorobenzene	<22		66	22	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dichloroethane	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,2-Dichloropropane	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,3,5-Trimethylbenzene	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,3-Dichlorobenzene	<27		66	27	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,3-Dichloropropane	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
1,4-Dichlorobenzene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
2,2-Dichloropropane	<30		66	30	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
2-Chlorotoluene	<21		66	21	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
4-Chlorotoluene	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Benzene	<9.7		17	9.7	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromobenzene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromochloromethane	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromodichloromethane	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromoform	<32		66	32	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Bromomethane	<53	*	200	53	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Carbon tetrachloride	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chlorobenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chloroethane	<34		66	34	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chloroform	<25		130	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Chloromethane	<21		66	21	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
cis-1,2-Dichloroethene	<27		66	27	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
cis-1,3-Dichloropropene	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Dibromochloromethane	<32		66	32	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Dibromomethane	<18		66	18	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Ethylbenzene	<12		17	12	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Hexachlorobutadiene	<30		66	30	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Isopropyl ether	<18		66	18	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Isopropylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Methyl tert-butyl ether	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Methylene Chloride	<110		330	110	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
n-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
N-Propylbenzene	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
p-Isopropyltoluene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
sec-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50

Client Sample ID: HA-6
Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6
Matrix: Solid
Percent Solids: 85.3

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
tert-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Tetrachloroethene	<25		66	25	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Toluene	**13**	**J**	17	9.8	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
trans-1,2-Dichloroethene	<23		66	23	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
trans-1,3-Dichloropropene	<24		66	24	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Trichloroethene	<11		33	11	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Trichlorofluoromethane	<28		66	28	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Vinyl chloride	<17		66	17	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50
Xylenes, Total	**25**	**J**	33	15	ug/Kg	☼	04/15/20 10:25	04/27/20 13:23	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*98*		*75 - 126*	*04/15/20 10:25*	*04/27/20 13:23*	*50*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*	*04/15/20 10:25*	*04/27/20 13:23*	*50*
Dibromofluoromethane (Surr)	*99*		*75 - 120*	*04/15/20 10:25*	*04/27/20 13:23*	*50*
Toluene-d8 (Surr)	*104*		*75 - 120*	*04/15/20 10:25*	*04/27/20 13:23*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**120**	**J**	390	47	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
2-Methylnaphthalene	**120**	**J**	390	35	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Acenaphthene	**190**		190	34	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Acenaphthylene	**39**	**J**	190	25	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Anthracene	**400**		190	32	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[a]anthracene	**1300**		190	26	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[a]pyrene	**1400**		190	37	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[b]fluoranthene	**1900**		190	41	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[g,h,i]perylene	**440**		190	62	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Benzo[k]fluoranthene	**570**		190	56	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Chrysene	**1300**		190	52	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Dibenz(a,h)anthracene	**100**	**J**	190	37	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Fluoranthene	**2400**		190	35	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Fluorene	**160**	**J**	190	27	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Indeno[1,2,3-cd]pyrene	**320**		190	50	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Naphthalene	**150**	**J**	190	29	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Phenanthrene	**1900**		190	27	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5
Pyrene	**2300**		190	38	ug/Kg	☼	04/29/20 07:52	04/30/20 02:42	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*101*		*43 - 145*	*04/29/20 07:52*	*04/30/20 02:42*	*5*
Nitrobenzene-d5 (Surr)	*103*		*37 - 147*	*04/29/20 07:52*	*04/30/20 02:42*	*5*
Terphenyl-d14 (Surr)	*117*		*42 - 157*	*04/29/20 07:52*	*04/30/20 02:42*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**6.8**		1.0	0.35	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Barium	**37**		1.0	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Cadmium	**0.36**		0.21	0.037	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Chromium	**12**		1.0	0.51	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Lead	**91**		0.52	0.24	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-6

Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6

Matrix: Solid
Percent Solids: 85.3

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.61		1.0	0.61	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1
Silver	**0.27**	**J**	0.52	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:08	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.053**		0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 10:31	1

Client Sample ID: HA-7

Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7

Matrix: Solid
Percent Solids: 85.1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		67	31	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1,1-Trichloroethane	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1,2,2-Tetrachloroethane	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1,2-Trichloroethane	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1-Dichloroethane	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1-Dichloroethene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,1-Dichloropropene	<20		67	20	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,3-Trichlorobenzene	<31		67	31	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,3-Trichloropropane	<28		130	28	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,4-Trichlorobenzene	<23		67	23	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2,4-Trimethylbenzene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dibromo-3-Chloropropane	<130		330	130	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dibromoethane	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dichlorobenzene	<22		67	22	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dichloroethane	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,2-Dichloropropane	<29		67	29	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,3,5-Trimethylbenzene	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,3-Dichlorobenzene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,3-Dichloropropane	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
1,4-Dichlorobenzene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
2,2-Dichloropropane	<30		67	30	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
2-Chlorotoluene	<21		67	21	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
4-Chlorotoluene	<23		67	23	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Benzene	<9.8		17	9.8	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromobenzene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromochloromethane	<29		67	29	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromodichloromethane	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromoform	<32		67	32	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Bromomethane	<53	*	200	53	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Carbon tetrachloride	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chlorobenzene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chloroethane	<34		67	34	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chloroform	<25		130	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Chloromethane	<21		67	21	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
cis-1,2-Dichloroethene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
cis-1,3-Dichloropropene	<28		67	28	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Dibromochloromethane	<33		67	33	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Dibromomethane	<18		67	18	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Ethylbenzene	<12		17	12	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Hexachlorobutadiene	<30		67	30	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Isopropyl ether	<18		67	18	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Isopropylbenzene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Methyl tert-butyl ether	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Methylene Chloride	<110		330	110	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
n-Butylbenzene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
N-Propylbenzene	<28		67	28	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
p-Isopropyltoluene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
sec-Butylbenzene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50

Client Sample ID: HA-7

Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7

Matrix: Solid
Percent Solids: 85.1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		67	26	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
tert-Butylbenzene	<27		67	27	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Tetrachloroethene	<25		67	25	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Toluene	<9.8		17	9.8	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
trans-1,2-Dichloroethene	<23		67	23	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
trans-1,3-Dichloropropene	<24		67	24	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Trichloroethene	<11		33	11	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Trichlorofluoromethane	<29		67	29	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Vinyl chloride	<18		67	18	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50
Xylenes, Total	**53**		33	15	ug/Kg	☼	04/15/20 10:40	04/27/20 13:47	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*98*		*75 - 126*	*04/15/20 10:40*	*04/27/20 13:47*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*04/15/20 10:40*	*04/27/20 13:47*	*50*
Dibromofluoromethane (Surr)	*101*		*75 - 120*	*04/15/20 10:40*	*04/27/20 13:47*	*50*
Toluene-d8 (Surr)	*103*		*75 - 120*	*04/15/20 10:40*	*04/27/20 13:47*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**86**		79	9.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
2-Methylnaphthalene	**100**		79	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Acenaphthene	**49**		39	7.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Acenaphthylene	**41**		39	5.1	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Anthracene	**100**		39	6.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[a]anthracene	**440**		39	5.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[a]pyrene	**450**		39	7.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[b]fluoranthene	**580**		39	8.4	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[g,h,i]perylene	**180**		39	13	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Benzo[k]fluoranthene	**260**		39	11	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Chrysene	**480**		39	11	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Dibenz(a,h)anthracene	**41**		39	7.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Fluoranthene	**760**		39	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Fluorene	**43**		39	5.5	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Indeno[1,2,3-cd]pyrene	**170**		39	10	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Naphthalene	**81**		39	6.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Phenanthrene	**630**		39	5.4	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1
Pyrene	**800**		39	7.7	ug/Kg	☼	04/29/20 07:52	04/30/20 00:22	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*94*		*43 - 145*	*04/29/20 07:52*	*04/30/20 00:22*	*1*
Nitrobenzene-d5 (Surr)	*84*		*37 - 147*	*04/29/20 07:52*	*04/30/20 00:22*	*1*
Terphenyl-d14 (Surr)	*118*		*42 - 157*	*04/29/20 07:52*	*04/30/20 00:22*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.0**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Barium	**44**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Cadmium	**0.43**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Lead	**86**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-7

Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7

Matrix: Solid
Percent Solids: 85.1

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1
Silver	**0.53**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:12	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.041**		0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 10:33	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		65	30	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1,1-Trichloroethane	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1,2,2-Tetrachloroethane	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1,2-Trichloroethane	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1-Dichloroethane	<27		65	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1-Dichloroethene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,1-Dichloropropene	<19		65	19	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,3-Trichlorobenzene	<30		65	30	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,4-Trichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2,4-Trimethylbenzene	**23**	**J**	65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dibromoethane	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dichloroethane	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,2-Dichloropropane	<28		65	28	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,3,5-Trimethylbenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,3-Dichlorobenzene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,3-Dichloropropane	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
1,4-Dichlorobenzene	<24		65	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
2,2-Dichloropropane	<29		65	29	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
2-Chlorotoluene	<20		65	20	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
4-Chlorotoluene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Benzene	**19**		16	9.4	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromobenzene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromochloromethane	<28		65	28	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromodichloromethane	<24		65	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromoform	<31		65	31	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Bromomethane	<51	*	190	51	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Carbon tetrachloride	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chlorobenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chloroethane	<33		65	33	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Chloromethane	<21		65	21	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
cis-1,2-Dichloroethene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
cis-1,3-Dichloropropene	<27		65	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Dibromochloromethane	<32		65	32	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Dibromomethane	<17		65	17	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Dichlorodifluoromethane	<44		190	44	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Ethylbenzene	**18**		16	12	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Hexachlorobutadiene	<29		65	29	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Isopropyl ether	<18		65	18	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Isopropylbenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Methyl tert-butyl ether	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Methylene Chloride	<110		320	110	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
n-Butylbenzene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
N-Propylbenzene	<27		65	27	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
p-Isopropyltoluene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
sec-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		65	25	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
tert-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Tetrachloroethene	<24		65	24	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Toluene	**49**		16	9.5	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
trans-1,2-Dichloroethene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
trans-1,3-Dichloropropene	<23		65	23	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Trichloroethene	<11		32	11	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Trichlorofluoromethane	<28		65	28	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Vinyl chloride	<17		65	17	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50
Xylenes, Total	**67**		32	14	ug/Kg	☼	04/15/20 10:55	04/27/20 14:11	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*	*04/15/20 10:55*	*04/27/20 14:11*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*04/15/20 10:55*	*04/27/20 14:11*	*50*
Dibromofluoromethane (Surr)	*99*		*75 - 120*	*04/15/20 10:55*	*04/27/20 14:11*	*50*
Toluene-d8 (Surr)	*106*		*75 - 120*	*04/15/20 10:55*	*04/27/20 14:11*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**100**		75	9.1	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
2-Methylnaphthalene	**140**		75	6.8	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Acenaphthene	**100**		37	6.7	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Acenaphthylene	**140**		37	4.9	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Anthracene	**310**		37	6.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[a]anthracene	**1100**		37	5.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[a]pyrene	**1200**		37	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[b]fluoranthene	**1600**		37	8.0	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[g,h,i]perylene	**340**		37	12	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Benzo[k]fluoranthene	**630**		37	11	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Chrysene	**1200**		37	10	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Dibenz(a,h)anthracene	**100**		37	7.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Fluoranthene	**2300**		37	6.9	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Fluorene	**96**		37	5.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Indeno[1,2,3-cd]pyrene	**330**		37	9.6	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Naphthalene	**160**		37	5.7	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Phenanthrene	**1600**		37	5.2	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1
Pyrene	**2600**		37	7.4	ug/Kg	☼	04/29/20 07:52	04/30/20 00:50	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*88*		*43 - 145*	*04/29/20 07:52*	*04/30/20 00:50*	*1*
Nitrobenzene-d5 (Surr)	*85*		*37 - 147*	*04/29/20 07:52*	*04/30/20 00:50*	*1*
Terphenyl-d14 (Surr)	*110*		*42 - 157*	*04/29/20 07:52*	*04/30/20 00:50*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**6.2**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Barium	**54**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Cadmium	**0.58**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Lead	**150**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1
Silver	**0.51**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:16	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.080**		0.018	0.0061	mg/Kg	☼	04/24/20 14:15	04/27/20 10:35	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid
Percent Solids: 87.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<29		64	29	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1,1-Trichloroethane	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1,2,2-Tetrachloroethane	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1,2-Trichloroethane	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1-Dichloroethane	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1-Dichloroethene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,1-Dichloropropene	<19		64	19	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,3-Trichlorobenzene	<29		64	29	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,3-Trichloropropane	<26		130	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,4-Trichlorobenzene	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2,4-Trimethylbenzene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dibromoethane	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dichlorobenzene	<21		64	21	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dichloroethane	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,2-Dichloropropane	<27		64	27	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,3,5-Trimethylbenzene	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,3-Dichlorobenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,3-Dichloropropane	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
1,4-Dichlorobenzene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
2,2-Dichloropropane	<28		64	28	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
2-Chlorotoluene	<20		64	20	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
4-Chlorotoluene	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Benzene	<9.3		16	9.3	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromobenzene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromochloromethane	<27		64	27	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromodichloromethane	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromoform	<31		64	31	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Bromomethane	<51	*	190	51	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Carbon tetrachloride	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chlorobenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chloroethane	<32		64	32	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Chloromethane	<20		64	20	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
cis-1,2-Dichloroethene	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
cis-1,3-Dichloropropene	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Dibromochloromethane	<31		64	31	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Dibromomethane	<17		64	17	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Dichlorodifluoromethane	<43		190	43	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Ethylbenzene	<12		16	12	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Hexachlorobutadiene	<28		64	28	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Isopropyl ether	<18		64	18	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Isopropylbenzene	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Methyl tert-butyl ether	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Methylene Chloride	<100		320	100	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
n-Butylbenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
N-Propylbenzene	<26		64	26	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
p-Isopropyltoluene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
sec-Butylbenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50

Client Sample ID: HA-9

Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9

Matrix: Solid
Percent Solids: 87.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
tert-Butylbenzene	<25		64	25	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Tetrachloroethene	<24		64	24	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Toluene	<9.4		16	9.4	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
trans-1,2-Dichloroethene	<22		64	22	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
trans-1,3-Dichloropropene	<23		64	23	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Trichloroethene	<10		32	10	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Trichlorofluoromethane	<27		64	27	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Vinyl chloride	<17		64	17	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50
Xylenes, Total	<14		32	14	ug/Kg	☼	04/15/20 11:15	04/27/20 14:35	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*	*04/15/20 11:15*	*04/27/20 14:35*	*50*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*	*04/15/20 11:15*	*04/27/20 14:35*	*50*
Dibromofluoromethane (Surr)	*102*		*75 - 120*	*04/15/20 11:15*	*04/27/20 14:35*	*50*
Toluene-d8 (Surr)	*102*		*75 - 120*	*04/15/20 11:15*	*04/27/20 14:35*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**21**	**J**	73	8.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
2-Methylnaphthalene	**35**	**J**	73	6.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Acenaphthene	**14**	**J**	36	6.5	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Acenaphthylene	**14**	**J**	36	4.8	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Anthracene	**48**		36	6.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[a]anthracene	**180**		36	4.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[a]pyrene	**170**		36	7.0	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[b]fluoranthene	**210**		36	7.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[g,h,i]perylene	**100**		36	12	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Benzo[k]fluoranthene	**55**		36	11	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Chrysene	**190**		36	9.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Dibenz(a,h)anthracene	**24**	**J**	36	7.0	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Fluoranthene	**300**		36	6.8	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Fluorene	**12**	**J**	36	5.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Indeno[1,2,3-cd]pyrene	**93**		36	9.4	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Naphthalene	**25**	**J**	36	5.6	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Phenanthrene	**240**		36	5.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1
Pyrene	**300**		36	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:59	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*86*		*43 - 145*	*04/29/20 07:52*	*04/29/20 22:59*	*1*
Nitrobenzene-d5 (Surr)	*78*		*37 - 147*	*04/29/20 07:52*	*04/29/20 22:59*	*1*
Terphenyl-d14 (Surr)	*109*		*42 - 157*	*04/29/20 07:52*	*04/29/20 22:59*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.0**		1.1	0.38	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Barium	**37**		1.1	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Cadmium	**0.18**	**J**	0.22	0.040	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Chromium	**13**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Lead	**53**		0.55	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid
Percent Solids: 87.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.65		1.1	0.65	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1
Silver	**0.23**	**J**	0.55	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:20	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.16**		0.018	0.0059	mg/Kg	☼	04/24/20 14:15	04/27/20 10:37	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-10
Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10
Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<31		66	31	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1,1-Trichloroethane	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1,2,2-Tetrachloroethane	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1,2-Trichloroethane	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1-Dichloroethane	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1-Dichloroethene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,1-Dichloropropene	<20		66	20	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,3-Trichlorobenzene	<30		66	30	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,4-Trichlorobenzene	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2,4-Trimethylbenzene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dibromo-3-Chloropropane	<130		330	130	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dibromoethane	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dichlorobenzene	<22		66	22	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dichloroethane	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,2-Dichloropropane	<28		66	28	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,3,5-Trimethylbenzene	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,3-Dichlorobenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,3-Dichloropropane	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
1,4-Dichlorobenzene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
2,2-Dichloropropane	<29		66	29	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
2-Chlorotoluene	<21		66	21	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
4-Chlorotoluene	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Benzene	<9.6		17	9.6	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromobenzene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromochloromethane	<28		66	28	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromodichloromethane	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromoform	<32		66	32	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Bromomethane	<53	*	200	53	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Carbon tetrachloride	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chlorobenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chloroethane	<33		66	33	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Chloromethane	<21		66	21	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
cis-1,2-Dichloroethene	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
cis-1,3-Dichloropropene	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Dibromochloromethane	<32		66	32	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Dibromomethane	<18		66	18	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Dichlorodifluoromethane	<45		200	45	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Ethylbenzene	<12		17	12	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Hexachlorobutadiene	<29		66	29	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Isopropyl ether	<18		66	18	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Isopropylbenzene	<25		66	25	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Methyl tert-butyl ether	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Methylene Chloride	<110		330	110	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
n-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
N-Propylbenzene	<27		66	27	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
p-Isopropyltoluene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
sec-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50

Client Sample ID: HA-10

Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10

Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
tert-Butylbenzene	<26		66	26	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Tetrachloroethene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Toluene	**23**		17	9.7	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
trans-1,2-Dichloroethene	<23		66	23	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
trans-1,3-Dichloropropene	<24		66	24	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Trichloroethene	<11		33	11	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Trichlorofluoromethane	<28		66	28	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Vinyl chloride	<17		66	17	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50
Xylenes, Total	**46**		33	15	ug/Kg	☼	04/15/20 11:30	04/27/20 14:59	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*104*		*75 - 126*	*04/15/20 11:30*	*04/27/20 14:59*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*04/15/20 11:30*	*04/27/20 14:59*	*50*
Dibromofluoromethane (Surr)	*103*		*75 - 120*	*04/15/20 11:30*	*04/27/20 14:59*	*50*
Toluene-d8 (Surr)	*103*		*75 - 120*	*04/15/20 11:30*	*04/27/20 14:59*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**120**	**J**	380	46	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
2-Methylnaphthalene	**160**	**J**	380	35	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Acenaphthene	**40**	**J**	190	34	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Acenaphthylene	**44**	**J**	190	25	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Anthracene	**150**	**J**	190	31	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[a]anthracene	**530**		190	25	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[a]pyrene	**620**		190	36	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[b]fluoranthene	**1000**		190	41	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[g,h,i]perylene	**150**	**J**	190	61	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Benzo[k]fluoranthene	**250**		190	55	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Chrysene	**720**		190	51	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Dibenz(a,h)anthracene	<36		190	36	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Fluoranthene	**980**		190	35	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Fluorene	**35**	**J**	190	26	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Indeno[1,2,3-cd]pyrene	**220**		190	49	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Naphthalene	**150**	**J**	190	29	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Phenanthrene	**600**		190	26	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5
Pyrene	**970**		190	37	ug/Kg	☼	04/29/20 07:52	04/30/20 03:10	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*87*		*43 - 145*	*04/29/20 07:52*	*04/30/20 03:10*	*5*
Nitrobenzene-d5 (Surr)	*81*		*37 - 147*	*04/29/20 07:52*	*04/30/20 03:10*	*5*
Terphenyl-d14 (Surr)	*103*		*42 - 157*	*04/29/20 07:52*	*04/30/20 03:10*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.0**		1.1	0.37	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Barium	**41**		1.1	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Cadmium	**0.44**		0.22	0.039	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Chromium	**16**		1.1	0.54	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Lead	**190**		0.54	0.25	mg/Kg	☼	04/21/20 07:24	04/22/20 11:05	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-10
Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10
Matrix: Solid
Percent Solids: 86.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.64		1.1	0.64	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1
Silver	**0.36**	**J**	0.54	0.14	mg/Kg	☼	04/21/20 07:24	04/22/20 01:33	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.22**		0.018	0.0059	mg/Kg	☼	04/24/20 14:15	04/27/20 10:39	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-11
Date Collected: 04/15/20 11:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-11
Matrix: Solid
Percent Solids: 81.6

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<33		72	33	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1,1-Trichloroethane	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1,2,2-Tetrachloroethane	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1,2-Trichloroethane	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1-Dichloroethane	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1-Dichloroethene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,1-Dichloropropene	<22		72	22	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,3-Trichlorobenzene	<33		72	33	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,3-Trichloropropane	<30		140	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,4-Trichlorobenzene	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2,4-Trimethylbenzene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dibromo-3-Chloropropane	<140		360	140	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dibromoethane	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dichlorobenzene	<24		72	24	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dichloroethane	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,2-Dichloropropane	<31		72	31	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,3,5-Trimethylbenzene	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,3-Dichlorobenzene	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,3-Dichloropropane	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
1,4-Dichlorobenzene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
2,2-Dichloropropane	<32		72	32	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
2-Chlorotoluene	<23		72	23	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
4-Chlorotoluene	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Benzene	<11		18	11	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromobenzene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromochloromethane	<31		72	31	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromodichloromethane	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromoform	<35		72	35	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Bromomethane	<58	*	220	58	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Carbon tetrachloride	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chlorobenzene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chloroethane	<36		72	36	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chloroform	<27		140	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Chloromethane	<23		72	23	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
cis-1,2-Dichloroethene	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
cis-1,3-Dichloropropene	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Dibromochloromethane	<35		72	35	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Dibromomethane	<20		72	20	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Dichlorodifluoromethane	<49		220	49	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Ethylbenzene	<13		18	13	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Hexachlorobutadiene	<32		72	32	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Isopropyl ether	<20		72	20	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Isopropylbenzene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Methyl tert-butyl ether	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Methylene Chloride	<120		360	120	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
n-Butylbenzene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
N-Propylbenzene	<30		72	30	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
p-Isopropyltoluene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
sec-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50

Client Sample ID: HA-11
Date Collected: 04/15/20 11:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-11
Matrix: Solid
Percent Solids: 81.6

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<28		72	28	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
tert-Butylbenzene	<29		72	29	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Tetrachloroethene	<27		72	27	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Toluene	<11		18	11	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
trans-1,2-Dichloroethene	<25		72	25	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
trans-1,3-Dichloropropene	<26		72	26	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Trichloroethene	<12		36	12	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Trichlorofluoromethane	<31		72	31	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Vinyl chloride	<19		72	19	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50
Xylenes, Total	<16		36	16	ug/Kg	☼	04/15/20 11:50	04/27/20 15:23	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*	*04/15/20 11:50*	*04/27/20 15:23*	*50*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*	*04/15/20 11:50*	*04/27/20 15:23*	*50*
Dibromofluoromethane (Surr)	*102*		*75 - 120*	*04/15/20 11:50*	*04/27/20 15:23*	*50*
Toluene-d8 (Surr)	*105*		*75 - 120*	*04/15/20 11:50*	*04/27/20 15:23*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**230**	**J**	410	49	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
2-Methylnaphthalene	**390**	**J**	410	37	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Acenaphthene	<36		200	36	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Acenaphthylene	**33**	**J**	200	27	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Anthracene	**140**	**J**	200	34	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[a]anthracene	**350**		200	27	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[a]pyrene	**370**		200	39	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[b]fluoranthene	**350**		200	44	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[g,h,i]perylene	<65		200	65	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Benzo[k]fluoranthene	**120**	**J**	200	60	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Chrysene	**460**		200	55	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Dibenz(a,h)anthracene	<39		200	39	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Fluoranthene	**530**		200	37	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Fluorene	**59**	**J**	200	28	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Indeno[1,2,3-cd]pyrene	<52		200	52	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Naphthalene	**130**	**J**	200	31	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Phenanthrene	**650**		200	28	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5
Pyrene	**690**		200	40	ug/Kg	☼	04/29/20 07:52	05/01/20 04:47	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*96*		*43 - 145*	*04/29/20 07:52*	*05/01/20 04:47*	*5*
Nitrobenzene-d5 (Surr)	*85*		*37 - 147*	*04/29/20 07:52*	*05/01/20 04:47*	*5*
Terphenyl-d14 (Surr)	*120*		*42 - 157*	*04/29/20 07:52*	*05/01/20 04:47*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**7.9**		1.0	0.35	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Barium	**70**		1.0	0.12	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Cadmium	**0.83**		0.21	0.037	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Chromium	**19**		1.0	0.51	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Lead	**250**		0.52	0.24	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-11
Date Collected: 04/15/20 11:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-11
Matrix: Solid
Percent Solids: 81.6

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	1.1		1.0	0.61	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1
Silver	0.82		0.52	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:37	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.19		0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 08:26	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-12
Date Collected: 04/15/20 12:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-12
Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<30		65	30	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1,1-Trichloroethane	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1,2,2-Tetrachloroethane	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1,2-Trichloroethane	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1-Dichloroethane	<27		65	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1-Dichloroethene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,1-Dichloropropene	<19		65	19	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,3-Trichlorobenzene	<30		65	30	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,3-Trichloropropane	<27		130	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,4-Trichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2,4-Trimethylbenzene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dibromo-3-Chloropropane	<130		320	130	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dibromoethane	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dichlorobenzene	<22		65	22	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dichloroethane	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,2-Dichloropropane	<28		65	28	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,3,5-Trimethylbenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,3-Dichlorobenzene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,3-Dichloropropane	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
1,4-Dichlorobenzene	<24		65	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
2,2-Dichloropropane	<29		65	29	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
2-Chlorotoluene	<20		65	20	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
4-Chlorotoluene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Benzene	<9.4		16	9.4	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromobenzene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromochloromethane	<28		65	28	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromodichloromethane	<24		65	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromoform	<31		65	31	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Bromomethane	<52	*	190	52	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Carbon tetrachloride	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chlorobenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chloroethane	<33		65	33	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chloroform	<24		130	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Chloromethane	<21		65	21	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
cis-1,2-Dichloroethene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
cis-1,3-Dichloropropene	<27		65	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Dibromochloromethane	<32		65	32	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Dibromomethane	<17		65	17	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Dichlorodifluoromethane	<44		190	44	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Ethylbenzene	<12		16	12	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Hexachlorobutadiene	<29		65	29	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Isopropyl ether	<18		65	18	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Isopropylbenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Methyl tert-butyl ether	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Methylene Chloride	<110		320	110	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
n-Butylbenzene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
N-Propylbenzene	<27		65	27	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
p-Isopropyltoluene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
sec-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50

Client Sample ID: HA-12

Date Collected: 04/15/20 12:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-12

Matrix: Solid
Percent Solids: 86.7

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<25		65	25	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
tert-Butylbenzene	<26		65	26	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Tetrachloroethene	<24		65	24	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Toluene	<9.5		16	9.5	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
trans-1,2-Dichloroethene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
trans-1,3-Dichloropropene	<23		65	23	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Trichloroethene	<11		32	11	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Trichlorofluoromethane	<28		65	28	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Vinyl chloride	<17		65	17	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50
Xylenes, Total	<14		32	14	ug/Kg	☼	04/15/20 12:10	04/27/20 15:47	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*	*04/15/20 12:10*	*04/27/20 15:47*	*50*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*	*04/15/20 12:10*	*04/27/20 15:47*	*50*
Dibromofluoromethane (Surr)	*103*		*75 - 120*	*04/15/20 12:10*	*04/27/20 15:47*	*50*
Toluene-d8 (Surr)	*101*		*75 - 120*	*04/15/20 12:10*	*04/27/20 15:47*	*50*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<9.1		75	9.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
2-Methylnaphthalene	<6.9		75	6.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Acenaphthene	<6.7		37	6.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Acenaphthylene	<4.9		37	4.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Anthracene	<6.2		37	6.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[a]anthracene	**36**	**J**	37	5.0	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[a]pyrene	**37**		37	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[b]fluoranthene	**46**		37	8.1	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[g,h,i]perylene	**22**	**J**	37	12	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Benzo[k]fluoranthene	**18**	**J**	37	11	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Chrysene	**43**		37	10	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Dibenz(a,h)anthracene	<7.2		37	7.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Fluoranthene	**57**		37	6.9	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Fluorene	<5.2		37	5.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Indeno[1,2,3-cd]pyrene	**23**	**J**	37	9.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Naphthalene	<5.7		37	5.7	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Phenanthrene	**17**	**J**	37	5.2	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1
Pyrene	**59**		37	7.4	ug/Kg	☼	04/29/20 07:52	04/29/20 22:31	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*72*		*43 - 145*	*04/29/20 07:52*	*04/29/20 22:31*	*1*
Nitrobenzene-d5 (Surr)	*70*		*37 - 147*	*04/29/20 07:52*	*04/29/20 22:31*	*1*
Terphenyl-d14 (Surr)	*104*		*42 - 157*	*04/29/20 07:52*	*04/29/20 22:31*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.0**		0.97	0.33	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Barium	**31**		0.97	0.11	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Cadmium	**0.040**	**J**	0.19	0.035	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Chromium	**14**		0.97	0.48	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Lead	**7.2**		0.49	0.22	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-12
Date Collected: 04/15/20 12:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-12
Matrix: Solid
Percent Solids: 86.7

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.57		0.97	0.57	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1
Silver	**0.13**	**J**	0.49	0.13	mg/Kg	☼	04/21/20 07:24	04/22/20 01:42	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.0083**	**J**	0.019	0.0062	mg/Kg	☼	04/24/20 14:15	04/27/20 08:28	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: Soil-Composite-1

Date Collected: 04/15/20 12:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-13

Matrix: Solid

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.010		0.050	0.010	mg/L		04/29/20 06:08	04/29/20 17:37	1
Lead	<0.0075		0.050	0.0075	mg/L		04/29/20 06:08	04/29/20 17:37	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.00020		0.00020	0.00020	mg/L		04/29/20 09:35	04/30/20 10:23	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-10
Date Collected: 04/16/20 08:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-14
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 16:11	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 16:11	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 16:11	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 16:11	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 16:11	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 16:11	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 16:11	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 16:11	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 16:11	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 16:11	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 16:11	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 16:11	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 16:11	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 16:11	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 16:11	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 16:11	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:11	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 16:11	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 16:11	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 16:11	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 16:11	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 16:11	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 16:11	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 16:11	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 16:11	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 16:11	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 16:11	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 16:11	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 16:11	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 16:11	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 16:11	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 16:11	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 16:11	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 16:11	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-10

Date Collected: 04/16/20 08:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-14

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 16:11	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:11	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 16:11	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 16:11	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 16:11	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 16:11	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 16:11	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:11	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 16:11	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 16:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*		*04/27/20 16:11*	*1*
4-Bromofluorobenzene (Surr)	*88*		*72 - 124*		*04/27/20 16:11*	*1*
Dibromofluoromethane (Surr)	*105*		*75 - 120*		*04/27/20 16:11*	*1*
Toluene-d8 (Surr)	*99*		*75 - 120*		*04/27/20 16:11*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.25		1.7	0.25	ug/L		04/21/20 18:29	04/23/20 00:53	1
2-Methylnaphthalene	<0.054		1.7	0.054	ug/L		04/21/20 18:29	04/23/20 00:53	1
Acenaphthene	<0.26		0.84	0.26	ug/L		04/21/20 18:29	04/23/20 00:53	1
Acenaphthylene	<0.22		0.84	0.22	ug/L		04/21/20 18:29	04/23/20 00:53	1
Anthracene	<0.28		0.84	0.28	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[a]anthracene	<0.047		0.17	0.047	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[a]pyrene	<0.083		0.17	0.083	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[b]fluoranthene	<0.067		0.17	0.067	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[g,h,i]perylene	<0.31		0.84	0.31	ug/L		04/21/20 18:29	04/23/20 00:53	1
Benzo[k]fluoranthene	<0.054		0.17	0.054	ug/L		04/21/20 18:29	04/23/20 00:53	1
Chrysene	<0.057		0.17	0.057	ug/L		04/21/20 18:29	04/23/20 00:53	1
Dibenz(a,h)anthracene	<0.042		0.25	0.042	ug/L		04/21/20 18:29	04/23/20 00:53	1
Fluoranthene	<0.38		0.84	0.38	ug/L		04/21/20 18:29	04/23/20 00:53	1
Fluorene	<0.20		0.84	0.20	ug/L		04/21/20 18:29	04/23/20 00:53	1
Indeno[1,2,3-cd]pyrene	<0.063		0.17	0.063	ug/L		04/21/20 18:29	04/23/20 00:53	1
Naphthalene	<0.26		0.84	0.26	ug/L		04/21/20 18:29	04/23/20 00:53	1
Phenanthrene	<0.25		0.84	0.25	ug/L		04/21/20 18:29	04/23/20 00:53	1
Pyrene	<0.36		0.84	0.36	ug/L		04/21/20 18:29	04/23/20 00:53	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*86*		*34 - 110*	*04/21/20 18:29*	*04/23/20 00:53*	*1*
Nitrobenzene-d5 (Surr)	*84*		*36 - 120*	*04/21/20 18:29*	*04/23/20 00:53*	*1*
Terphenyl-d14 (Surr)	*125*		*40 - 145*	*04/21/20 18:29*	*04/23/20 00:53*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.56**	**J**	1.0	0.23	ug/L		04/21/20 17:30	04/22/20 17:59	1
Barium	**29**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 17:59	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 17:59	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:36	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:36	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-10
Date Collected: 04/16/20 08:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-14
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	**1.3**	**J**	2.5	0.98	ug/L		04/21/20 17:30	04/22/20 17:59	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:36	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:29	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-11
Date Collected: 04/16/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-15
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 16:35	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 16:35	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 16:35	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 16:35	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 16:35	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 16:35	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 16:35	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 16:35	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 16:35	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 16:35	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 16:35	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 16:35	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 16:35	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 16:35	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 16:35	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 16:35	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:35	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 16:35	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 16:35	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 16:35	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 16:35	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 16:35	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 16:35	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 16:35	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 16:35	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 16:35	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 16:35	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 16:35	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 16:35	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 16:35	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 16:35	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 16:35	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 16:35	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 16:35	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-11

Date Collected: 04/16/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-15

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 16:35	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:35	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 16:35	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 16:35	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 16:35	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 16:35	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 16:35	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:35	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 16:35	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 16:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*		*04/27/20 16:35*	*1*
4-Bromofluorobenzene (Surr)	*87*		*72 - 124*		*04/27/20 16:35*	*1*
Dibromofluoromethane (Surr)	*103*		*75 - 120*		*04/27/20 16:35*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 16:35*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.27		1.8	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
2-Methylnaphthalene	<0.058		1.8	0.058	ug/L		04/21/20 18:29	04/23/20 01:21	1
Acenaphthene	<0.27		0.89	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
Acenaphthylene	<0.24		0.89	0.24	ug/L		04/21/20 18:29	04/23/20 01:21	1
Anthracene	<0.30		0.89	0.30	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[a]anthracene	<0.050		0.18	0.050	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[a]pyrene	<0.088		0.18	0.088	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[b]fluoranthene	<0.072		0.18	0.072	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[g,h,i]perylene	<0.33		0.89	0.33	ug/L		04/21/20 18:29	04/23/20 01:21	1
Benzo[k]fluoranthene	<0.057		0.18	0.057	ug/L		04/21/20 18:29	04/23/20 01:21	1
Chrysene	<0.061		0.18	0.061	ug/L		04/21/20 18:29	04/23/20 01:21	1
Dibenz(a,h)anthracene	<0.045		0.27	0.045	ug/L		04/21/20 18:29	04/23/20 01:21	1
Fluoranthene	<0.40		0.89	0.40	ug/L		04/21/20 18:29	04/23/20 01:21	1
Fluorene	<0.22		0.89	0.22	ug/L		04/21/20 18:29	04/23/20 01:21	1
Indeno[1,2,3-cd]pyrene	<0.067		0.18	0.067	ug/L		04/21/20 18:29	04/23/20 01:21	1
Naphthalene	<0.27		0.89	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
Phenanthrene	<0.27		0.89	0.27	ug/L		04/21/20 18:29	04/23/20 01:21	1
Pyrene	<0.38		0.89	0.38	ug/L		04/21/20 18:29	04/23/20 01:21	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*84*		*34 - 110*	*04/21/20 18:29*	*04/23/20 01:21*	*1*
Nitrobenzene-d5 (Surr)	*80*		*36 - 120*	*04/21/20 18:29*	*04/23/20 01:21*	*1*
Terphenyl-d14 (Surr)	*118*		*40 - 145*	*04/21/20 18:29*	*04/23/20 01:21*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.2**		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:03	1
Barium	**330**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:03	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 18:03	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:41	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:41	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-11
Date Collected: 04/16/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-15
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:03	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:41	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:31	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-13
Date Collected: 04/16/20 09:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-16
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 16:59	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 16:59	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 16:59	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 16:59	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 16:59	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 16:59	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 16:59	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 16:59	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 16:59	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 16:59	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 16:59	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 16:59	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 16:59	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 16:59	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 16:59	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 16:59	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:59	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 16:59	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 16:59	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 16:59	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 16:59	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 16:59	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 16:59	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 16:59	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 16:59	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 16:59	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 16:59	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 16:59	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 16:59	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 16:59	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 16:59	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 16:59	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 16:59	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 16:59	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1

Client Sample ID: TW-13

Date Collected: 04/16/20 09:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-16

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 16:59	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 16:59	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 16:59	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 16:59	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 16:59	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 16:59	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 16:59	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 16:59	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 16:59	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 16:59	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 126*		*04/27/20 16:59*	*1*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*		*04/27/20 16:59*	*1*
Dibromofluoromethane (Surr)	*108*		*75 - 120*		*04/27/20 16:59*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*		*04/27/20 16:59*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.26		1.8	0.26	ug/L		04/21/20 18:29	04/23/20 01:49	1
2-Methylnaphthalene	<0.057		1.8	0.057	ug/L		04/21/20 18:29	04/23/20 01:49	1
Acenaphthene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 01:49	1
Acenaphthylene	<0.23		0.88	0.23	ug/L		04/21/20 18:29	04/23/20 01:49	1
Anthracene	<0.29		0.88	0.29	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[a]anthracene	<0.050		0.18	0.050	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[a]pyrene	<0.087		0.18	0.087	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[b]fluoranthene	<0.071		0.18	0.071	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[g,h,i]perylene	<0.33		0.88	0.33	ug/L		04/21/20 18:29	04/23/20 01:49	1
Benzo[k]fluoranthene	<0.056		0.18	0.056	ug/L		04/21/20 18:29	04/23/20 01:49	1
Chrysene	<0.060		0.18	0.060	ug/L		04/21/20 18:29	04/23/20 01:49	1
Dibenz(a,h)anthracene	<0.044		0.26	0.044	ug/L		04/21/20 18:29	04/23/20 01:49	1
Fluoranthene	<0.40		0.88	0.40	ug/L		04/21/20 18:29	04/23/20 01:49	1
Fluorene	<0.21		0.88	0.21	ug/L		04/21/20 18:29	04/23/20 01:49	1
Indeno[1,2,3-cd]pyrene	<0.065		0.18	0.065	ug/L		04/21/20 18:29	04/23/20 01:49	1
Naphthalene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 01:49	1
Phenanthrene	<0.26		0.88	0.26	ug/L		04/21/20 18:29	04/23/20 01:49	1
Pyrene	<0.37		0.88	0.37	ug/L		04/21/20 18:29	04/23/20 01:49	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*91*		*34 - 110*	*04/21/20 18:29*	*04/23/20 01:49*	*1*
Nitrobenzene-d5 (Surr)	*85*		*36 - 120*	*04/21/20 18:29*	*04/23/20 01:49*	*1*
Terphenyl-d14 (Surr)	*111*		*40 - 145*	*04/21/20 18:29*	*04/23/20 01:49*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.77**	**J**	1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:07	1
Barium	**91**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:07	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 18:07	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:45	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:45	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-13
Date Collected: 04/16/20 09:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-16
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:07	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:45	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:53	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-15
Date Collected: 04/16/20 10:20
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-17
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 17:23	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 17:23	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 17:23	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 17:23	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 17:23	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 17:23	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 17:23	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 17:23	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 17:23	1
1,2,4-Trimethylbenzene	**3.9**		1.0	0.36	ug/L			04/27/20 17:23	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 17:23	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 17:23	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 17:23	1
1,3,5-Trimethylbenzene	**2.4**		1.0	0.25	ug/L			04/27/20 17:23	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:23	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 17:23	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 17:23	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 17:23	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 17:23	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:23	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 17:23	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 17:23	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 17:23	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 17:23	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 17:23	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 17:23	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 17:23	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 17:23	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 17:23	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 17:23	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 17:23	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 17:23	1
Ethylbenzene	**0.21**	**J**	0.50	0.18	ug/L			04/27/20 17:23	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 17:23	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 17:23	1
Isopropylbenzene	**2.9**		1.0	0.39	ug/L			04/27/20 17:23	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 17:23	1
n-Butylbenzene	**9.2**		1.0	0.39	ug/L			04/27/20 17:23	1
N-Propylbenzene	**4.6**		1.0	0.41	ug/L			04/27/20 17:23	1
p-Isopropyltoluene	**2.1**		1.0	0.36	ug/L			04/27/20 17:23	1
sec-Butylbenzene	**3.6**		1.0	0.40	ug/L			04/27/20 17:23	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-15

Date Collected: 04/16/20 10:20
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-17

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 17:23	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:23	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 17:23	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 17:23	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 17:23	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 17:23	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 17:23	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:23	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 17:23	1
Xylenes, Total	**1.6**		1.0	0.22	ug/L			04/27/20 17:23	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 126*		*04/27/20 17:23*	*1*
4-Bromofluorobenzene (Surr)	*82*		*72 - 124*		*04/27/20 17:23*	*1*
Dibromofluoromethane (Surr)	*105*		*75 - 120*		*04/27/20 17:23*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 17:23*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.26		1.7	0.26	ug/L		04/21/20 18:29	04/23/20 02:17	1
2-Methylnaphthalene	<0.057		1.7	0.057	ug/L		04/21/20 18:29	04/23/20 02:17	1
Acenaphthene	<0.27		0.87	0.27	ug/L		04/21/20 18:29	04/23/20 02:17	1
Acenaphthylene	<0.23		0.87	0.23	ug/L		04/21/20 18:29	04/23/20 02:17	1
Anthracene	<0.29		0.87	0.29	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[a]anthracene	<0.049		0.17	0.049	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[a]pyrene	<0.086		0.17	0.086	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[b]fluoranthene	<0.070		0.17	0.070	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[g,h,i]perylene	<0.33		0.87	0.33	ug/L		04/21/20 18:29	04/23/20 02:17	1
Benzo[k]fluoranthene	<0.056		0.17	0.056	ug/L		04/21/20 18:29	04/23/20 02:17	1
Chrysene	<0.059		0.17	0.059	ug/L		04/21/20 18:29	04/23/20 02:17	1
Dibenz(a,h)anthracene	<0.044		0.26	0.044	ug/L		04/21/20 18:29	04/23/20 02:17	1
Fluoranthene	<0.39		0.87	0.39	ug/L		04/21/20 18:29	04/23/20 02:17	1
Fluorene	<0.21		0.87	0.21	ug/L		04/21/20 18:29	04/23/20 02:17	1
Indeno[1,2,3-cd]pyrene	<0.065		0.17	0.065	ug/L		04/21/20 18:29	04/23/20 02:17	1
Naphthalene	<0.27		0.87	0.27	ug/L		04/21/20 18:29	04/23/20 02:17	1
Phenanthrene	<0.26		0.87	0.26	ug/L		04/21/20 18:29	04/23/20 02:17	1
Pyrene	<0.37		0.87	0.37	ug/L		04/21/20 18:29	04/23/20 02:17	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*85*		*34 - 110*	*04/21/20 18:29*	*04/23/20 02:17*	*1*
Nitrobenzene-d5 (Surr)	*86*		*36 - 120*	*04/21/20 18:29*	*04/23/20 02:17*	*1*
Terphenyl-d14 (Surr)	*114*		*40 - 145*	*04/21/20 18:29*	*04/23/20 02:17*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.0**		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:18	1
Barium	**47**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:18	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/23/20 12:48	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:48	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:48	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-15
Date Collected: 04/16/20 10:20
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-17
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	**7.9**		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:18	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:48	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:55	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-17
Date Collected: 04/16/20 12:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-18
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 17:47	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 17:47	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 17:47	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 17:47	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 17:47	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 17:47	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 17:47	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 17:47	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 17:47	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 17:47	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 17:47	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 17:47	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 17:47	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 17:47	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 17:47	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 17:47	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:47	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 17:47	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 17:47	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 17:47	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 17:47	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 17:47	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 17:47	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 17:47	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 17:47	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 17:47	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 17:47	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 17:47	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 17:47	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 17:47	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 17:47	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 17:47	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 17:47	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 17:47	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1

Client Sample ID: TW-17

Date Collected: 04/16/20 12:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-18

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 17:47	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 17:47	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 17:47	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 17:47	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 17:47	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 17:47	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 17:47	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 17:47	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 17:47	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 17:47	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 126*		*04/27/20 17:47*	*1*
4-Bromofluorobenzene (Surr)	*90*		*72 - 124*		*04/27/20 17:47*	*1*
Dibromofluoromethane (Surr)	*105*		*75 - 120*		*04/27/20 17:47*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 17:47*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.27		1.8	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
2-Methylnaphthalene	<0.057		1.8	0.057	ug/L		04/21/20 18:29	04/23/20 02:45	1
Acenaphthene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
Acenaphthylene	<0.24		0.88	0.24	ug/L		04/21/20 18:29	04/23/20 02:45	1
Anthracene	<0.29		0.88	0.29	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[a]anthracene	**0.21**		0.18	0.050	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[a]pyrene	**0.36**		0.18	0.087	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[b]fluoranthene	**0.29**		0.18	0.071	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[g,h,i]perylene	<0.33		0.88	0.33	ug/L		04/21/20 18:29	04/23/20 02:45	1
Benzo[k]fluoranthene	**0.23**		0.18	0.056	ug/L		04/21/20 18:29	04/23/20 02:45	1
Chrysene	**0.17**	**J**	0.18	0.060	ug/L		04/21/20 18:29	04/23/20 02:45	1
Dibenz(a,h)anthracene	<0.045		0.26	0.045	ug/L		04/21/20 18:29	04/23/20 02:45	1
Fluoranthene	<0.40		0.88	0.40	ug/L		04/21/20 18:29	04/23/20 02:45	1
Fluorene	<0.21		0.88	0.21	ug/L		04/21/20 18:29	04/23/20 02:45	1
Indeno[1,2,3-cd]pyrene	**0.23**		0.18	0.066	ug/L		04/21/20 18:29	04/23/20 02:45	1
Naphthalene	<0.27		0.88	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
Phenanthrene	**0.29**	**J**	0.88	0.27	ug/L		04/21/20 18:29	04/23/20 02:45	1
Pyrene	<0.38		0.88	0.38	ug/L		04/21/20 18:29	04/23/20 02:45	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*98*		*34 - 110*	*04/21/20 18:29*	*04/23/20 02:45*	*1*
Nitrobenzene-d5 (Surr)	*88*		*36 - 120*	*04/21/20 18:29*	*04/23/20 02:45*	*1*
Terphenyl-d14 (Surr)	*109*		*40 - 145*	*04/21/20 18:29*	*04/23/20 02:45*	*1*

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.3**		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 18:22	1
Barium	**67**		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 18:22	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/23/20 12:52	1
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:52	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:52	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-17
Date Collected: 04/16/20 12:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-18
Matrix: Water

Method: 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 18:22	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:52	1

Method: 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:57	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: Trip Blank

Date Collected: 04/16/20 00:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-19

Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 18:11	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 18:11	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 18:11	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 18:11	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 18:11	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 18:11	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 18:11	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 18:11	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 18:11	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 18:11	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 18:11	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 18:11	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 18:11	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 18:11	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 18:11	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 18:11	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 18:11	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 18:11	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 18:11	1
Bromomethane	<0.80	*	3.0	0.80	ug/L			04/27/20 18:11	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 18:11	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 18:11	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 18:11	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 18:11	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 18:11	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 18:11	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 18:11	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 18:11	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 18:11	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 18:11	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 18:11	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 18:11	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 18:11	1
Naphthalene	<0.34		1.0	0.34	ug/L			04/27/20 18:11	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 18:11	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: Trip Blank
Date Collected: 04/16/20 00:00
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-19
Matrix: Water

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 18:11	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 18:11	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 18:11	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 18:11	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 18:11	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 18:11	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 18:11	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 18:11	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 18:11	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 18:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*105*		*75 - 126*		*04/27/20 18:11*	*1*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*		*04/27/20 18:11*	*1*
Dibromofluoromethane (Surr)	*109*		*75 - 120*		*04/27/20 18:11*	*1*
Toluene-d8 (Surr)	*102*		*75 - 120*		*04/27/20 18:11*	*1*

Definitions/Glossary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
*	LCS or LCSD is outside acceptance limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

GC/MS VOA

Prep Batch: 539190

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	5035	
500-180867-2	HA-2	Total/NA	Solid	5035	
500-180867-3	HA-3	Total/NA	Solid	5035	
500-180867-4	HA-4	Total/NA	Solid	5035	
500-180867-5	HA-5	Total/NA	Solid	5035	
500-180867-6	HA-6	Total/NA	Solid	5035	
500-180867-7	HA-7	Total/NA	Solid	5035	
500-180867-8	HA-8	Total/NA	Solid	5035	
500-180867-9	HA-9	Total/NA	Solid	5035	
500-180867-10	HA-10	Total/NA	Solid	5035	
500-180867-11	HA-11	Total/NA	Solid	5035	
500-180867-12	HA-12	Total/NA	Solid	5035	

Analysis Batch: 539811

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	8260B	539190
500-180867-2	HA-2	Total/NA	Solid	8260B	539190
500-180867-3	HA-3	Total/NA	Solid	8260B	539190
500-180867-4	HA-4	Total/NA	Solid	8260B	539190
500-180867-5	HA-5	Total/NA	Solid	8260B	539190
500-180867-6	HA-6	Total/NA	Solid	8260B	539190
500-180867-7	HA-7	Total/NA	Solid	8260B	539190
500-180867-8	HA-8	Total/NA	Solid	8260B	539190
500-180867-9	HA-9	Total/NA	Solid	8260B	539190
500-180867-10	HA-10	Total/NA	Solid	8260B	539190
500-180867-11	HA-11	Total/NA	Solid	8260B	539190
500-180867-12	HA-12	Total/NA	Solid	8260B	539190
MB 500-539811/6	Method Blank	Total/NA	Solid	8260B	
LCS 500-539811/4	Lab Control Sample	Total/NA	Solid	8260B	

Analysis Batch: 539816

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Total/NA	Water	8260B	
500-180867-15	TW-11	Total/NA	Water	8260B	
500-180867-16	TW-13	Total/NA	Water	8260B	
500-180867-17	TW-15	Total/NA	Water	8260B	
500-180867-18	TW-17	Total/NA	Water	8260B	
500-180867-19	Trip Blank	Total/NA	Water	8260B	
MB 500-539816/6	Method Blank	Total/NA	Water	8260B	
LCS 500-539816/4	Lab Control Sample	Total/NA	Water	8260B	

GC/MS Semi VOA

Prep Batch: 539168

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Total/NA	Water	3510C	
500-180867-15	TW-11	Total/NA	Water	3510C	
500-180867-16	TW-13	Total/NA	Water	3510C	
500-180867-17	TW-15	Total/NA	Water	3510C	
500-180867-18	TW-17	Total/NA	Water	3510C	
MB 500-539168/1-A	Method Blank	Total/NA	Water	3510C	

GC/MS Semi VOA (Continued)

Prep Batch: 539168 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 500-539168/2-A	Lab Control Sample	Total/NA	Water	3510C	
LCSD 500-539168/3-A	Lab Control Sample Dup	Total/NA	Water	3510C	

Analysis Batch: 539355

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Total/NA	Water	8270D	539168
500-180867-15	TW-11	Total/NA	Water	8270D	539168
500-180867-16	TW-13	Total/NA	Water	8270D	539168
500-180867-17	TW-15	Total/NA	Water	8270D	539168
500-180867-18	TW-17	Total/NA	Water	8270D	539168
MB 500-539168/1-A	Method Blank	Total/NA	Water	8270D	539168
LCS 500-539168/2-A	Lab Control Sample	Total/NA	Water	8270D	539168
LCSD 500-539168/3-A	Lab Control Sample Dup	Total/NA	Water	8270D	539168

Prep Batch: 540269

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	3541	
500-180867-2	HA-2	Total/NA	Solid	3541	
500-180867-3	HA-3	Total/NA	Solid	3541	
500-180867-4	HA-4	Total/NA	Solid	3541	
500-180867-5	HA-5	Total/NA	Solid	3541	
500-180867-6	HA-6	Total/NA	Solid	3541	
500-180867-7	HA-7	Total/NA	Solid	3541	
500-180867-8	HA-8	Total/NA	Solid	3541	
500-180867-9	HA-9	Total/NA	Solid	3541	
500-180867-10	HA-10	Total/NA	Solid	3541	
500-180867-11	HA-11	Total/NA	Solid	3541	
500-180867-12	HA-12	Total/NA	Solid	3541	
MB 500-540269/1-A	Method Blank	Total/NA	Solid	3541	
LCS 500-540269/2-A	Lab Control Sample	Total/NA	Solid	3541	

Analysis Batch: 540348

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-540269/1-A	Method Blank	Total/NA	Solid	8270D	540269
LCS 500-540269/2-A	Lab Control Sample	Total/NA	Solid	8270D	540269

Analysis Batch: 540354

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	8270D	540269
500-180867-2	HA-2	Total/NA	Solid	8270D	540269
500-180867-3	HA-3	Total/NA	Solid	8270D	540269
500-180867-4	HA-4	Total/NA	Solid	8270D	540269
500-180867-5	HA-5	Total/NA	Solid	8270D	540269
500-180867-6	HA-6	Total/NA	Solid	8270D	540269
500-180867-7	HA-7	Total/NA	Solid	8270D	540269
500-180867-8	HA-8	Total/NA	Solid	8270D	540269
500-180867-9	HA-9	Total/NA	Solid	8270D	540269
500-180867-10	HA-10	Total/NA	Solid	8270D	540269
500-180867-12	HA-12	Total/NA	Solid	8270D	540269

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

GC/MS Semi VOA

Analysis Batch: 540575

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-11	HA-11	Total/NA	Solid	8270D	540269

Metals

Prep Batch: 539043

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	3050B	
500-180867-2	HA-2	Total/NA	Solid	3050B	
500-180867-3	HA-3	Total/NA	Solid	3050B	
500-180867-4	HA-4	Total/NA	Solid	3050B	
500-180867-5	HA-5	Total/NA	Solid	3050B	
500-180867-6	HA-6	Total/NA	Solid	3050B	
500-180867-7	HA-7	Total/NA	Solid	3050B	
500-180867-8	HA-8	Total/NA	Solid	3050B	
500-180867-9	HA-9	Total/NA	Solid	3050B	
500-180867-10	HA-10	Total/NA	Solid	3050B	
500-180867-11	HA-11	Total/NA	Solid	3050B	
500-180867-12	HA-12	Total/NA	Solid	3050B	
MB 500-539043/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-539043/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Prep Batch: 539129

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	3005A	
500-180867-15	TW-11	Dissolved	Water	3005A	
500-180867-16	TW-13	Dissolved	Water	3005A	
500-180867-17	TW-15	Dissolved	Water	3005A	
500-180867-18	TW-17	Dissolved	Water	3005A	
MB 500-539129/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 500-539129/2-A	Lab Control Sample	Total Recoverable	Water	3005A	

Analysis Batch: 539203

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	6010C	539043
500-180867-2	HA-2	Total/NA	Solid	6010C	539043
500-180867-3	HA-3	Total/NA	Solid	6010C	539043
500-180867-4	HA-4	Total/NA	Solid	6010C	539043
500-180867-5	HA-5	Total/NA	Solid	6010C	539043
500-180867-6	HA-6	Total/NA	Solid	6010C	539043
500-180867-7	HA-7	Total/NA	Solid	6010C	539043
500-180867-8	HA-8	Total/NA	Solid	6010C	539043
500-180867-9	HA-9	Total/NA	Solid	6010C	539043
500-180867-10	HA-10	Total/NA	Solid	6010C	539043
500-180867-11	HA-11	Total/NA	Solid	6010C	539043
500-180867-12	HA-12	Total/NA	Solid	6010C	539043
MB 500-539043/1-A	Method Blank	Total/NA	Solid	6010C	539043
LCS 500-539043/2-A	Lab Control Sample	Total/NA	Solid	6010C	539043

Analysis Batch: 539324

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-10	HA-10	Total/NA	Solid	6010C	539043

Metals

Analysis Batch: 539487

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	6020A	539129
500-180867-15	TW-11	Dissolved	Water	6020A	539129
500-180867-16	TW-13	Dissolved	Water	6020A	539129
500-180867-17	TW-15	Dissolved	Water	6020A	539129
500-180867-18	TW-17	Dissolved	Water	6020A	539129
MB 500-539129/1-A	Method Blank	Total Recoverable	Water	6020A	539129
LCS 500-539129/2-A	Lab Control Sample	Total Recoverable	Water	6020A	539129

Analysis Batch: 539529

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	6020A	539129
500-180867-15	TW-11	Dissolved	Water	6020A	539129
500-180867-16	TW-13	Dissolved	Water	6020A	539129
500-180867-17	TW-15	Dissolved	Water	6020A	539129
500-180867-18	TW-17	Dissolved	Water	6020A	539129
MB 500-539129/1-A	Method Blank	Total Recoverable	Water	6020A	539129
LCS 500-539129/2-A	Lab Control Sample	Total Recoverable	Water	6020A	539129

Prep Batch: 539655

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	7470A	
500-180867-15	TW-11	Dissolved	Water	7470A	
500-180867-16	TW-13	Dissolved	Water	7470A	
500-180867-17	TW-15	Dissolved	Water	7470A	
500-180867-18	TW-17	Dissolved	Water	7470A	
MB 500-539655/12-A	Method Blank	Total/NA	Water	7470A	
LCS 500-539655/13-A	Lab Control Sample	Total/NA	Water	7470A	
500-180867-15 MS	TW-11	Dissolved	Water	7470A	
500-180867-15 MSD	TW-11	Dissolved	Water	7470A	
500-180867-15 DU	TW-11	Dissolved	Water	7470A	

Prep Batch: 539663

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	7471B	
500-180867-2	HA-2	Total/NA	Solid	7471B	
500-180867-3	HA-3	Total/NA	Solid	7471B	
500-180867-4	HA-4	Total/NA	Solid	7471B	
500-180867-5	HA-5	Total/NA	Solid	7471B	
500-180867-6	HA-6	Total/NA	Solid	7471B	
500-180867-7	HA-7	Total/NA	Solid	7471B	
500-180867-8	HA-8	Total/NA	Solid	7471B	
500-180867-9	HA-9	Total/NA	Solid	7471B	
500-180867-10	HA-10	Total/NA	Solid	7471B	
MB 500-539663/12-A	Method Blank	Total/NA	Solid	7471B	
LCS 500-539663/13-A	Lab Control Sample	Total/NA	Solid	7471B	
500-180867-1 MS	HA-1	Total/NA	Solid	7471B	
500-180867-1 MSD	HA-1	Total/NA	Solid	7471B	
500-180867-1 DU	HA-1	Total/NA	Solid	7471B	

Metals

Prep Batch: 539665

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-11	HA-11	Total/NA	Solid	7471B	
500-180867-12	HA-12	Total/NA	Solid	7471B	
MB 500-539665/12-A	Method Blank	Total/NA	Solid	7471B	
LCS 500-539665/13-A	Lab Control Sample	Total/NA	Solid	7471B	

Analysis Batch: 539879

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-14	TW-10	Dissolved	Water	7470A	539655
500-180867-15	TW-11	Dissolved	Water	7470A	539655
500-180867-16	TW-13	Dissolved	Water	7470A	539655
500-180867-17	TW-15	Dissolved	Water	7470A	539655
500-180867-18	TW-17	Dissolved	Water	7470A	539655
MB 500-539655/12-A	Method Blank	Total/NA	Water	7470A	539655
LCS 500-539655/13-A	Lab Control Sample	Total/NA	Water	7470A	539655
500-180867-15 MS	TW-11	Dissolved	Water	7470A	539655
500-180867-15 MSD	TW-11	Dissolved	Water	7470A	539655
500-180867-15 DU	TW-11	Dissolved	Water	7470A	539655

Analysis Batch: 539887

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	7471B	539663
500-180867-2	HA-2	Total/NA	Solid	7471B	539663
500-180867-3	HA-3	Total/NA	Solid	7471B	539663
500-180867-4	HA-4	Total/NA	Solid	7471B	539663
500-180867-5	HA-5	Total/NA	Solid	7471B	539663
500-180867-6	HA-6	Total/NA	Solid	7471B	539663
500-180867-7	HA-7	Total/NA	Solid	7471B	539663
500-180867-8	HA-8	Total/NA	Solid	7471B	539663
500-180867-9	HA-9	Total/NA	Solid	7471B	539663
500-180867-10	HA-10	Total/NA	Solid	7471B	539663
500-180867-11	HA-11	Total/NA	Solid	7471B	539665
500-180867-12	HA-12	Total/NA	Solid	7471B	539665
MB 500-539663/12-A	Method Blank	Total/NA	Solid	7471B	539663
MB 500-539665/12-A	Method Blank	Total/NA	Solid	7471B	539665
LCS 500-539663/13-A	Lab Control Sample	Total/NA	Solid	7471B	539663
LCS 500-539665/13-A	Lab Control Sample	Total/NA	Solid	7471B	539665
500-180867-1 MS	HA-1	Total/NA	Solid	7471B	539663
500-180867-1 MSD	HA-1	Total/NA	Solid	7471B	539663
500-180867-1 DU	HA-1	Total/NA	Solid	7471B	539663

Leach Batch: 539901

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	1311	
LB 500-539901/1-B	Method Blank	TCLP	Solid	1311	
LB 500-539901/1-D	Method Blank	TCLP	Solid	1311	

Prep Batch: 540208

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	3010A	539901
LB 500-539901/1-B	Method Blank	TCLP	Solid	3010A	539901
LCS 500-540208/2-A	Lab Control Sample	Total/NA	Solid	3010A	

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Metals

Prep Batch: 540294

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	7470A	539901
LB 500-539901/1-D	Method Blank	TCLP	Solid	7470A	539901
MB 500-540294/12-A	Method Blank	Total/NA	Solid	7470A	
LCS 500-540294/14-A	Lab Control Sample	Total/NA	Solid	7470A	

Analysis Batch: 540392

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	6010C	540208
LB 500-539901/1-B	Method Blank	TCLP	Solid	6010C	540208
LCS 500-540208/2-A	Lab Control Sample	Total/NA	Solid	6010C	540208

Analysis Batch: 540518

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-13	Soil-Composite-1	TCLP	Solid	7470A	540294
LB 500-539901/1-D	Method Blank	TCLP	Solid	7470A	540294
MB 500-540294/12-A	Method Blank	Total/NA	Solid	7470A	540294
LCS 500-540294/14-A	Lab Control Sample	Total/NA	Solid	7470A	540294

General Chemistry

Analysis Batch: 538860

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-180867-1	HA-1	Total/NA	Solid	Moisture	
500-180867-2	HA-2	Total/NA	Solid	Moisture	
500-180867-3	HA-3	Total/NA	Solid	Moisture	
500-180867-4	HA-4	Total/NA	Solid	Moisture	
500-180867-5	HA-5	Total/NA	Solid	Moisture	
500-180867-6	HA-6	Total/NA	Solid	Moisture	
500-180867-7	HA-7	Total/NA	Solid	Moisture	
500-180867-8	HA-8	Total/NA	Solid	Moisture	
500-180867-9	HA-9	Total/NA	Solid	Moisture	
500-180867-10	HA-10	Total/NA	Solid	Moisture	
500-180867-11	HA-11	Total/NA	Solid	Moisture	
500-180867-12	HA-12	Total/NA	Solid	Moisture	
500-180867-2 DU	HA-2	Total/NA	Solid	Moisture	

Surrogate Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Solid — **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(75-126)	(72-124)	(75-120)	(75-120)
500-180867-1	HA-1	94	89	98	107
500-180867-2	HA-2	94	88	97	106
500-180867-3	HA-3	100	87	101	106
500-180867-4	HA-4	96	87	99	106
500-180867-5	HA-5	101	87	98	106
500-180867-6	HA-6	98	88	99	104
500-180867-7	HA-7	98	90	101	103
500-180867-8	HA-8	99	89	99	106
500-180867-9	HA-9	103	88	102	102
500-180867-10	HA-10	104	90	103	103
500-180867-11	HA-11	102	89	102	105
500-180867-12	HA-12	105	90	103	101
LCS 500-539811/4	Lab Control Sample	101	89	106	102
MB 500-539811/6	Method Blank	100	89	103	103

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Water — **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(75-126)	(72-124)	(75-120)	(75-120)
500-180867-14	TW-10	105	88	105	99
500-180867-15	TW-11	101	87	103	102
500-180867-16	TW-13	102	90	108	103
500-180867-17	TW-15	99	82	105	102
500-180867-18	TW-17	103	90	105	102
500-180867-19	Trip Blank	105	89	109	102
LCS 500-539816/4	Lab Control Sample	101	89	106	102
MB 500-539816/6	Method Blank	100	89	103	103

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Solid — **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(43-145)	(37-147)	(42-157)
500-180867-1	HA-1	95	94	123
500-180867-2	HA-2	99	98	120
500-180867-3	HA-3	106	90	117

Surrogate Summary

Client: Stantec Consulting Corp. Job ID: 500-180867-1
Project/Site: Fox Shores Kaukauna - 193706620

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Matrix: Solid **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(43-145)	(37-147)	(42-157)
500-180867-4	HA-4	100	91	117
500-180867-5	HA-5	78	79	110
500-180867-6	HA-6	101	103	117
500-180867-7	HA-7	94	84	118
500-180867-8	HA-8	88	85	110
500-180867-9	HA-9	86	78	109
500-180867-10	HA-10	87	81	103
500-180867-11	HA-11	96	85	120
500-180867-12	HA-12	72	70	104
LCS 500-540269/2-A	Lab Control Sample	85	91	97
MB 500-540269/1-A	Method Blank	83	85	109

Surrogate Legend

FBP = 2-Fluorobiphenyl (Surr)
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Water **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)		
		FBP	NBZ	TPHL
Lab Sample ID	Client Sample ID	(34-110)	(36-120)	(40-145)
500-180867-14	TW-10	86	84	125
500-180867-15	TW-11	84	80	118
500-180867-16	TW-13	91	85	111
500-180867-17	TW-15	85	86	114
500-180867-18	TW-17	98	88	109
LCS 500-539168/2-A	Lab Control Sample	92	89	111
LCSD 500-539168/3-A	Lab Control Sample Dup	91	95	120
MB 500-539168/1-A	Method Blank	85	89	123

Surrogate Legend

FBP = 2-Fluorobiphenyl (Surr)
NBZ = Nitrobenzene-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-539811/6
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/Kg			04/27/20 10:58	1
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/Kg			04/27/20 10:58	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/Kg			04/27/20 10:58	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/Kg			04/27/20 10:58	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/Kg			04/27/20 10:58	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/Kg			04/27/20 10:58	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/Kg			04/27/20 10:58	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/Kg			04/27/20 10:58	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/Kg			04/27/20 10:58	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/Kg			04/27/20 10:58	1
1,3,5-Trimethylbenzene	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/Kg			04/27/20 10:58	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/Kg			04/27/20 10:58	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/Kg			04/27/20 10:58	1
Benzene	<0.15		0.25	0.15	ug/Kg			04/27/20 10:58	1
Bromobenzene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
Bromochloromethane	<0.43		1.0	0.43	ug/Kg			04/27/20 10:58	1
Bromodichloromethane	<0.37		1.0	0.37	ug/Kg			04/27/20 10:58	1
Bromoform	<0.48		1.0	0.48	ug/Kg			04/27/20 10:58	1
Bromomethane	<0.80		3.0	0.80	ug/Kg			04/27/20 10:58	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
Chlorobenzene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
Chloroethane	<0.50		1.0	0.50	ug/Kg			04/27/20 10:58	1
Chloroform	<0.37		2.0	0.37	ug/Kg			04/27/20 10:58	1
Chloromethane	<0.32		1.0	0.32	ug/Kg			04/27/20 10:58	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/Kg			04/27/20 10:58	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/Kg			04/27/20 10:58	1
Dibromochloromethane	<0.49		1.0	0.49	ug/Kg			04/27/20 10:58	1
Dibromomethane	<0.27		1.0	0.27	ug/Kg			04/27/20 10:58	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/Kg			04/27/20 10:58	1
Ethylbenzene	<0.18		0.25	0.18	ug/Kg			04/27/20 10:58	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/Kg			04/27/20 10:58	1
Isopropyl ether	<0.28		1.0	0.28	ug/Kg			04/27/20 10:58	1
Isopropylbenzene	<0.38		1.0	0.38	ug/Kg			04/27/20 10:58	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
Methylene Chloride	<1.6		5.0	1.6	ug/Kg			04/27/20 10:58	1
Naphthalene	0.486	J	1.0	0.33	ug/Kg			04/27/20 10:58	1
n-Butylbenzene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
N-Propylbenzene	<0.41		1.0	0.41	ug/Kg			04/27/20 10:58	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539811/6
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
p-Isopropyltoluene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
Styrene	<0.39		1.0	0.39	ug/Kg			04/27/20 10:58	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/Kg			04/27/20 10:58	1
Tetrachloroethene	<0.37		1.0	0.37	ug/Kg			04/27/20 10:58	1
Toluene	<0.15		0.25	0.15	ug/Kg			04/27/20 10:58	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/Kg			04/27/20 10:58	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/Kg			04/27/20 10:58	1
Trichloroethene	<0.16		0.50	0.16	ug/Kg			04/27/20 10:58	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/Kg			04/27/20 10:58	1
Vinyl chloride	<0.26		1.0	0.26	ug/Kg			04/27/20 10:58	1
Xylenes, Total	<0.22		0.50	0.22	ug/Kg			04/27/20 10:58	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*		*04/27/20 10:58*	*1*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*		*04/27/20 10:58*	*1*
Dibromofluoromethane (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*

Lab Sample ID: LCS 500-539811/4
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	52.3		ug/Kg		105	70 - 125
1,1,1-Trichloroethane	50.0	48.1		ug/Kg		96	70 - 125
1,1,2,2-Tetrachloroethane	50.0	51.4		ug/Kg		103	62 - 140
1,1,2-Trichloroethane	50.0	51.8		ug/Kg		104	71 - 130
1,1-Dichloroethane	50.0	44.7		ug/Kg		89	70 - 125
1,1-Dichloroethene	50.0	40.9		ug/Kg		82	67 - 122
1,1-Dichloropropene	50.0	46.8		ug/Kg		94	70 - 121
1,2,3-Trichlorobenzene	50.0	51.2		ug/Kg		102	51 - 145
1,2,3-Trichloropropane	50.0	48.4		ug/Kg		97	50 - 133
1,2,4-Trichlorobenzene	50.0	50.4		ug/Kg		101	57 - 137
1,2,4-Trimethylbenzene	50.0	48.0		ug/Kg		96	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	47.3		ug/Kg		95	56 - 123
1,2-Dibromoethane	50.0	53.1		ug/Kg		106	70 - 125
1,2-Dichlorobenzene	50.0	51.5		ug/Kg		103	70 - 125
1,2-Dichloroethane	50.0	49.4		ug/Kg		99	68 - 127
1,2-Dichloropropane	50.0	46.0		ug/Kg		92	67 - 130
1,3,5-Trimethylbenzene	50.0	48.5		ug/Kg		97	70 - 123
1,3-Dichlorobenzene	50.0	50.6		ug/Kg		101	70 - 125
1,3-Dichloropropane	50.0	50.8		ug/Kg		102	62 - 136
1,4-Dichlorobenzene	50.0	50.3		ug/Kg		101	70 - 120
2,2-Dichloropropane	50.0	46.6		ug/Kg		93	58 - 139
2-Chlorotoluene	50.0	48.3		ug/Kg		97	70 - 125
4-Chlorotoluene	50.0	48.7		ug/Kg		97	68 - 124
Benzene	50.0	50.1		ug/Kg		100	70 - 120

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-539811/4
Matrix: Solid
Analysis Batch: 539811

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromobenzene	50.0	48.6		ug/Kg		97	70 - 122
Bromochloromethane	50.0	50.7		ug/Kg		101	65 - 122
Bromodichloromethane	50.0	50.3		ug/Kg		101	69 - 120
Bromoform	50.0	56.2		ug/Kg		112	56 - 132
Bromomethane	50.0	78.7	*	ug/Kg		157	40 - 152
Carbon tetrachloride	50.0	47.4		ug/Kg		95	59 - 133
Chlorobenzene	50.0	51.7		ug/Kg		103	70 - 120
Chloroethane	50.0	59.5		ug/Kg		119	48 - 136
Chloroform	50.0	49.0		ug/Kg		98	70 - 120
Chloromethane	50.0	28.1		ug/Kg		56	56 - 152
cis-1,2-Dichloroethene	50.0	50.8		ug/Kg		102	70 - 125
cis-1,3-Dichloropropene	50.0	50.0		ug/Kg		100	64 - 127
Dibromochloromethane	50.0	52.1		ug/Kg		104	68 - 125
Dibromomethane	50.0	55.4		ug/Kg		111	70 - 120
Dichlorodifluoromethane	50.0	26.3		ug/Kg		53	40 - 159
Ethylbenzene	50.0	51.6		ug/Kg		103	70 - 123
Hexachlorobutadiene	50.0	46.5		ug/Kg		93	51 - 150
Isopropylbenzene	50.0	48.2		ug/Kg		96	70 - 126
Methyl tert-butyl ether	50.0	50.3		ug/Kg		101	55 - 123
Methylene Chloride	50.0	48.6		ug/Kg		97	69 - 125
Naphthalene	50.0	49.9		ug/Kg		100	53 - 144
n-Butylbenzene	50.0	50.3		ug/Kg		101	68 - 125
N-Propylbenzene	50.0	49.3		ug/Kg		99	69 - 127
p-Isopropyltoluene	50.0	48.2		ug/Kg		96	70 - 125
sec-Butylbenzene	50.0	49.5		ug/Kg		99	70 - 123
Styrene	50.0	51.9		ug/Kg		104	70 - 120
tert-Butylbenzene	50.0	46.7		ug/Kg		93	70 - 121
Tetrachloroethene	50.0	52.3		ug/Kg		105	70 - 128
Toluene	50.0	51.1		ug/Kg		102	70 - 125
trans-1,2-Dichloroethene	50.0	48.0		ug/Kg		96	70 - 125
trans-1,3-Dichloropropene	50.0	49.7		ug/Kg		99	62 - 128
Trichloroethene	50.0	49.7		ug/Kg		99	70 - 125
Trichlorofluoromethane	50.0	48.0		ug/Kg		96	55 - 128
Vinyl chloride	50.0	36.9		ug/Kg		74	64 - 126
Xylenes, Total	100	103		ug/Kg		103	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*
Dibromofluoromethane (Surr)	*106*		*75 - 120*
Toluene-d8 (Surr)	*102*		*75 - 120*

Lab Sample ID: MB 500-539816/6
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	<0.46		1.0	0.46	ug/L			04/27/20 10:58	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539816/6
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	<0.38		1.0	0.38	ug/L			04/27/20 10:58	1
1,1,2,2-Tetrachloroethane	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1
1,1,2-Trichloroethane	<0.35		1.0	0.35	ug/L			04/27/20 10:58	1
1,1-Dichloroethane	<0.41		1.0	0.41	ug/L			04/27/20 10:58	1
1,1-Dichloroethene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
1,1-Dichloropropene	<0.30		1.0	0.30	ug/L			04/27/20 10:58	1
1,2,3-Trichlorobenzene	<0.46		1.0	0.46	ug/L			04/27/20 10:58	1
1,2,3-Trichloropropane	<0.41		2.0	0.41	ug/L			04/27/20 10:58	1
1,2,4-Trichlorobenzene	<0.34		1.0	0.34	ug/L			04/27/20 10:58	1
1,2,4-Trimethylbenzene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
1,2-Dibromo-3-Chloropropane	<2.0		5.0	2.0	ug/L			04/27/20 10:58	1
1,2-Dibromoethane	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
1,2-Dichlorobenzene	<0.33		1.0	0.33	ug/L			04/27/20 10:58	1
1,2-Dichloroethane	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
1,2-Dichloropropane	<0.43		1.0	0.43	ug/L			04/27/20 10:58	1
1,3,5-Trimethylbenzene	<0.25		1.0	0.25	ug/L			04/27/20 10:58	1
1,3-Dichlorobenzene	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1
1,3-Dichloropropane	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
1,4-Dichlorobenzene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
2,2-Dichloropropane	<0.44		1.0	0.44	ug/L			04/27/20 10:58	1
2-Chlorotoluene	<0.31		1.0	0.31	ug/L			04/27/20 10:58	1
4-Chlorotoluene	<0.35		1.0	0.35	ug/L			04/27/20 10:58	1
Benzene	<0.15		0.50	0.15	ug/L			04/27/20 10:58	1
Bromobenzene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
Bromochloromethane	<0.43		1.0	0.43	ug/L			04/27/20 10:58	1
Bromodichloromethane	<0.37		1.0	0.37	ug/L			04/27/20 10:58	1
Bromoform	<0.48		1.0	0.48	ug/L			04/27/20 10:58	1
Bromomethane	<0.80		3.0	0.80	ug/L			04/27/20 10:58	1
Carbon tetrachloride	<0.38		1.0	0.38	ug/L			04/27/20 10:58	1
Chlorobenzene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
Chloroethane	<0.51		1.0	0.51	ug/L			04/27/20 10:58	1
Chloroform	<0.37		2.0	0.37	ug/L			04/27/20 10:58	1
Chloromethane	<0.32		1.0	0.32	ug/L			04/27/20 10:58	1
cis-1,2-Dichloroethene	<0.41		1.0	0.41	ug/L			04/27/20 10:58	1
cis-1,3-Dichloropropene	<0.42		1.0	0.42	ug/L			04/27/20 10:58	1
Dibromochloromethane	<0.49		1.0	0.49	ug/L			04/27/20 10:58	1
Dibromomethane	<0.27		1.0	0.27	ug/L			04/27/20 10:58	1
Dichlorodifluoromethane	<0.67		3.0	0.67	ug/L			04/27/20 10:58	1
Ethylbenzene	<0.18		0.50	0.18	ug/L			04/27/20 10:58	1
Hexachlorobutadiene	<0.45		1.0	0.45	ug/L			04/27/20 10:58	1
Isopropyl ether	<0.28		1.0	0.28	ug/L			04/27/20 10:58	1
Isopropylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
Methyl tert-butyl ether	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
Methylene Chloride	<1.6		5.0	1.6	ug/L			04/27/20 10:58	1
Naphthalene	0.486	J	1.0	0.34	ug/L			04/27/20 10:58	1
n-Butylbenzene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
N-Propylbenzene	<0.41		1.0	0.41	ug/L			04/27/20 10:58	1
p-Isopropyltoluene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
sec-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539816/6
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Styrene	<0.39		1.0	0.39	ug/L			04/27/20 10:58	1
tert-Butylbenzene	<0.40		1.0	0.40	ug/L			04/27/20 10:58	1
Tetrachloroethene	<0.37		1.0	0.37	ug/L			04/27/20 10:58	1
Toluene	<0.15		0.50	0.15	ug/L			04/27/20 10:58	1
trans-1,2-Dichloroethene	<0.35		1.0	0.35	ug/L			04/27/20 10:58	1
trans-1,3-Dichloropropene	<0.36		1.0	0.36	ug/L			04/27/20 10:58	1
Trichloroethene	<0.16		0.50	0.16	ug/L			04/27/20 10:58	1
Trichlorofluoromethane	<0.43		1.0	0.43	ug/L			04/27/20 10:58	1
Vinyl chloride	<0.20		1.0	0.20	ug/L			04/27/20 10:58	1
Xylenes, Total	<0.22		1.0	0.22	ug/L			04/27/20 10:58	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 126*		*04/27/20 10:58*	*1*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*		*04/27/20 10:58*	*1*
Dibromofluoromethane (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*		*04/27/20 10:58*	*1*

Lab Sample ID: LCS 500-539816/4
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1,2-Tetrachloroethane	50.0	52.3		ug/L		105	70 - 125
1,1,1-Trichloroethane	50.0	48.1		ug/L		96	70 - 125
1,1,2,2-Tetrachloroethane	50.0	51.4		ug/L		103	62 - 140
1,1,2-Trichloroethane	50.0	51.8		ug/L		104	71 - 130
1,1-Dichloroethane	50.0	44.7		ug/L		89	70 - 125
1,1-Dichloroethene	50.0	40.9		ug/L		82	67 - 122
1,1-Dichloropropene	50.0	46.8		ug/L		94	70 - 121
1,2,3-Trichlorobenzene	50.0	51.2		ug/L		102	51 - 145
1,2,3-Trichloropropane	50.0	48.4		ug/L		97	50 - 133
1,2,4-Trichlorobenzene	50.0	50.4		ug/L		101	57 - 137
1,2,4-Trimethylbenzene	50.0	48.0		ug/L		96	70 - 123
1,2-Dibromo-3-Chloropropane	50.0	47.3		ug/L		95	56 - 123
1,2-Dibromoethane	50.0	53.1		ug/L		106	70 - 125
1,2-Dichlorobenzene	50.0	51.5		ug/L		103	70 - 125
1,2-Dichloroethane	50.0	49.4		ug/L		99	68 - 127
1,2-Dichloropropane	50.0	46.0		ug/L		92	67 - 130
1,3,5-Trimethylbenzene	50.0	48.5		ug/L		97	70 - 123
1,3-Dichlorobenzene	50.0	50.6		ug/L		101	70 - 125
1,3-Dichloropropane	50.0	50.8		ug/L		102	62 - 136
1,4-Dichlorobenzene	50.0	50.3		ug/L		101	70 - 120
2,2-Dichloropropane	50.0	46.6		ug/L		93	58 - 139
2-Chlorotoluene	50.0	48.3		ug/L		97	70 - 125
4-Chlorotoluene	50.0	48.7		ug/L		97	68 - 124
Benzene	50.0	50.1		ug/L		100	70 - 120
Bromobenzene	50.0	48.6		ug/L		97	70 - 122
Bromochloromethane	50.0	50.7		ug/L		101	65 - 122

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-539816/4
Matrix: Water
Analysis Batch: 539816

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromodichloromethane	50.0	50.3		ug/L		101	69 - 120
Bromoform	50.0	56.2		ug/L		112	56 - 132
Bromomethane	50.0	78.7	*	ug/L		157	40 - 152
Carbon tetrachloride	50.0	47.4		ug/L		95	59 - 133
Chlorobenzene	50.0	51.7		ug/L		103	70 - 120
Chloroethane	50.0	59.5		ug/L		119	48 - 136
Chloroform	50.0	49.0		ug/L		98	70 - 120
Chloromethane	50.0	28.1		ug/L		56	56 - 152
cis-1,2-Dichloroethene	50.0	50.8		ug/L		102	70 - 125
cis-1,3-Dichloropropene	50.0	50.0		ug/L		100	64 - 127
Dibromochloromethane	50.0	52.1		ug/L		104	68 - 125
Dibromomethane	50.0	55.4		ug/L		111	70 - 120
Dichlorodifluoromethane	50.0	26.3		ug/L		53	40 - 159
Ethylbenzene	50.0	51.6		ug/L		103	70 - 123
Hexachlorobutadiene	50.0	46.5		ug/L		93	51 - 150
Isopropylbenzene	50.0	48.2		ug/L		96	70 - 126
Methyl tert-butyl ether	50.0	50.3		ug/L		101	55 - 123
Methylene Chloride	50.0	48.6		ug/L		97	69 - 125
Naphthalene	50.0	49.9		ug/L		100	53 - 144
n-Butylbenzene	50.0	50.3		ug/L		101	68 - 125
N-Propylbenzene	50.0	49.3		ug/L		99	69 - 127
p-Isopropyltoluene	50.0	48.2		ug/L		96	70 - 125
sec-Butylbenzene	50.0	49.5		ug/L		99	70 - 123
Styrene	50.0	51.9		ug/L		104	70 - 120
tert-Butylbenzene	50.0	46.7		ug/L		93	70 - 121
Tetrachloroethene	50.0	52.3		ug/L		105	70 - 128
Toluene	50.0	51.1		ug/L		102	70 - 125
trans-1,2-Dichloroethene	50.0	48.0		ug/L		96	70 - 125
trans-1,3-Dichloropropene	50.0	49.7		ug/L		99	62 - 128
Trichloroethene	50.0	49.7		ug/L		99	70 - 125
Trichlorofluoromethane	50.0	48.0		ug/L		96	55 - 128
Vinyl chloride	50.0	36.9		ug/L		74	64 - 126
Xylenes, Total	100	103		ug/L		103	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 126*
4-Bromofluorobenzene (Surr)	*89*		*72 - 124*
Dibromofluoromethane (Surr)	*106*		*75 - 120*
Toluene-d8 (Surr)	*102*		*75 - 120*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 500-539168/1-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539168

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<0.24		1.6	0.24	ug/L		04/21/20 18:29	04/22/20 23:30	1
2-Methylnaphthalene	<0.052		1.6	0.052	ug/L		04/21/20 18:29	04/22/20 23:30	1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-539168/1-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539168

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	<0.25		0.80	0.25	ug/L		04/21/20 18:29	04/22/20 23:30	1
Acenaphthylene	<0.21		0.80	0.21	ug/L		04/21/20 18:29	04/22/20 23:30	1
Anthracene	<0.27		0.80	0.27	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[a]anthracene	<0.045		0.16	0.045	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[a]pyrene	<0.079		0.16	0.079	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[b]fluoranthene	<0.065		0.16	0.065	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[g,h,i]perylene	<0.30		0.80	0.30	ug/L		04/21/20 18:29	04/22/20 23:30	1
Benzo[k]fluoranthene	<0.051		0.16	0.051	ug/L		04/21/20 18:29	04/22/20 23:30	1
Chrysene	<0.055		0.16	0.055	ug/L		04/21/20 18:29	04/22/20 23:30	1
Dibenz(a,h)anthracene	<0.041		0.24	0.041	ug/L		04/21/20 18:29	04/22/20 23:30	1
Fluoranthene	<0.36		0.80	0.36	ug/L		04/21/20 18:29	04/22/20 23:30	1
Fluorene	<0.20		0.80	0.20	ug/L		04/21/20 18:29	04/22/20 23:30	1
Indeno[1,2,3-cd]pyrene	<0.060		0.16	0.060	ug/L		04/21/20 18:29	04/22/20 23:30	1
Naphthalene	<0.25		0.80	0.25	ug/L		04/21/20 18:29	04/22/20 23:30	1
Phenanthrene	<0.24		0.80	0.24	ug/L		04/21/20 18:29	04/22/20 23:30	1
Pyrene	<0.34		0.80	0.34	ug/L		04/21/20 18:29	04/22/20 23:30	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*85*		*34 - 110*	*04/21/20 18:29*	*04/22/20 23:30*	*1*
Nitrobenzene-d5 (Surr)	*89*		*36 - 120*	*04/21/20 18:29*	*04/22/20 23:30*	*1*
Terphenyl-d14 (Surr)	*123*		*40 - 145*	*04/21/20 18:29*	*04/22/20 23:30*	*1*

Lab Sample ID: LCS 500-539168/2-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539168

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	32.0	16.2		ug/L		51	38 - 110
2-Methylnaphthalene	32.0	16.0		ug/L		50	34 - 110
Acenaphthene	32.0	21.8		ug/L		68	46 - 110
Acenaphthylene	32.0	24.8		ug/L		78	47 - 113
Anthracene	32.0	34.2		ug/L		107	67 - 118
Benzo[a]anthracene	32.0	34.3		ug/L		107	70 - 126
Benzo[a]pyrene	32.0	34.3		ug/L		107	70 - 135
Benzo[b]fluoranthene	32.0	33.9		ug/L		106	69 - 136
Benzo[g,h,i]perylene	32.0	38.2		ug/L		119	70 - 135
Benzo[k]fluoranthene	32.0	32.0		ug/L		100	70 - 133
Chrysene	32.0	35.8		ug/L		112	68 - 129
Dibenz(a,h)anthracene	32.0	32.9		ug/L		103	70 - 134
Fluoranthene	32.0	39.3		ug/L		123	68 - 126
Fluorene	32.0	25.1		ug/L		78	53 - 120
Indeno[1,2,3-cd]pyrene	32.0	34.4		ug/L		107	65 - 133
Naphthalene	32.0	16.4		ug/L		51	36 - 110
Phenanthrene	32.0	32.3		ug/L		101	65 - 120
Pyrene	32.0	33.6		ug/L		105	70 - 126

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl (Surr)	*92*		*34 - 110*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 500-539168/2-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539168

Surrogate	LCS %Recovery	LCS Qualifier	Limits
Nitrobenzene-d5 (Surr)	89		36 - 120
Terphenyl-d14 (Surr)	111		40 - 145

Lab Sample ID: LCSD 500-539168/3-A
Matrix: Water
Analysis Batch: 539355

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 539168

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1-Methylnaphthalene			32.0	15.6		ug/L		49	38 - 110	4	20
2-Methylnaphthalene			32.0	15.6		ug/L		49	34 - 110	2	20
Acenaphthene			32.0	21.0		ug/L		66	46 - 110	4	20
Acenaphthylene			32.0	23.6		ug/L		74	47 - 113	5	20
Anthracene			32.0	34.1		ug/L		107	67 - 118	0	20
Benzo[a]anthracene			32.0	35.4		ug/L		111	70 - 126	3	20
Benzo[a]pyrene			32.0	35.0		ug/L		109	70 - 135	2	20
Benzo[b]fluoranthene			32.0	34.4		ug/L		108	69 - 136	2	20
Benzo[g,h,i]perylene			32.0	39.6		ug/L		124	70 - 135	4	20
Benzo[k]fluoranthene			32.0	33.6		ug/L		105	70 - 133	5	20
Chrysene			32.0	37.1		ug/L		116	68 - 129	4	20
Dibenz(a,h)anthracene			32.0	34.2		ug/L		107	70 - 134	4	20
Fluoranthene			32.0	39.2		ug/L		122	68 - 126	0	20
Fluorene			32.0	25.7		ug/L		80	53 - 120	2	20
Indeno[1,2,3-cd]pyrene			32.0	35.4		ug/L		111	65 - 133	3	20
Naphthalene			32.0	16.1		ug/L		50	36 - 110	2	20
Phenanthrene			32.0	32.7		ug/L		102	65 - 120	1	20
Pyrene			32.0	34.8		ug/L		109	70 - 126	3	20

Surrogate	LCSD %Recovery	LCSD Qualifier	Limits
2-Fluorobiphenyl (Surr)	91		34 - 110
Nitrobenzene-d5 (Surr)	95		36 - 120
Terphenyl-d14 (Surr)	120		40 - 145

Lab Sample ID: MB 500-540269/1-A
Matrix: Solid
Analysis Batch: 540348

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 540269

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	<8.1		67	8.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
2-Methylnaphthalene	<6.1		67	6.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Acenaphthene	<6.0		33	6.0	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Acenaphthylene	<4.4		33	4.4	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Anthracene	<5.6		33	5.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[a]anthracene	<4.5		33	4.5	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[a]pyrene	<6.4		33	6.4	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[b]fluoranthene	<7.2		33	7.2	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[g,h,i]perylene	<11		33	11	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Benzo[k]fluoranthene	<9.8		33	9.8	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Chrysene	<9.1		33	9.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 500-540269/1-A
Matrix: Solid
Analysis Batch: 540348

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 540269

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dibenz(a,h)anthracene	<6.4		33	6.4	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Fluoranthene	<6.2		33	6.2	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Fluorene	<4.7		33	4.7	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Indeno[1,2,3-cd]pyrene	<8.6		33	8.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Naphthalene	<5.1		33	5.1	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Phenanthrene	<4.6		33	4.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1
Pyrene	<6.6		33	6.6	ug/Kg		04/29/20 07:52	04/29/20 21:01	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl (Surr)	*83*		*43 - 145*	*04/29/20 07:52*	*04/29/20 21:01*	*1*
Nitrobenzene-d5 (Surr)	*85*		*37 - 147*	*04/29/20 07:52*	*04/29/20 21:01*	*1*
Terphenyl-d14 (Surr)	*109*		*42 - 157*	*04/29/20 07:52*	*04/29/20 21:01*	*1*

Lab Sample ID: LCS 500-540269/2-A
Matrix: Solid
Analysis Batch: 540348

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 540269

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	1330	1240		ug/Kg		93	68 - 111
2-Methylnaphthalene	1330	1230		ug/Kg		92	69 - 112
Acenaphthene	1330	1270		ug/Kg		96	65 - 124
Acenaphthylene	1330	1140		ug/Kg		86	68 - 120
Anthracene	1330	1160		ug/Kg		87	70 - 114
Benzo[a]anthracene	1330	1320		ug/Kg		99	67 - 122
Benzo[a]pyrene	1330	1370		ug/Kg		103	65 - 133
Benzo[b]fluoranthene	1330	1340		ug/Kg		101	69 - 129
Benzo[g,h,i]perylene	1330	1430		ug/Kg		107	72 - 131
Benzo[k]fluoranthene	1330	1290		ug/Kg		97	68 - 127
Chrysene	1330	1230		ug/Kg		92	63 - 120
Dibenz(a,h)anthracene	1330	1330		ug/Kg		100	64 - 131
Fluoranthene	1330	1310		ug/Kg		98	62 - 120
Fluorene	1330	1250		ug/Kg		94	62 - 120
Indeno[1,2,3-cd]pyrene	1330	1300		ug/Kg		97	68 - 130
Naphthalene	1330	1110		ug/Kg		84	63 - 110
Phenanthrene	1330	1170		ug/Kg		88	62 - 120
Pyrene	1330	1220		ug/Kg		91	61 - 128

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl (Surr)	*85*		*43 - 145*
Nitrobenzene-d5 (Surr)	*91*		*37 - 147*
Terphenyl-d14 (Surr)	*97*		*42 - 157*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 500-539043/1-A
Matrix: Solid
Analysis Batch: 539203

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539043

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.34		1.0	0.34	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Barium	<0.11		1.0	0.11	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Cadmium	<0.036		0.20	0.036	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Chromium	<0.50		1.0	0.50	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Lead	<0.23		0.50	0.23	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Selenium	<0.59		1.0	0.59	mg/Kg		04/21/20 07:24	04/22/20 00:08	1
Silver	<0.13		0.50	0.13	mg/Kg		04/21/20 07:24	04/22/20 00:08	1

Lab Sample ID: LCS 500-539043/2-A
Matrix: Solid
Analysis Batch: 539203

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539043

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	10.0	9.55		mg/Kg		95	80 - 120
Barium	200	194		mg/Kg		97	80 - 120
Cadmium	5.00	4.82		mg/Kg		96	80 - 120
Chromium	20.0	19.5		mg/Kg		98	80 - 120
Lead	10.0	9.53		mg/Kg		95	80 - 120
Selenium	10.0	9.35		mg/Kg		94	80 - 120
Silver	5.00	4.75		mg/Kg		95	80 - 120

Lab Sample ID: LCS 500-540208/2-A
Matrix: Solid
Analysis Batch: 540392

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 540208

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	0.100	0.103		mg/L		103	80 - 120
Lead	0.100	0.0950		mg/L		95	80 - 120

Lab Sample ID: LB 500-539901/1-B
Matrix: Solid
Analysis Batch: 540392

Client Sample ID: Method Blank
Prep Type: TCLP
Prep Batch: 540208

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.010		0.050	0.010	mg/L		04/29/20 06:08	04/29/20 17:21	1
Lead	<0.0075		0.050	0.0075	mg/L		04/29/20 06:08	04/29/20 17:21	1

Method: 6020A - Metals (ICP/MS)

Lab Sample ID: MB 500-539129/1-A
Matrix: Water
Analysis Batch: 539487

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	<0.23		1.0	0.23	ug/L		04/21/20 17:30	04/22/20 16:49	1
Barium	<0.73		2.5	0.73	ug/L		04/21/20 17:30	04/22/20 16:49	1
Cadmium	<0.17		0.50	0.17	ug/L		04/21/20 17:30	04/22/20 16:49	1
Selenium	<0.98		2.5	0.98	ug/L		04/21/20 17:30	04/22/20 16:49	1

Method: 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 500-539129/1-A
Matrix: Water
Analysis Batch: 539529

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chromium	<1.1		5.0	1.1	ug/L		04/21/20 17:30	04/23/20 12:25	1
Lead	<0.19		0.50	0.19	ug/L		04/21/20 17:30	04/23/20 12:25	1
Silver	<0.12		0.50	0.12	ug/L		04/21/20 17:30	04/23/20 12:25	1

Lab Sample ID: LCS 500-539129/2-A
Matrix: Water
Analysis Batch: 539487

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	100	104		ug/L		104	80 - 120
Barium	500	563		ug/L		113	80 - 120
Cadmium	50.0	55.2		ug/L		110	80 - 120
Selenium	100	107		ug/L		107	80 - 120

Lab Sample ID: LCS 500-539129/2-A
Matrix: Water
Analysis Batch: 539529

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 539129

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chromium	200	203		ug/L		102	80 - 120
Lead	100	103		ug/L		103	80 - 120
Silver	50.0	51.6		ug/L		103	80 - 120

Method: 7470A - Mercury (CVAA)

Lab Sample ID: MB 500-539655/12-A
Matrix: Water
Analysis Batch: 539879

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539655

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.098		0.20	0.098	ug/L		04/24/20 10:00	04/27/20 08:22	1

Lab Sample ID: LCS 500-539655/13-A
Matrix: Water
Analysis Batch: 539879

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539655

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	2.00	2.07		ug/L		103	80 - 120

Lab Sample ID: MB 500-540294/12-A
Matrix: Solid
Analysis Batch: 540518

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 540294

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.00020		0.00020	0.00020	mg/L		04/29/20 09:35	04/30/20 09:41	1

Method: 7470A - Mercury (CVAA) (Continued)

Lab Sample ID: LCS 500-540294/14-A
Matrix: Solid
Analysis Batch: 540518

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 540294

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury			0.00200	0.00206		mg/L		103	80 - 120		

Lab Sample ID: 500-180867-15 MS
Matrix: Water
Analysis Batch: 539879

Client Sample ID: TW-11
Prep Type: Dissolved
Prep Batch: 539655

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury	<0.098		1.00	1.15		ug/L		115	75 - 125		

Lab Sample ID: 500-180867-15 MSD
Matrix: Water
Analysis Batch: 539879

Client Sample ID: TW-11
Prep Type: Dissolved
Prep Batch: 539655

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury	<0.098		1.00	1.15		ug/L		115	75 - 125	0	20

Lab Sample ID: 500-180867-15 DU
Matrix: Water
Analysis Batch: 539879

Client Sample ID: TW-11
Prep Type: Dissolved
Prep Batch: 539655

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Mercury	<0.098		<0.098		ug/L		NC	20

Lab Sample ID: LB 500-539901/1-D
Matrix: Solid
Analysis Batch: 540518

Client Sample ID: Method Blank
Prep Type: TCLP
Prep Batch: 540294

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.00020		0.00020	0.00020	mg/L		04/29/20 09:35	04/30/20 10:20	1

Method: 7471B - Mercury (CVAA)

Lab Sample ID: MB 500-539663/12-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539663

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.0056		0.017	0.0056	mg/Kg		04/24/20 14:15	04/27/20 09:15	1

Lab Sample ID: LCS 500-539663/13-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539663

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury			0.167	0.160		mg/Kg		96	80 - 120		

Method: 7471B - Mercury (CVAA) (Continued)

Lab Sample ID: 500-180867-1 MS
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: HA-1
Prep Type: Total/NA
Prep Batch: 539663

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.070		0.0963	0.160		mg/Kg	☼	93	75 - 125

Lab Sample ID: 500-180867-1 MSD
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: HA-1
Prep Type: Total/NA
Prep Batch: 539663

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury	0.070		0.0963	0.174		mg/Kg	☼	108	75 - 125	8	20

Lab Sample ID: 500-180867-1 DU
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: HA-1
Prep Type: Total/NA
Prep Batch: 539663

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Mercury	0.070		0.0770		mg/Kg	☼	9	20

Lab Sample ID: MB 500-539665/12-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 539665

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.0056		0.017	0.0056	mg/Kg		04/24/20 14:15	04/27/20 08:22	1

Lab Sample ID: LCS 500-539665/13-A
Matrix: Solid
Analysis Batch: 539887

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 539665

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.167	0.163		mg/Kg		98	80 - 120

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-1
Date Collected: 04/15/20 08:45
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-1
Matrix: Solid
Percent Solids: 81.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 08:45	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 11:22	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/29/20 23:26	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:46	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:10	MJG	TAL CHI

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-2
Date Collected: 04/15/20 09:10
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-2
Matrix: Solid
Percent Solids: 81.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 09:10	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 11:46	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 01:18	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:51	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:18	MJG	TAL CHI

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-3
Date Collected: 04/15/20 09:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-3
Matrix: Solid
Percent Solids: 82.9

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 09:25	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 12:10	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/29/20 23:54	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:55	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:20	MJG	TAL CHI

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-4
Date Collected: 04/15/20 09:50
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-4
Matrix: Solid
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 09:50	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 12:35	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 01:46	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 00:59	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:26	MJG	TAL CHI

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:05	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 12:59	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 02:14	NRJ	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-5
Date Collected: 04/15/20 10:05
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-5
Matrix: Solid
Percent Solids: 84.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:03	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:29	MJG	TAL CHI

Client Sample ID: HA-6
Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-6
Date Collected: 04/15/20 10:25
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-6
Matrix: Solid
Percent Solids: 85.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:25	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 13:23	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 02:42	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:08	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:31	MJG	TAL CHI

Client Sample ID: HA-7
Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-7
Date Collected: 04/15/20 10:40
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-7
Matrix: Solid
Percent Solids: 85.1

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:40	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 13:47	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/30/20 00:22	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:12	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:33	MJG	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-8
Date Collected: 04/15/20 10:55
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-8
Matrix: Solid
Percent Solids: 86.5

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 10:55	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 14:11	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/30/20 00:50	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:16	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:35	MJG	TAL CHI

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-9
Date Collected: 04/15/20 11:15
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-9
Matrix: Solid
Percent Solids: 87.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 11:15	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 14:35	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/29/20 22:59	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:20	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:37	MJG	TAL CHI

Client Sample ID: HA-10
Date Collected: 04/15/20 11:30
Date Received: 04/17/20 09:45

Lab Sample ID: 500-180867-10
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-10

Lab Sample ID: 500-180867-10
Date Collected: 04/15/20 11:30
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 86.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 11:30	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 14:59	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540354	04/30/20 03:10	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539324	04/22/20 11:05	JEF	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:33	JEF	TAL CHI
Total/NA	Prep	7471B			539663	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 10:39	MJG	TAL CHI

Client Sample ID: HA-11

Lab Sample ID: 500-180867-11
Date Collected: 04/15/20 11:50
Matrix: Solid
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-11

Lab Sample ID: 500-180867-11
Date Collected: 04/15/20 11:50
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 81.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 11:50	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 15:23	JDD	TAL CHI
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		5	540575	05/01/20 04:47	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:37	JEF	TAL CHI
Total/NA	Prep	7471B			539665	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 08:26	MJG	TAL CHI

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12
Date Collected: 04/15/20 12:10
Matrix: Solid
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	538860	04/20/20 11:08	LWN	TAL CHI

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12
Date Collected: 04/15/20 12:10
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 86.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			539190	04/15/20 12:10	WRE	TAL CHI
Total/NA	Analysis	8260B		50	539811	04/27/20 15:47	JDD	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: HA-12

Lab Sample ID: 500-180867-12
Date Collected: 04/15/20 12:10
Matrix: Solid
Date Received: 04/17/20 09:45
Percent Solids: 86.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			540269	04/29/20 07:52	BSO	TAL CHI
Total/NA	Analysis	8270D		1	540354	04/29/20 22:31	NRJ	TAL CHI
Total/NA	Prep	3050B			539043	04/21/20 07:24	LMN	TAL CHI
Total/NA	Analysis	6010C		1	539203	04/22/20 01:42	JEF	TAL CHI
Total/NA	Prep	7471B			539665	04/24/20 14:15	MJG	TAL CHI
Total/NA	Analysis	7471B		1	539887	04/27/20 08:28	MJG	TAL CHI

Client Sample ID: Soil-Composite-1

Lab Sample ID: 500-180867-13
Date Collected: 04/15/20 12:40
Matrix: Solid
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
TCLP	Leach	1311			539901	04/27/20 11:55	BEC	TAL CHI
TCLP	Prep	3010A			540208	04/29/20 06:08	LMN	TAL CHI
TCLP	Analysis	6010C		1	540392	04/29/20 17:37	EEN	TAL CHI
TCLP	Leach	1311			539901	04/27/20 11:55	BEC	TAL CHI
TCLP	Prep	7470A			540294	04/29/20 09:35	MJG	TAL CHI
TCLP	Analysis	7470A		1	540518	04/30/20 10:23	MJG	TAL CHI

Client Sample ID: TW-10

Lab Sample ID: 500-180867-14
Date Collected: 04/16/20 08:50
Matrix: Water
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 16:11	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 00:53	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 17:59	FXG	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:36	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:29	MJG	TAL CHI

Client Sample ID: TW-11

Lab Sample ID: 500-180867-15
Date Collected: 04/16/20 11:15
Matrix: Water
Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 16:35	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 01:21	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:03	FXG	TAL CHI

Client Sample ID: TW-11

Lab Sample ID: 500-180867-15

Date Collected: 04/16/20 11:15

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:41	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:31	MJG	TAL CHI

Client Sample ID: TW-13

Lab Sample ID: 500-180867-16

Date Collected: 04/16/20 09:40

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 16:59	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 01:49	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:07	FXG	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:45	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:53	MJG	TAL CHI

Client Sample ID: TW-15

Lab Sample ID: 500-180867-17

Date Collected: 04/16/20 10:20

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 17:23	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 02:17	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:18	FXG	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:48	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:55	MJG	TAL CHI

Client Sample ID: TW-17

Lab Sample ID: 500-180867-18

Date Collected: 04/16/20 12:00

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 17:47	JDD	TAL CHI
Total/NA	Prep	3510C			539168	04/21/20 18:29	CMC	TAL CHI
Total/NA	Analysis	8270D		1	539355	04/23/20 02:45	SS	TAL CHI
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539487	04/22/20 18:22	FXG	TAL CHI

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Kaukauna - 193706620

Job ID: 500-180867-1

Client Sample ID: TW-17

Lab Sample ID: 500-180867-18

Date Collected: 04/16/20 12:00

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3005A			539129	04/21/20 17:30	BDE	TAL CHI
Dissolved	Analysis	6020A		1	539529	04/23/20 12:52	FXG	TAL CHI
Dissolved	Prep	7470A			539655	04/24/20 10:00	MJG	TAL CHI
Dissolved	Analysis	7470A		1	539879	04/27/20 08:57	MJG	TAL CHI

Client Sample ID: Trip Blank

Lab Sample ID: 500-180867-19

Date Collected: 04/16/20 00:00

Matrix: Water

Date Received: 04/17/20 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	539816	04/27/20 18:11	JDD	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Stantec Consulting Corp. Job ID: 500-180867-1
Project/Site: Fox Shores Kaukauna - 193706620

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State	999580010	08-31-20

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins Environment Testing TestAmerica

COOLER 2 of 2

Client Information	Sampler: TYLER HISCHKE	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-80927-37067.1
Client Contact: Tyler Hischke	Phone: 920-278-3192	E-Mail: sandie.fredrick@testamericainc.com		Page: Page 1 of 2
Company: Stantec Consulting Corp.				Job #: 500-180867
Address: 1165 Scheuring Road	Due Date Requested:			
City: De Pere	TAT Requested (days): 10			
State, Zip: WI, 54115	PO #: 193706620			
Phone: 920-278-3192	WO #:			
Email: tyler.hischke@stantec.com	Project #: 50009659			
Project Name: Soils/Waters 193706620	SSOW#:			
Site: FOX SHORES KAJKAUNA				

500-180867 COC

Analysis Requested

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

	Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 7470A TCLP As, Pb, Hg	6010C, 7471B, 8270D RCRA/PAH	8260B - VOC	8270D - PAH	6020A, 7470A RCRA Dissolved	8260B - VOC	Total Number of containers	Special Instructions/Note:
				Preservation Code:				N	N	N	N	D	A		
1	HA-1	4/15/20	0845	G	Solid				X	X				3	
2	HA-2	4/15/20	0910	G	Solid				X	X				3	
3	HA-3	4/15/20	0925	G	Solid				X	X				3	
4	HA-4	4/15/20	0950	G	Solid				X	X				3	
5	HA-5	4/15/20	1005	G	Solid				X	X				3	
6	HA-6	4/15/20	1025	G	Solid				X	X				3	
7	HA-7	4/15/20	1040	G	Solid				X	X				3	
8	HA-8	4/15/20	1055	G	Solid				X	X				3	
9	HA-9	4/15/20	1115	G	Solid				X	X				3	
10	HA-10	4/15/20	1130	G	Solid				X	X				3	
11	HA-11	4/15/20	1150	G	Solid				X	X				3	

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time	Company	Received by:	Date/Time:	Company
TYLER HISCHKE	4/16/20 1500	STANTEC		4/17/20 0945	DA-CHI
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 0.5, 2.6

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins | Environment Testing TestAmerica

COOLER 2 of 2

Client Information	Sampler: TYLER HISCHKE	Lab PM: Fredrick, Sandie	Carrier Tracking No(s):	COC No: 500-80927-37067.2
Client Contact: Tyler Hischke	Phone: 920-278-3192	E-Mail: sandie.fredrick@testamericainc.com		Page: Page 2 of 2
Company: Stantec Consulting Corp.		Analysis Requested		Job #: 500-180867
Address: 1165 Scheuring Road	Due Date Requested:			Preservation Codes: A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
City: De Pere	TAT Requested (days): 10			
State, Zip: WI, 54115				
Phone: 920-278-3192	PO #: 193706620			Other:
Email: tyler.hischke@stantec.com	WO #:			
Project Name: Soils/Waters 193706620	Project #: 50009659			
Site: FOX SHORES KAUKAUNA	SSOW#:			

	Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 7470A TCLP As, Pb, Hg	6010C, 7471B, 8270D RCRA/PAH	8260B - VOC	8270D - PAH RCRA Dissolved	6020A, 7470A	8260B - VOC	Total Number of containers	Special Instructions/Note:
				Preservation Code:				N	N	N	N	D	A		
12	HA-12	4/15/20	1210	G	Solid				X	X				3	
13	SOIL-COMPOSITE-1	4/15/20	1240	C	Solid			X						1	
14	TW-10	4/16/20	0850	G	Water	Y					X	X	X	6	
15	TW-11	4/16/20	1115	G	Water	Y					X	X	X	6	
16	TW-13	4/16/20	0940	G	Water	Y					X	X	X	6	
17	TW-15	4/16/20	1020	G	Water	Y					X	X	X	6	
18	TW-17	4/16/20	1200	G	Water	Y					X	X	X	6	
19	Trip Blank				Water										Added by TA
					Water										

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by: TYLER HISCHKE	Date/Time: 4/16/20	Company: STANTEC	Received by:	Date/Time: 4/17/20 0945	Company: TA-CHI
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks:		

Login Sample Receipt Checklist

Client: Stantec Consulting Corp. Job Number: 500-180867-1

Login Number: 180867 **List Source: Eurofins TestAmerica, Chicago**
List Number: 1
Creator: Scott, Sherri L

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	0.5,2.6
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	False	Received Trip Blank(s) not listed on COC.
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Appendix F

Air Analytical Reports and Chain-of-Custody Forms

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING



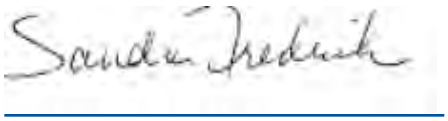
ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Burlington
30 Community Drive
Suite 11
South Burlington, VT 05403
Tel: (802)660-1990

TestAmerica Job ID: 200-47582-1
Client Project/Site: Fox Shores Apts - 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Mr. Jeff Brand



Authorized for release by:
3/10/2019 4:50:11 PM

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Definitions/Glossary 3
Case Narrative 4
Detection Summary 5
Client Sample Results 6
QC Sample Results 8
QC Association Summary 9
Lab Chronicle 10
Certification Summary 12
Method Summary 13
Sample Summary 14
Chain of Custody 15
Receipt Checklists 19
Clean Canister Certification 20
    Pre-Ship Certification 20
    Clean Canister Data 24

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Case Narrative

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Job ID: 200-47582-1

Laboratory: TestAmerica Burlington

Narrative

Job Narrative
200-47582-1

Comments
No additional comments.

Receipt
The samples were received on 2/27/2019 10:35 AM; the samples arrived in good condition, properly preserved and, where required, on ice.

Air Toxics
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Client Sample ID: VP-4 AMBIENT — Lab Sample ID: 200-47582-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	3.9		0.50	0.056	ppb v/v	1		TO-15	Total/NA
Dichlorodifluoromethane	19		2.5	0.28	ug/m3	1		TO-15	Total/NA

Client Sample ID: VP-5 AMBIENT — Lab Sample ID: 200-47582-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	1.2		0.50	0.056	ppb v/v	1		TO-15	Total/NA
Dichlorodifluoromethane	6.0		2.5	0.28	ug/m3	1		TO-15	Total/NA

Client Sample ID: VP-6 AMBIENT — Lab Sample ID: 200-47582-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	1.1		0.50	0.056	ppb v/v	1		TO-15	Total/NA
Dichlorodifluoromethane	5.3		2.5	0.28	ug/m3	1		TO-15	Total/NA

Client Sample ID: VP-4 — Lab Sample ID: 200-47582-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	370		11	1.2	ppb v/v	22		TO-15	Total/NA
Dichlorodifluoromethane	1800		54	6.1	ug/m3	22		TO-15	Total/NA

Client Sample ID: VP-5 — Lab Sample ID: 200-47582-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	550		14	1.5	ppb v/v	27		TO-15	Total/NA
Dichlorodifluoromethane	2700		67	7.5	ug/m3	27		TO-15	Total/NA

Client Sample ID: VP-6 — Lab Sample ID: 200-47582-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	940		18	2.0	ppb v/v	35		TO-15	Total/NA
Dichlorodifluoromethane	4700		87	9.7	ug/m3	35		TO-15	Total/NA

Client Sample ID: VP-2R — Lab Sample ID: 200-47582-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	7200		160	18	ppb v/v	313		TO-15	Total/NA
Dichlorodifluoromethane	35000		770	87	ug/m3	313		TO-15	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: VP-4 AMBIENT

Lab Sample ID: 200-47582-1
Matrix: Air
Date Collected: 02/26/19 10:43
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	3.9		0.50	0.056	ppb v/v			03/01/19 05:07	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	19		2.5	0.28	ug/m3			03/01/19 05:07	1

Client Sample ID: VP-5 AMBIENT

Lab Sample ID: 200-47582-2
Matrix: Air
Date Collected: 02/26/19 10:24
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	1.2		0.50	0.056	ppb v/v			03/01/19 06:00	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	6.0		2.5	0.28	ug/m3			03/01/19 06:00	1

Client Sample ID: VP-6 AMBIENT

Lab Sample ID: 200-47582-3
Matrix: Air
Date Collected: 02/26/19 10:10
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	1.1		0.50	0.056	ppb v/v			03/01/19 06:53	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	5.3		2.5	0.28	ug/m3			03/01/19 06:53	1

Client Sample ID: VP-4

Lab Sample ID: 200-47582-4
Matrix: Air
Date Collected: 02/26/19 11:32
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	370		11	1.2	ppb v/v			03/01/19 07:46	22

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	1800		54	6.1	ug/m3			03/01/19 07:46	22

Client Sample ID: VP-5

Lab Sample ID: 200-47582-5
Matrix: Air
Date Collected: 02/26/19 11:26
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	550		14	1.5	ppb v/v			03/01/19 08:40	27

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	2700		67	7.5	ug/m3			03/01/19 08:40	27

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Client Sample ID: VP-6

Lab Sample ID: 200-47582-6

Date Collected: 02/26/19 11:23
Matrix: Air
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	940		18	2.0	ppb v/v			03/02/19 18:22	35

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	4700		87	9.7	ug/m3			03/02/19 18:22	35

Client Sample ID: VP-2R

Lab Sample ID: 200-47582-7

Date Collected: 02/26/19 11:00
Matrix: Air
Date Received: 02/27/19 10:35
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	7200		160	18	ppb v/v			03/02/19 19:12	313

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	35000		770	87	ug/m3			03/02/19 19:12	313

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Lab Sample ID: MB 200-140390/6
Matrix: Air
Analysis Batch: 140390

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.056		0.50	0.056	ppb v/v			02/28/19 17:32	1

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.28		2.5	0.28	ug/m3			02/28/19 17:32	1

Lab Sample ID: LCS 200-140390/4
Matrix: Air
Analysis Batch: 140390

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	10.0	11.6		ppb v/v		116	68 - 128

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	49	57.3		ug/m3		116	68 - 128

Lab Sample ID: LCSD 200-140390/5
Matrix: Air
Analysis Batch: 140390

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Dichlorodifluoromethane	10.0	11.4		ppb v/v		114	68 - 128	2	25

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Dichlorodifluoromethane	49	56.4		ug/m3		114	68 - 128	2	25

Lab Sample ID: MB 200-140447/5
Matrix: Air
Analysis Batch: 140447

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.056		0.50	0.056	ppb v/v			03/02/19 15:43	1

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.28		2.5	0.28	ug/m3			03/02/19 15:43	1

Lab Sample ID: LCS 200-140447/3
Matrix: Air
Analysis Batch: 140447

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	10.0	11.5		ppb v/v		115	68 - 128

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	49	56.8		ug/m3		115	68 - 128

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Air - GC/MS VOA

Analysis Batch: 140390

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-47582-1	VP-4 AMBIENT	Total/NA	Air	TO-15	
200-47582-2	VP-5 AMBIENT	Total/NA	Air	TO-15	
200-47582-3	VP-6 AMBIENT	Total/NA	Air	TO-15	
200-47582-4	VP-4	Total/NA	Air	TO-15	
200-47582-5	VP-5	Total/NA	Air	TO-15	
MB 200-140390/6	Method Blank	Total/NA	Air	TO-15	
LCS 200-140390/4	Lab Control Sample	Total/NA	Air	TO-15	
LCSD 200-140390/5	Lab Control Sample Dup	Total/NA	Air	TO-15	

Analysis Batch: 140447

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-47582-6	VP-6	Total/NA	Air	TO-15	
200-47582-7	VP-2R	Total/NA	Air	TO-15	
MB 200-140447/5	Method Blank	Total/NA	Air	TO-15	
LCS 200-140447/3	Lab Control Sample	Total/NA	Air	TO-15	

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Client Sample ID: VP-4 AMBIENT
Lab Sample ID: 200-47582-1
Date Collected: 02/26/19 10:43
Matrix: Air
Date Received: 02/27/19 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	140390	03/01/19 05:07	K1P	TAL BUR

Client Sample ID: VP-5 AMBIENT
Lab Sample ID: 200-47582-2
Date Collected: 02/26/19 10:24
Matrix: Air
Date Received: 02/27/19 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	140390	03/01/19 06:00	K1P	TAL BUR

Client Sample ID: VP-6 AMBIENT
Lab Sample ID: 200-47582-3
Date Collected: 02/26/19 10:10
Matrix: Air
Date Received: 02/27/19 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	140390	03/01/19 06:53	K1P	TAL BUR

Client Sample ID: VP-4
Lab Sample ID: 200-47582-4
Date Collected: 02/26/19 11:32
Matrix: Air
Date Received: 02/27/19 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		22	140390	03/01/19 07:46	K1P	TAL BUR

Client Sample ID: VP-5
Lab Sample ID: 200-47582-5
Date Collected: 02/26/19 11:26
Matrix: Air
Date Received: 02/27/19 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		27	140390	03/01/19 08:40	K1P	TAL BUR

Client Sample ID: VP-6
Lab Sample ID: 200-47582-6
Date Collected: 02/26/19 11:23
Matrix: Air
Date Received: 02/27/19 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		35	140447	03/02/19 18:22	A1B	TAL BUR

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Client Sample ID: VP-2R
Date Collected: 02/26/19 11:00
Date Received: 02/27/19 10:35

Lab Sample ID: 200-47582-7
Matrix: Air

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		313	140447	03/02/19 19:12	A1B	TAL BUR

Laboratory References:

TAL BUR = TestAmerica Burlington, 30 Community Drive, Suite 11, South Burlington, VT 05403, TEL (802)660-1990

Accreditation/Certification Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Laboratory: TestAmerica Burlington

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
ANAB	DoD / DOE		L2336	02-25-20
Connecticut	State Program	1	PH-0751	09-30-19
DE Haz. Subst. Cleanup Act (HSCA)	State Program	3	NA	02-01-19 *
Florida	NELAP	4	E87467	06-30-19
Maine	State Program	1	VT00008	04-17-19 *
Minnesota	NELAP	5	050-999-436	12-31-19
New Hampshire	NELAP	1	2006	12-18-19
New Jersey	NELAP	2	VT972	06-30-19
New York	NELAP	2	10391	04-01-19 *
Pennsylvania	NELAP	3	68-00489	04-30-19 *
Rhode Island	State Program	1	LAO00298	12-30-19
US Fish & Wildlife	Federal		LE-058448-0	07-31-19
USDA	Federal		P330-11-00093	07-24-20
Vermont	State Program	1	VT-4000	12-31-19
Virginia	NELAP	3	460209	12-14-19

Laboratory: TestAmerica Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Wisconsin	State Program	5	999580010	08-31-19

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Method	Method Description	Protocol	Laboratory
TO-15	Volatile Organic Compounds in Ambient Air	EPA	TAL BUR

Protocol References:

EPA = US Environmental Protection Agency

Laboratory References:

TAL BUR = TestAmerica Burlington, 30 Community Drive, Suite 11, South Burlington, VT 05403, TEL (802)660-1990

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apts - 193706620

TestAmerica Job ID: 200-47582-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
200-47582-1	VP-4 AMBIENT	Air	02/26/19 10:43	02/27/19 10:35
200-47582-2	VP-5 AMBIENT	Air	02/26/19 10:24	02/27/19 10:35
200-47582-3	VP-6 AMBIENT	Air	02/26/19 10:10	02/27/19 10:35
200-47582-4	VP-4	Air	02/26/19 11:32	02/27/19 10:35
200-47582-5	VP-5	Air	02/26/19 11:26	02/27/19 10:35
200-47582-6	VP-6	Air	02/26/19 11:23	02/27/19 10:35
200-47582-7	VP-2R	Air	02/26/19 11:00	02/27/19 10:35

TestAmerica Burlington
30 Community Drive
Suite 11
South Burlington, VT 05403-6809
phone 802.660.1990 fax 802.660.1919

Canister Samples Chain of Custody Record

TestAmerica Laboratories, Inc. assumes no liability with respect to the collection and shipment of these samples.

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Client Contact Information	Client Project Manager: Jeff Brand	Samples Collected By:	COC No:
Company Name: Stantec	Phone: 920-278-3208		1 of 1 COCs
Address: 1165 Scheuring Rd	Email: Jeff.brand@stantec.com		
City/State/Zip: De Pere WI 54115			For Lab Use Only:
Phone: 920-592-8400	Site Contact:		Walk-in Client:
FAX: 920-592-8444	Tel/Fax: SAME		Lab Sampling:
Project Name: Fox Shores Apts	Anaylsis Turnaround Time		Job / SDG No.:
Site/Location: Kaukauna WI	Standard (Specific):		(See below for Add'l Items)
PO# Proj # 19370 6620	Rush (Specifiy):		

Sample Identification	Sample Date(s)	Time Start	Time Stop	Canister Vacuum in Field, 'Hg (Start)'	Canister Vacuum in Field, 'Hg (Stop)'	Flow Controller ID	Canister ID	TO-14/15 (Standard / Low Level)	TO-15 SIM	EPA 3C	EPA 25C	ASTM D-1946	EPA 15/16	Other (Please specify in notes sectio	Sample Type	Indoor Air/Ambient Air	Sub-Slab	Soil Gas	Soil Vapor Extraction (SVE)	Landfill Gas	Other (Please specify in notes section)	Sample Specific Notes:
VP-4 Ambient	2/25 2/26	1016	1043	-30	-2	4506	5050	X														*
VP-5 Ambient	↓	1012	1024	-30	-2	3467	3568	X														*
VP-6 Ambient	↓	1007	1010	-30	-2	3703	6007	X														*
VP-4	2/26/19	1051	1132	-30	0	4617	2538	X														*
VP-5	↓	1035	1126	-30	0	5332	4023	X														*
VP-6	↓	1022	1123	-30	0	6127	6247	X														*
VP-2R	↓	1010	1100	-30	0	5890	4449	X														*

200-47582 Chain of Custody

Temperature (Fahrenheit)			
Start	Interior	Ambient	
Stop			

Pressure (inches of Hg)			
Start	Interior	Ambient	
Stop			

Special Instructions/QC Requirements & Comments: * Report only dichlorodifluoromethane for each sample *

Samples Shipped by: Stantec	Date / Time: 2/26/19 1330	Samples Received by: Sam Hall TABurl 2-27-19 1035
Samples Relinquished by:	Date / Time:	Received by:
Relinquished by:	Date / Time:	Received by:

Lab Use Only: Shipper Name: Opened by: Condition:

Form No. CA-C-WI-003, Rev. 2.5, dated 9/22/2017

FedEx Express® **NEW Package US Airbill**

FedEx Tracking Number 8008 9457 3544

0200 Form ID No.

FedEx Retrieval

1 From

Date 2/26/19

Sender's Name Jeff Brand Phone 920 592-8400

Company Stantec.

Address 1165 Scheuring Rd Dept./Floor/Suite/Room

City De Pere State WI ZIP 54115

2 Your Internal Billing Reference

3 To

Recipient's Name Test America Burlington Phone 802 660-1990

Company

Address 30 Community Drive Dept./Floor/Suite/Room
We cannot deliver to P.O. boxes or P.O. ZIP codes.

Address Suite 11
Use this line for the HOLD location address or for continuation of your shipping address.

City South Burlington State VT ZIP 05403

01 ☐ HOLD Weekday — FedEx location address REQUIRED. NOT available for FedEx First Overnight.

31 ☐ HOLD Saturday — FedEx location address REQUIRED. Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations.

4 Express Package Service * To most locations.

NOTE: Service order has changed. Please select carefully.

Packages up to — For packages over 150 lbs., use FedEx Express Freight

Next Business Day

06 ☐ FedEx First Overnight — Earliest next business morning delivery to select locations. Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

01 ☒ FedEx Priority Overnight — Next business morning.* Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

05 ☐ FedEx Standard Overnight — Next business afternoon.* Saturday Delivery NOT available.

2 or 3 Business Days

49 ☐ NEW FedEx 2Day A.M. — Second business morning.* Saturday Delivery NOT available.

03 ☐ FedEx 2Day — Second business afternoon.* Thursday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

20 ☐ FedEx Express Saver — Third business day.* Saturday Delivery NOT available.

5 Packaging * Declared value limit $500.

06 ☐ FedEx Envelope* 02 ☐ FedEx Pak* 03 ☐ FedEx Box 04 ☐ FedEx Tube 01 ☒

6 Special Handling and Delivery Signature Options

03 ☐ **SATURDAY DELIVERY**

☒ No Signature Required — Package may be left without obtaining a signature for delivery.

10 ☐ Direct Signature — Someone at recipient's address may sign for delivery. Fee applies.

34 ☐ Indirect Signature — If no one is available at recip address, someone at a neigh address may sign for delivery residential deliveries only. Fe

Does this shipment contain dangerous goods?

One box must be checked.

☒ No 04 ☐ Yes — As per attached Shipper's Declaration. ☐ Yes — Shipper's Declaration not required. 06 ☐ Dry Ice — Dry Ice, 9, UN 1845 ____ x ____

Dangerous goods (including dry ice) cannot be shipped in FedEx packaging or placed in a FedEx Express Drop Box. ☐ Cargo Aircraft Only

7 Payment *Bill to:*

Enter FedEx Acct. No. or Credit Card No. below. Obtain recip Acct. No

1 ☐ Sender Acct. No. in Section 1 will be billed. 2 ☒ Recipient 3 ☐ Third Party 4 ☐ Credit Card 5 ☐ Cash/

Total Packages 1 Total Weight 17 Credit Card Auth.

fedex.com 1.800.GoFedEx 1.800.463.3339

3/10/2019

FedEx Express **NEW Package US Airbill**

FedEx Tracking Number 8008 9457 3198

'0200 Form ID No.

FedEx Retrieval (

1 From

Date 2/26/19 [redacted]

Sender's Name Jeff Brand Phone 920 592-8400

Company Stantec

Address 1165 Scheuring Rd Dept/Floor/Suite/Room

City DePere State WI ZIP 54115

2 Your Internal Billing Reference

3 To

Recipient's Name Test America Burlington Phone 802 660-1990

Company

Address 30 Community Drive Dept/Floor/Suite/Room
We cannot deliver to P.O. boxes or P.O. ZIP codes.

Address Suite 11
Use this line for the HOLD location address or for continuation of your shipping address.

City South Burlington State VT ZIP 05403

01 ☐ HOLD Weekday FedEx location address REQUIRED. NOT available for FedEx First Overnight.

31 ☐ HOLD Saturday FedEx location address REQUIRED. Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations.

4 Express Package Service * To most locations.

NOTE: Service order has changed. Please select carefully.

Packages up to
For packages over 150 lbs., u
FedEx Express Freigh

Next Business Day

06 ☐ FedEx First Overnight
Earliest next business morning delivery to select locations. Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

01 ☒ FedEx Priority Overnight
Next business morning.* Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

05 ☐ FedEx Standard Overnight
Next business afternoon.* Saturday Delivery NOT available.

2 or 3 Business Days

49 ☐ **NEW** FedEx 2Day A.M.
Second business morning.* Saturday Delivery NOT available.

03 ☐ FedEx 2Day
Second business afternoon.* Thursday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

20 ☐ FedEx Express Saver
Third business day.* Saturday Delivery NOT available.

5 Packaging * Declared value limit $500.

06 ☐ FedEx Envelope* 02 ☐ FedEx Pak* 03 ☐ FedEx Box 04 ☐ FedEx Tube 01 ☒

6 Special Handling and Delivery Signature Options

03 ☐ **SATURDAY DELIVERY**

☐ No Signature Required
Package may be left without obtaining a signature for delivery.

10 ☐ Direct Signature
Someone at recipient's address may sign for delivery. *Fee applies.*

34 ☐ Indirect Signature
If no one is available at recip address, someone at a neig address may sign for delive residential deliveries only. *A*

Does this shipment contain dangerous goods?

One box must be checked.

☒ No 04 ☐ Yes As per attached Shipper's Declaration. ☐ Yes Shipper's Declaration not required. 06 ☐ Dry Ice Dry Ice, 9, UN 1845 ____ x ____

Dangerous goods (including dry ice) cannot be shipped in FedEx packaging or placed in a FedEx Express Drop Box.

☐ Cargo Aircraft Only

7 Payment *Bill to:*

Enter FedEx Acct. No. or Credit Card No. below. Obtain reci Acct. N

1 ☐ Sender Acct. No. in Section 1 will be billed. 2 ☒ Recipient 3 ☐ Third Party 4 ☐ Credit Card 5 ☐ Cash

[redacted] 2 [redacted]

fedex.com 1.800.GoFedEx 1.800.463.3339

3/10/2019


ORIGIN ID:BTVA (802) 923-1058
JEFF BRAND
STANTEC CONSULTING CORP.
1165 SCHEURING ROAD

DE PERE, WI 54115
UNITED STATES US

ACTWGT: 10.00 LB MAN
CAD: 000890364/CAFE3210

TO SAMPLE MANAGEMENT
TEST AMERICA BURLINGTON
30 COMMUNITY DRIVE
SUITE 11
SOUTH BURLINGTON VT 05403
(802) 923-1058
REF: S500-69938

RMA:

FedEx Express

FedEx
TRK# 0221 4838 4987 2181

WED - 27 FEB 10:30A
PRIORITY OVERNIGHT

NC BTVA

05403
VT-US
BTV

FID 5006119 26FEB19 GRBA 553C2/0E3D/0CBA

Login Sample Receipt Checklist

Client: Stantec Consulting Corp.

Job Number: 200-47582-1

Login Number: 47582
List Number: 1
Creator: Lavigne, Scott M

List Source: TestAmerica Burlington

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	Lab does not accept radioactive samples.
The cooler's custody seal, if present, is intact.	True	Not present
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	Thermal preservation not required.
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	N/A	Thermal preservation not required.
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	N/A	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Pre-Shipment Clean Canister Certification Report

Canister Cleaning & Pre-Shipment Leak Test

System ID	Max DF#	# Cycles	Cleaning Start Date/Time		System Start Temp(s):		Technician	Can Size	Certification Type:
Bottom Rack	150	25	1/21/2019	1436	20	20	EJE	6 liter	batch

Port	Can ID	Initial[1] (psia)	Final (psia)	Diff.[3]	Final ("Hg)	Initial Reading Gauge:	Date:	Time:	Tech:	Temp:	Final Reading Gauge:	Date:	Time:	Tech:	Temp:
1	2900	.02	.04	.02	-29.8	G26	1.22.19	9:02	EE	22	G26	2.4.19	14:46	EE	21
2	4544	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
3	4923	"	.06	.04	"	G26	"	"	"	"	G26	"	"	"	"
4	5141	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
5	5689	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
6	5656	.02	.02	.00	"	G26	1.22.19	9:02	EE	22	G26	"	"	"	"
7	5694	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
8	5727	.02	.08	.06	-29.8	G26	2.1.19	10:11	EE	21	G26	2.7.19	9:25	EE	21
9	3278	"	.02	.00	-29.8	G26	"	"	"	"	G26	2.4.19	14:48	EE	21
10	3568	"	.14	.12	"	G26	"	"	"	"	G26	"	"	"	"
11	5139	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
12	6247	"	.04	.02	"	G26	"	"	"	"	G26	"	"	"	"

[1] Batch Certification: The reading is taken on the "batch" canister and this value is used as the initial pressure for all canisters in the batch.

[3] Difference = Final Pressure - Initial Pressure . Acceptance Criteria: (1) The difference must be less than or equal to + 0.25psi. (2) Pressure readings must be at least 24 hours apart.

If time frame was not met, the PM must authorize shipment of canister **PM Authorization** **Date:**

Clean Canister Certification Analysis & Authorization of Release to Inventory

Test Method: ☑TO15 Routine ☐ TO15 LL

Can ID	Date	Sequence	Analyst	Inventory Level 1	2	3	4	Secondary Review Limited	Review Date	Reviewer
~~5689~~ VTP 1/11		Reclean			XXXX					
5727	2/1/19	34351	JTB/						2/1/19	VTP

Inventory Level 1: Individual Canister Certification (TO15LL 0.01).

Inventory Level 2: Individual or Batch Certification (TO15 0.04 ppbv).

Inventory Level 3: Individual or Batch Certification (TO15 0.2 ppbv).

Inventory Level Limited: Canisters may only be used for certain projects.

Dup Tees/Vac gauges (enter IDs if included):

Comments:

Form ID: FAI023:12
Revision Date: 12/18/2018

TestAmerica Burlington

Page 20 of 95

3/10/2019

200-47102-A-8
5727
Location: Air-Storage
Bottle: Summa Canister 6L
Sampled: 1/21/2019 12:00 AM 200-125113

Loc: 200
47102
#8
A

Pre-Shipment Clean Canister Certification Report

Canister Cleaning & Pre-Shipment Leak Test

System ID	Max DF#	# Cycles	Cleaning Start Date/Time		System Start Temp(s):		Technician	Can Size	Certification Type:
Bottom Rack	150	25	1/23/2019	1611	21	21	EJE	6 liter	batch

Port	Can ID	Initial[1] (psia)	Final (psia)	Diff.[3]	Final ("Hg)	Initial Reading Gauge:	Date:	Time:	Tech:	Temp:	Final Reading Gauge:	Date:	Time:	Tech:	Temp:
1	4023	.02	.08	.06	-30.5	G26	1/24/2019	9:34	EJE	22	G26	2.6.19	16:17	EE	21
2	6007	〃	.07	.05	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
3	5034	.02	.02	.00	-29.5	G26	2.6.19	16:10	EE	21	G26	2.8.19	12:22	EE	22
4	5413	.02	.02	.00	-30.0	G26	1/24/2019	9:34	EJE	22	G26	2.6.19	16:17	EE	21
5	4280	〃	.04	.02	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
6	2538	〃	.05	.03	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
7	3000	〃	.02	.00	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
8	2601	〃	.02	.00	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
9	4370	〃	.07	.05	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
10	4288	〃	.04	.02	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
11	2786	〃	.02	.00	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃
12	6148	〃	.04	.02	〃	G26	〃	〃	〃	〃	G26	〃	〃	〃	〃

[1] Batch Certification: The reading is taken on the "batch" canister and this value is used as the initial pressure for all canisters in the batch.

[3] Difference = Final Pressure - Initial Pressure . Acceptance Criteria: (1) The difference must be less than or equal to + 0.25psi. (2) Pressure readings must be at least 24 hours apart.

If time frame was not met, the PM must authorize shipment of canister **PM Authorization** **Date:**

Clean Canister Certification Analysis & Authorization of Release to Inventory

Test Method: ☑ TO15 Routine ☐ TO15 LL

Can ID	Date	Sequence	Analyst	Inventory Level 1	2	3	4	Secondary Review Limited	Review Date	Review
5034	~~2/6/19~~	606 2/6/19			XXXXX					
	2/6/19	34352	666						2/6/19	GT

Inventory Level 1: Individual Canister Certification (TO15LL 0.01).

Inventory Level 2: Individual or Batch Certification (TO15 0.04 ppbv).

Inventory Level 3: Individual or Batch Certification (TO15 0.2 ppbv).

Inventory Level Limited: Canisters may only be used for certain projects.

Dup Tees/Vac gauges (enter IDs if included):

Comments: Carry over from LCS okay

Form ID: FAI023:12
Revision Date: 12/18/2018

TestAmerica Burlington

Page 21 of 95

3/10/2019

200-47143-A-3
5034
Location: Air-Storage
Bottle: Summa Canister 6L
Sampled: 1/23/2019 12:00 AM 200-1252016

Loc: 200
47143
#3
A

Pre-Shipment Clean Canister Certification Report

Canister Cleaning & Pre-Shipment Leak Test

System ID	Max DF#	# Cycles	Cleaning Start Date/Time		System Start Temp(s):		Technician	Can Size	Certification Type:
Top Rack	1	25	1/29/2019	1431	21	21	EJE	6 liter	batch

						Initial Reading					Final Reading				
Port	Can ID	Initial[1] (psia)	Final (psia)	Diff.[3]	Final ("Hg)	Gauge:	Date:	Time:	Tech:	Temp:	Gauge:	Date:	Time:	Tech:	Temp:
1	5022	.02	.07	.05	29.8	G26	1/30/2019	825	EE	21	G26	2.4.19	13:49	EE	21
2	4124	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
3	3164	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
4	4133	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
5	5050	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
6	4101	"	.03	.01	"	G26	"	"	"	"	G26	"	"	"	"
7	~~3667~~					~~G26~~					~~G26~~				
8	4472	.02	.02	.00	29.8	G26	1/30/2019	825	EE	21	G26	2.4.19	13:49	EE	21
9	3317	"	.17	.15	"	G26	"	"	"	"	G26	"	"	"	"
10	5439	"	.02	.00	"	G26	"	"	"	"	G26	"	"	"	"
11	4292	"	.03	.01	"	G26	"	"	"	"	G26	"	"	"	"
12	4266	"	.07	.05	"	G26	"	"	"	"	G26	"	"	"	"

EE 2.15.19

[1] Batch Certification: The reading is taken on the "batch" canister and this value is used as the initial pressure for all canisters in the batch.

[3] Difference = Final Pressure - Initial Pressure . Acceptance Criteria: (1) The difference must be less than or equal to + 0.25psi. (2) Pressure readings must be at least 24 hours apart.

If time frame was not met, the PM must authorize shipment of canister **PM Authorization** **Date:**

Clean Canister Certification Analysis & Authorization of Release to Inventory

Test Method: ☒ TO15 Routine ☐ TO15 LL

Can ID	Date	Sequence	Analyst	Inventory Level 1	2	3	4	Secondary Review: Limited	Review Date	Reviewer
3667	2/1/19	34379	GGG		XXX				2/4/19	BMT

Inventory Level 1: Individual Canister Certification (TO15LL 0.01).

Inventory Level 2: Individual or Batch Certification (TO15 0.04 ppbv).

Inventory Level 3: Individual or Batch Certification (TO15 0.2 ppbv).

Inventory Level Limited: Canisters may only be used for certain projects.

Dup Tees/Vac gauges (enter IDs if included):

Comments:

H20

200-47202-A-7
3667
Location: Air-Storage
Bottle: Summa Canister 6L
Sampled: 1/29/2019 12:00 AM 200-1253211

Loc: 200 47202 #7 A

Page 22 of 95

3/10/2019

Form ID: FAI023:12
Revision Date: 12/18/2018

TestAmerica Burlington

Pre-Shipment Clean Canister Certification Report

Canister Cleaning & Pre-Shipment Leak Test

System ID	Max DF#	# Cycles	Cleaning Start Date/Time		System Start Temp(s):		Technician	Can Size	Certification Type:
Bottom Rack	1	20	2/13/2019	1456	21	21	EJE	6 liter	batch

						Initial Reading					Final Reading				
Port	Can ID	Initial[1] (psia)	Final (psia)	Diff.[3]	Final ("Hg)	Gauge:	Date:	Time:	Tech:	Temp:	Gauge:	Date:	Time:	Tech:	Temp:
1	4277	.02	.02	.00	-29.8	G26	2.14.19	9:50	EE	21	G26	2.B.R	1234	EE	22
2	3348	.02	.02	.00	-3.4	G26	2.R.19	14:44	EE	22	G26	2.19.19	15:02	EE	22
3	3328	.07	.08	.06	-29.8	G26	2.14.R	9:50	EE	21	G26	2.B.R	1234	EE	22
4	2791		.02	.00		G26					G26				
5	5708		.02	.00		G26					G26				
6	5974		.10	.08		G26					G26				
7	5686		.05	.03		G26					G26				
8	5640		.02	.00		G26					G26				
9	4449		.02	.00		G26					G26				
10	3040		.15	.13		G26					G26				
11	4783		.02	.00		G26					G26				
12	4467		.02	.00		G26					G26				

[1] Batch Certification: The reading is taken on the "batch" canister and this value is used as the initial pressure for all canisters in the batch.

[3] Difference = Final Pressure - Initial Pressure . Acceptance Criteria: (1) The difference must be less than or equal to + 0.25psi. (2) Pressure readings must be at least 24 hours apart.

If time frame was not met, the PM must authorize shipment of canister **PM Authorization** **Date:**

Clean Canister Certification Analysis & Authorization of Release to Inventory

Test Method: ☑TO15 Routine ☐ TO15 LL

				Inventory Level				Secondary Review		
Can ID	Date	Sequence	Analyst	1	2	3	4	Limited	Review Date	Reviewer
3348	2/16/19	34613	WRD		XXXX				2/16/19	GG

Inventory Level 1: Individual Canister Certification (TO15LL 0.01).

Inventory Level 2: Individual or Batch Certification (TO15 0.04 ppbv).

Inventory Level 3: Individual or Batch Certification (TO15 0.2 ppbv).

Inventory Level Limited: Canisters may only be used for certain projects.

Dup Tees/Vac gauges (enter IDs if included):

Comments:

H2O

Page 23 of 95

3/10/2019

Form ID: FAI023:12
Revision Date: 12/18/2018

TestAmerica Burlington

200-47390-A-2
3348
Location: Air-Storage
Bottle: Summa Canister 6L
Sampled: 2/13/2019 12:00 AM 200-1257107

Loc: 200
47390
#2
A

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47102-1

SDG No.:

Client Sample ID: 5727 Lab Sample ID: 200-47102-8

Matrix: Air Lab File ID: 34351-21.D

Analysis Method: TO-15 Date Collected: 01/21/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/30/2019 09:17

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139540 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
115-07-1	Propylene	1.0	U	1.0	1.0
75-71-8	Dichlorodifluoromethane	0.10	U	0.10	0.10
75-45-6	Freon 22	0.10	U	0.10	0.10
76-14-2	1,2-Dichlorotetrafluoroethane	0.040	U	0.040	0.040
74-87-3	Chloromethane	0.10	U	0.10	0.10
106-97-8	n-Butane	0.10	U	0.10	0.10
75-01-4	Vinyl chloride	0.040	U	0.040	0.040
106-99-0	1,3-Butadiene	0.040	U	0.040	0.040
74-83-9	Bromomethane	0.040	U	0.040	0.040
75-00-3	Chloroethane	0.10	U	0.10	0.10
593-60-2	Bromoethene(Vinyl Bromide)	0.040	U	0.040	0.040
75-69-4	Trichlorofluoromethane	0.040	U	0.040	0.040
64-17-5	Ethanol	1.0	U	1.0	1.0
76-13-1	Freon TF	0.040	U	0.040	0.040
75-35-4	1,1-Dichloroethene	0.040	U	0.040	0.040
67-64-1	Acetone	1.0	U	1.0	1.0
67-63-0	Isopropyl alcohol	1.0	U	1.0	1.0
75-15-0	Carbon disulfide	0.10	U	0.10	0.10
107-05-1	3-Chloropropene	0.10	U	0.10	0.10
75-09-2	Methylene Chloride	0.10	U	0.10	0.10
75-65-0	tert-Butyl alcohol	1.0	U	1.0	1.0
1634-04-4	Methyl tert-butyl ether	0.040	U	0.040	0.040
156-60-5	trans-1,2-Dichloroethene	0.040	U	0.040	0.040
110-54-3	n-Hexane	0.040	U	0.040	0.040
75-34-3	1,1-Dichloroethane	0.040	U	0.040	0.040
108-05-4	Vinyl acetate	1.0	U	1.0	1.0
141-78-6	Ethyl acetate	1.0	U	1.0	1.0
78-93-3	Methyl Ethyl Ketone	0.10	U	0.10	0.10
156-59-2	cis-1,2-Dichloroethene	0.040	U	0.040	0.040
540-59-0	1,2-Dichloroethene, Total	0.080	U	0.080	0.080
67-66-3	Chloroform	0.040	U	0.040	0.040
109-99-9	Tetrahydrofuran	1.0	U	1.0	1.0
71-55-6	1,1,1-Trichloroethane	0.040	U	0.040	0.040
110-82-7	Cyclohexane	0.040	U	0.040	0.040
56-23-5	Carbon tetrachloride	0.040	U	0.040	0.040
540-84-1	2,2,4-Trimethylpentane	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47102-1

SDG No.:

Client Sample ID: 5727 Lab Sample ID: 200-47102-8

Matrix: Air Lab File ID: 34351-21.D

Analysis Method: TO-15 Date Collected: 01/21/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/30/2019 09:17

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139540 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
71-43-2	Benzene	0.040	U	0.040	0.040
107-06-2	1,2-Dichloroethane	0.040	U	0.040	0.040
142-82-5	n-Heptane	0.040	U	0.040	0.040
79-01-6	Trichloroethene	0.040	U	0.040	0.040
80-62-6	Methyl methacrylate	0.10	U	0.10	0.10
78-87-5	1,2-Dichloropropane	0.040	U	0.040	0.040
123-91-1	1,4-Dioxane	1.0	U	1.0	1.0
75-27-4	Bromodichloromethane	0.040	U	0.040	0.040
10061-01-5	cis-1,3-Dichloropropene	0.040	U	0.040	0.040
108-10-1	methyl isobutyl ketone	0.10	U	0.10	0.10
108-88-3	Toluene	0.040	U	0.040	0.040
10061-02-6	trans-1,3-Dichloropropene	0.040	U	0.040	0.040
79-00-5	1,1,2-Trichloroethane	0.040	U	0.040	0.040
127-18-4	Tetrachloroethene	0.040	U	0.040	0.040
591-78-6	Methyl Butyl Ketone (2-Hexanone)	0.10	U	0.10	0.10
124-48-1	Dibromochloromethane	0.040	U	0.040	0.040
106-93-4	1,2-Dibromoethane	0.040	U	0.040	0.040
108-90-7	Chlorobenzene	0.040	U	0.040	0.040
100-41-4	Ethylbenzene	0.040	U	0.040	0.040
179601-23-1	m,p-Xylene	0.10	U	0.10	0.10
95-47-6	Xylene, o-	0.040	U	0.040	0.040
1330-20-7	Xylene (total)	0.14	U	0.14	0.14
100-42-5	Styrene	0.040	U	0.040	0.040
75-25-2	Bromoform	0.040	U	0.040	0.040
98-82-8	Cumene	0.040	U	0.040	0.040
79-34-5	1,1,2,2-Tetrachloroethane	0.040	U	0.040	0.040
103-65-1	n-Propylbenzene	0.040	U	0.040	0.040
622-96-8	4-Ethyltoluene	0.040	U	0.040	0.040
108-67-8	1,3,5-Trimethylbenzene	0.040	U	0.040	0.040
95-49-8	2-Chlorotoluene	0.040	U	0.040	0.040
98-06-6	tert-Butylbenzene	0.040	U	0.040	0.040
95-63-6	1,2,4-Trimethylbenzene	0.040	U *	0.040	0.040
135-98-8	sec-Butylbenzene	0.040	U	0.040	0.040
99-87-6	4-Isopropyltoluene	0.040	U	0.040	0.040
541-73-1	1,3-Dichlorobenzene	0.040	U	0.040	0.040
106-46-7	1,4-Dichlorobenzene	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47102-1

SDG No.:

Client Sample ID: 5727 Lab Sample ID: 200-47102-8

Matrix: Air Lab File ID: 34351-21.D

Analysis Method: TO-15 Date Collected: 01/21/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/30/2019 09:17

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139540 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
100-44-7	Benzyl chloride	0.040	U *	0.040	0.040
104-51-8	n-Butylbenzene	0.040	U *	0.040	0.040
95-50-1	1,2-Dichlorobenzene	0.040	U	0.040	0.040
120-82-1	1,2,4-Trichlorobenzene	0.10	U *	0.10	0.10
87-68-3	Hexachlorobutadiene	0.040	U	0.040	0.040
91-20-3	Naphthalene	0.10	U *	0.10	0.10

Report Date: 04-Feb-2019 14:23:59 Chrom Revision: 2.3 15-Jan-2019 08:51:34

TestAmerica Burlington
Target Compound Quantitation Report

Data File: \\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D
Lims ID: 200-47102-A-8
Client ID: 5727
Sample Type: Client
Inject. Date: 30-Jan-2019 09:17:30 ALS Bottle#: 20 Worklist Smp#: 21
Purge Vol: 200.000 mL Dil. Factor: 0.2000
Sample Info: 200-0034351-021
Misc. Info.: 47189-12
Operator ID: ert Instrument ID: CHX.i

Method: \\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\TO15_MasterMethod_X.m.m
Limit Group: AI_TO15_ICAL
Last Update: 04-Feb-2019 14:23:49 Calib Date: 24-Jan-2019 08:07:30
Integrator: RTE ID Type: Deconvolution ID
Quant Method: Internal Standard Quant By: Initial Calibration
Last ICal File: \\chromna\Burlington\ChromData\CHX.i\20190123-34274.b\34274-17.D

Column 1 : RTX-624 (0.32 mm) Det: MS SCAN
Process Host: CTX1008

First Level Reviewer: bunmaa Date: 31-Jan-2019 10:44:19

	Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
	1 Propene	41		4.083				ND	
	2 Dichlorodifluoromethane	85		4.169				ND	
	3 Chlorodifluoromethane	51		4.238				ND	U
	4 1,2-Dichloro-1,1,2,2-tetra	85		4.506				ND	
	5 Chloromethane	50		4.693				ND	U
	6 Butane	43		4.923				ND	U
	7 Vinyl chloride	62		4.982				ND	
	8 Butadiene	54		5.067				ND	
	10 Bromomethane	94		5.865				ND	
	11 Chloroethane	64		6.121				ND	
	13 Vinyl bromide	106		6.544				ND	
	14 Trichlorofluoromethane	101		6.635				ND	
	17 Ethanol	45		7.229				ND	U
	20 1,1,2-Trichloro-1,2,2-trif	101		7.726				ND	
	21 1,1-Dichloroethene	96		7.790				ND	
	22 Acetone	43		8.037				ND	
	23 Carbon disulfide	76		8.213				ND	
	24 Isopropyl alcohol	45		8.309				ND	U
	25 3-Chloro-1-propene	41		8.593				ND	
	27 Methylene Chloride	49		8.898				ND	
	28 2-Methyl-2-propanol	59		9.101				ND	
	29 Methyl tert-butyl ether	73		9.299				ND	
	31 trans-1,2-Dichloroethene	61		9.347				ND	
S	30 1,2-Dichloroethene, Total	61		9.665				ND	
	33 Hexane	57		9.722				ND	
	34 1,1-Dichloroethane	63		10.251				ND	
	35 Vinyl acetate	43		10.310				ND	
	37 cis-1,2-Dichloroethene	96		11.375				ND	
	38 2-Butanone (MEK)	72		11.412				ND	
	39 Ethyl acetate	88		11.434				ND	
*	40 Chlorobromomethane	128	11.835	11.835	0.000	64	201979	10.0	

	Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
	41 Tetrahydrofuran	42		11.840				ND	
	42 Chloroform	83		11.947				ND	
	43 Cyclohexane	84		12.199				ND	
	44 1,1,1-Trichloroethane	97		12.225				ND	
	45 Carbon tetrachloride	117		12.466				ND	
	46 Isooctane	57		12.851				ND	
	47 Benzene	78		12.910				ND	
	48 1,2-Dichloroethane	62		13.081				ND	
	49 n-Heptane	43		13.204				ND	
*	50 1,4-Difluorobenzene	114	13.675	13.675	0.000	92	982435	10.0	
	53 Trichloroethene	95		14.108				ND	
	54 1,2-Dichloropropane	63		14.627				ND	
	55 Methyl methacrylate	69		14.740				ND	
	56 1,4-Dioxane	88		14.820				ND	
	57 Dibromomethane	174		14.863				ND	
	58 Dichlorobromomethane	83		15.120				ND	
	60 cis-1,3-Dichloropropene	75		15.970				ND	
	61 4-Methyl-2-pentanone (MIBK	43		16.227				ND	
	65 Toluene	92		16.516				ND	
	66 trans-1,3-Dichloropropene	75		17.072				ND	
	67 1,1,2-Trichloroethane	83		17.431				ND	
	68 Tetrachloroethene	166		17.538				ND	
	69 2-Hexanone	43		17.843				ND	
	71 Chlorodibromomethane	129		18.169				ND	
	72 Ethylene Dibromide	107		18.436				ND	
*	74 Chlorobenzene-d5	117	19.292	19.287	0.005	83	845133	10.0	
	75 Chlorobenzene	112		19.346				ND	
	76 Ethylbenzene	91		19.480				ND	U
S	73 Xylenes, Total	106		19.600				ND	
	78 m-Xylene & p-Xylene	106		19.720				ND	
	79 o-Xylene	106		20.523				ND	
	80 Styrene	104		20.571				ND	
	81 Bromoform	173		20.977				ND	
	82 Isopropylbenzene	105		21.149				ND	
	84 1,1,2,2-Tetrachloroethane	83		21.775				ND	
	85 N-Propylbenzene	91		21.833				ND	
	88 4-Ethyltoluene	105		22.015				ND	
	89 2-Chlorotoluene	91		22.031				ND	
	90 1,3,5-Trimethylbenzene	105		22.117				ND	
	92 tert-Butylbenzene	119		22.588				ND	
	93 1,2,4-Trimethylbenzene	105		22.679				ND	
	94 sec-Butylbenzene	105		22.903				ND	
	95 4-Isopropyltoluene	119		23.096				ND	
	96 1,3-Dichlorobenzene	146		23.139				ND	U
	97 1,4-Dichlorobenzene	146		23.272				ND	U
	98 Benzyl chloride	91		23.470				ND	
	100 n-Butylbenzene	91		23.668				ND	
	101 1,2-Dichlorobenzene	146		23.813				ND	
	103 1,2,4-Trichlorobenzene	180		26.365				ND	
	104 Hexachlorobutadiene	225		26.541				ND	
	105 Naphthalene	128		26.867				ND	

QC Flag Legend

Review Flags

U - Marked Undetected

Reagents:

ATTO15XISs_00002 Amount Added: 20.00 Units: mL Run Reagent

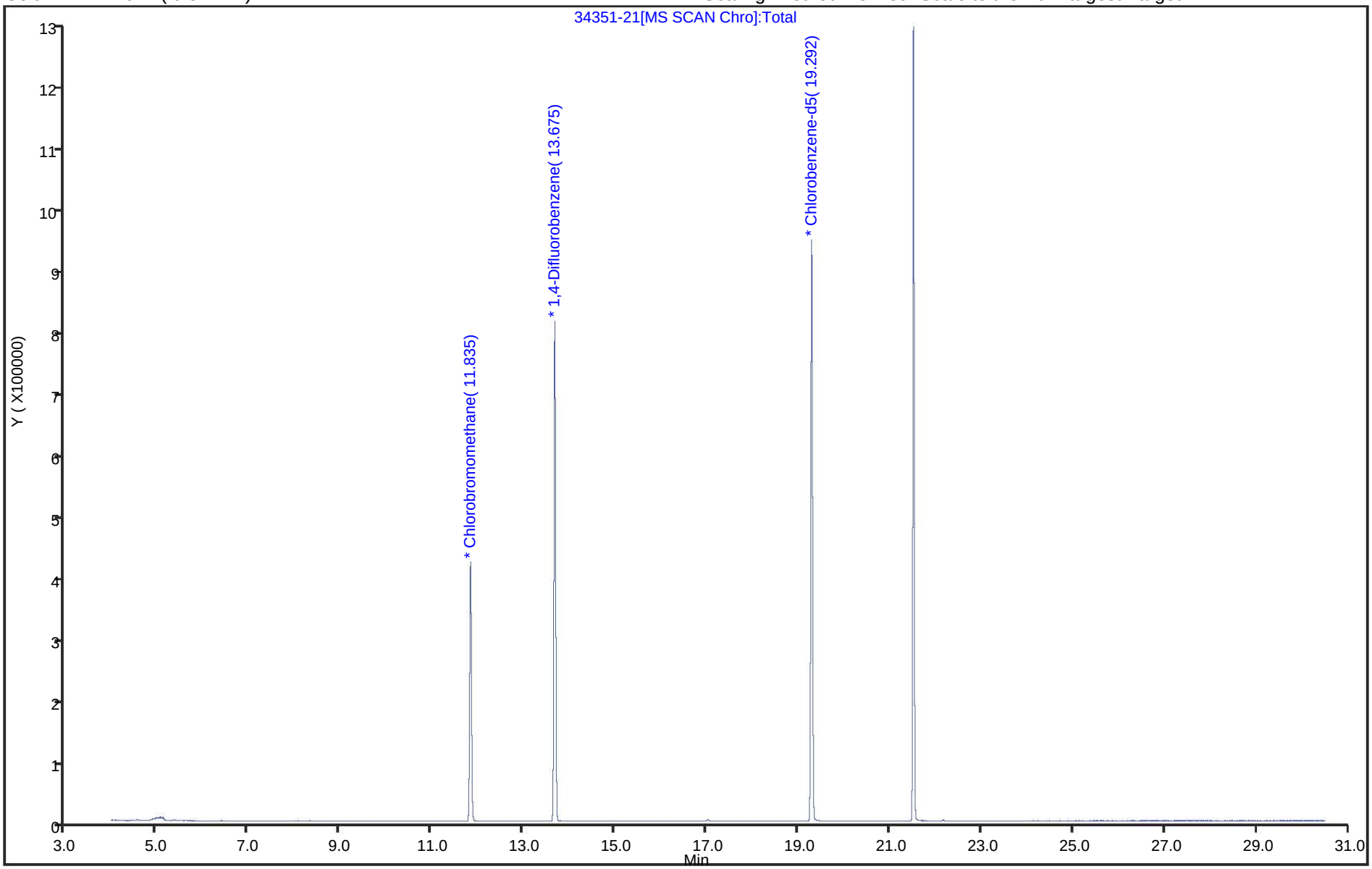
Report Date: 04-Feb-2019 14:23:59 Chrom Revision: 2.3 15-Jan-2019 08:51:34

TestAmerica Burlington

Data File: \\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D

Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i	Operator ID:	ert
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8	Worklist Smp#:	21
Client ID:	5727				
Purge Vol:	200.000 mL	Dil. Factor:	0.2000	ALS Bottle#:	20
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		

Column: RTX-624 (0.32 mm) Y Scaling: Method Defined: Scale to the Nth Largest Target: 1



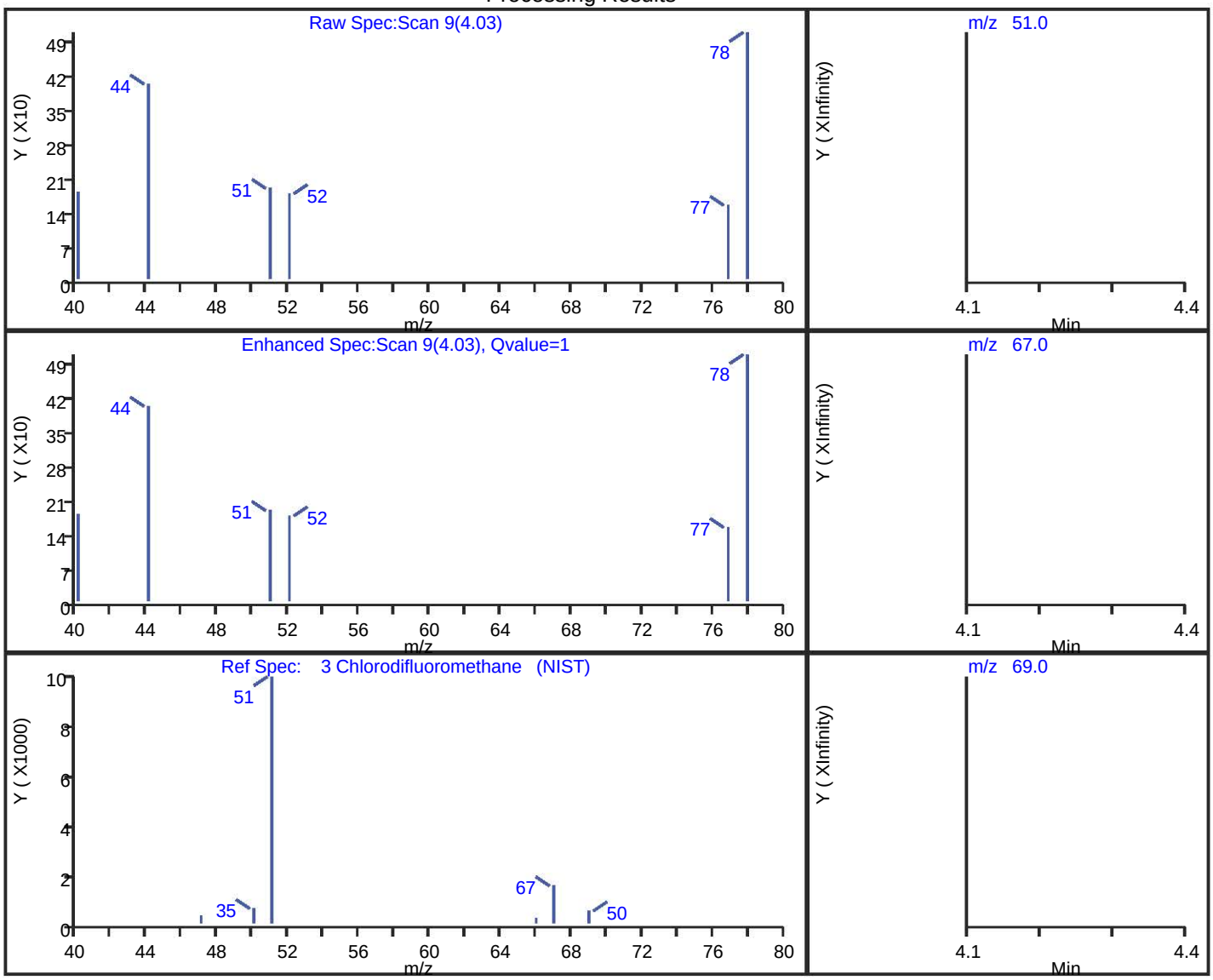
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

3 Chlorodifluoromethane, CAS: 75-45-6

Processing Results



RT	Mass	Response	Amount
4.03	51.00	171	0.004301
4.24	67.00	0	
4.24	69.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:43:05

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

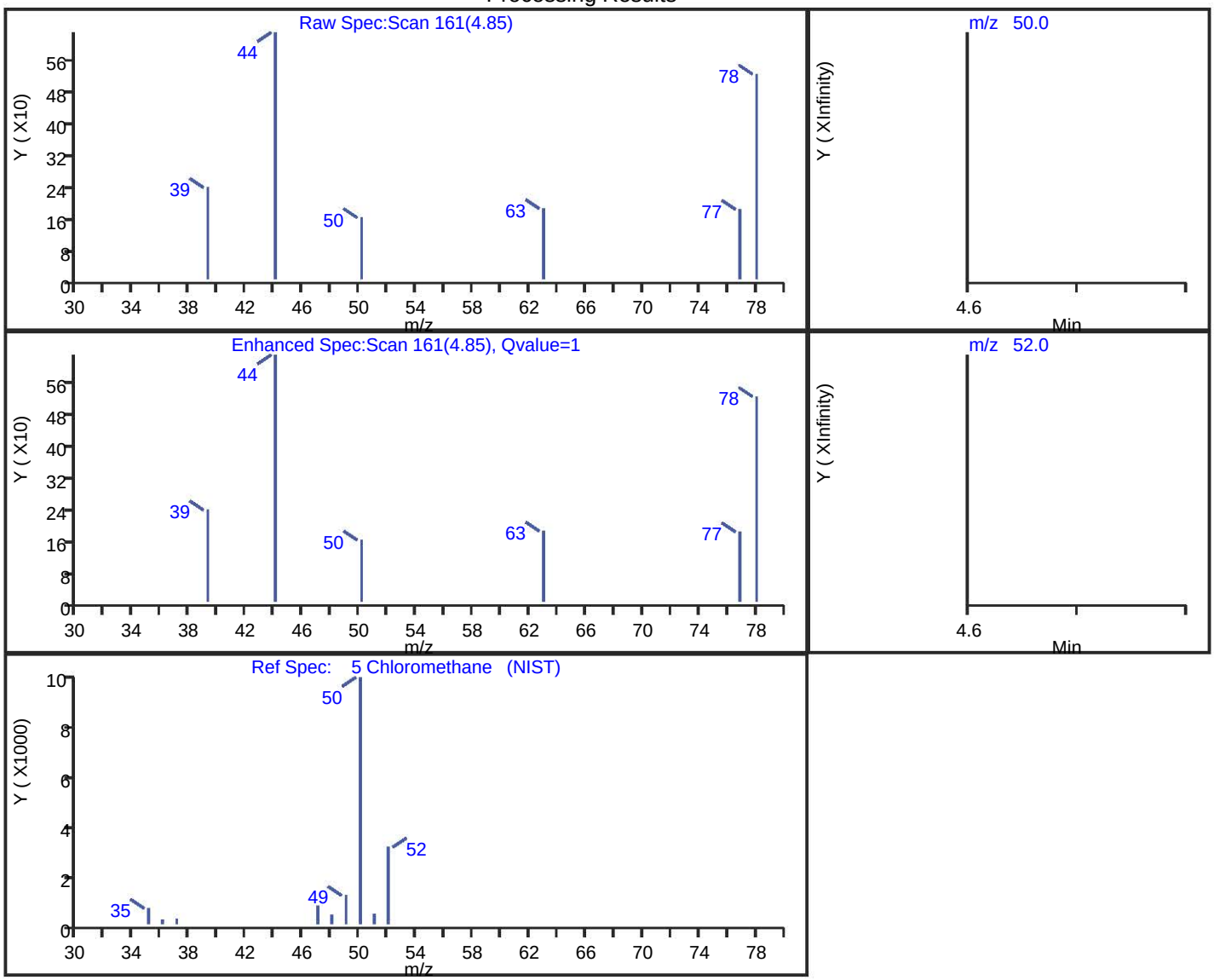
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

5 Chloromethane, CAS: 74-87-3

Processing Results



RT	Mass	Response	Amount
4.85	50.00	49	0.002450
4.69	52.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:43:10

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

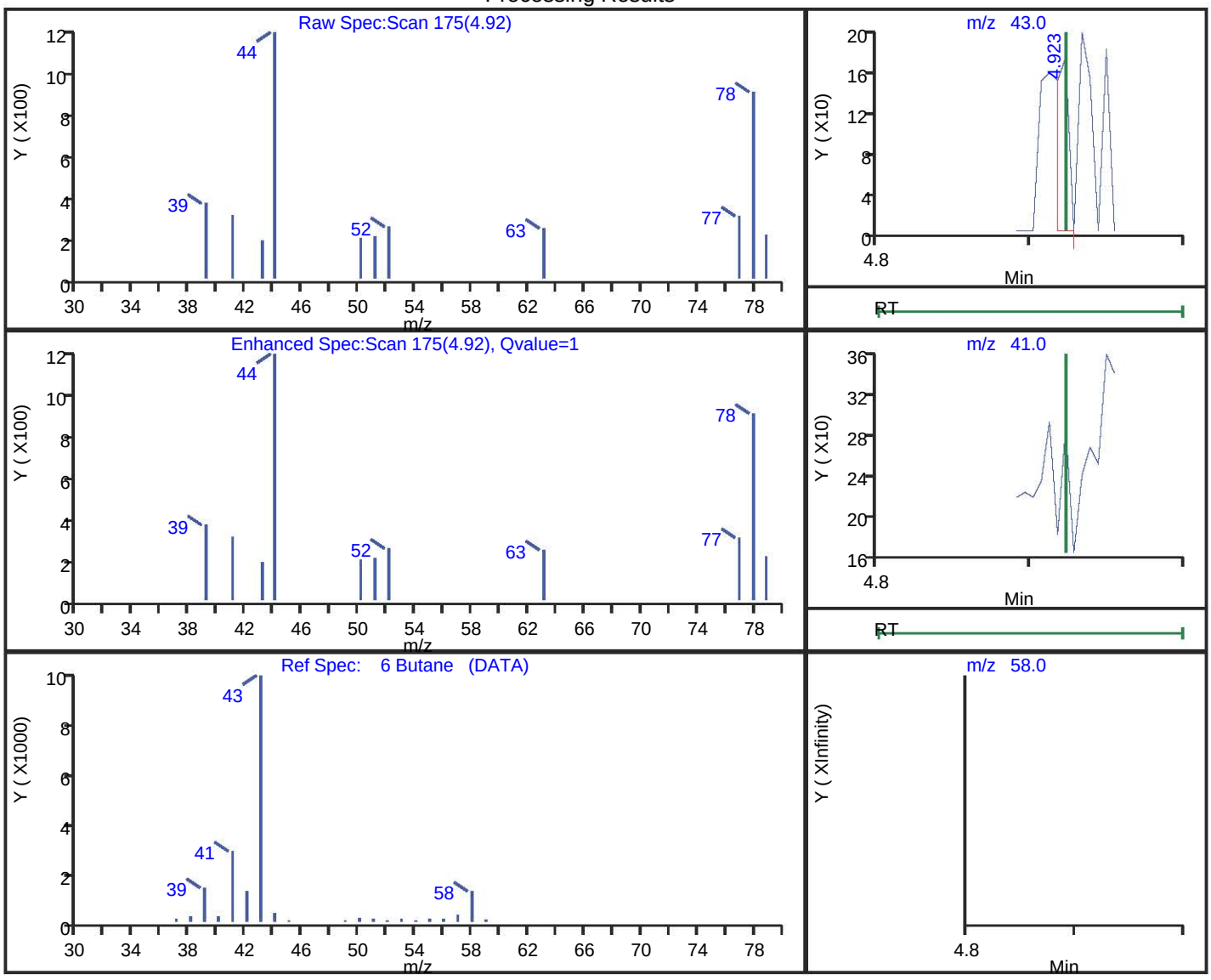
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

6 Butane, CAS: 106-97-8

Processing Results



RT	Mass	Response	Amount
4.92	43.00	104	0.004824
4.92	41.00	0	
4.92	58.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:43:13

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

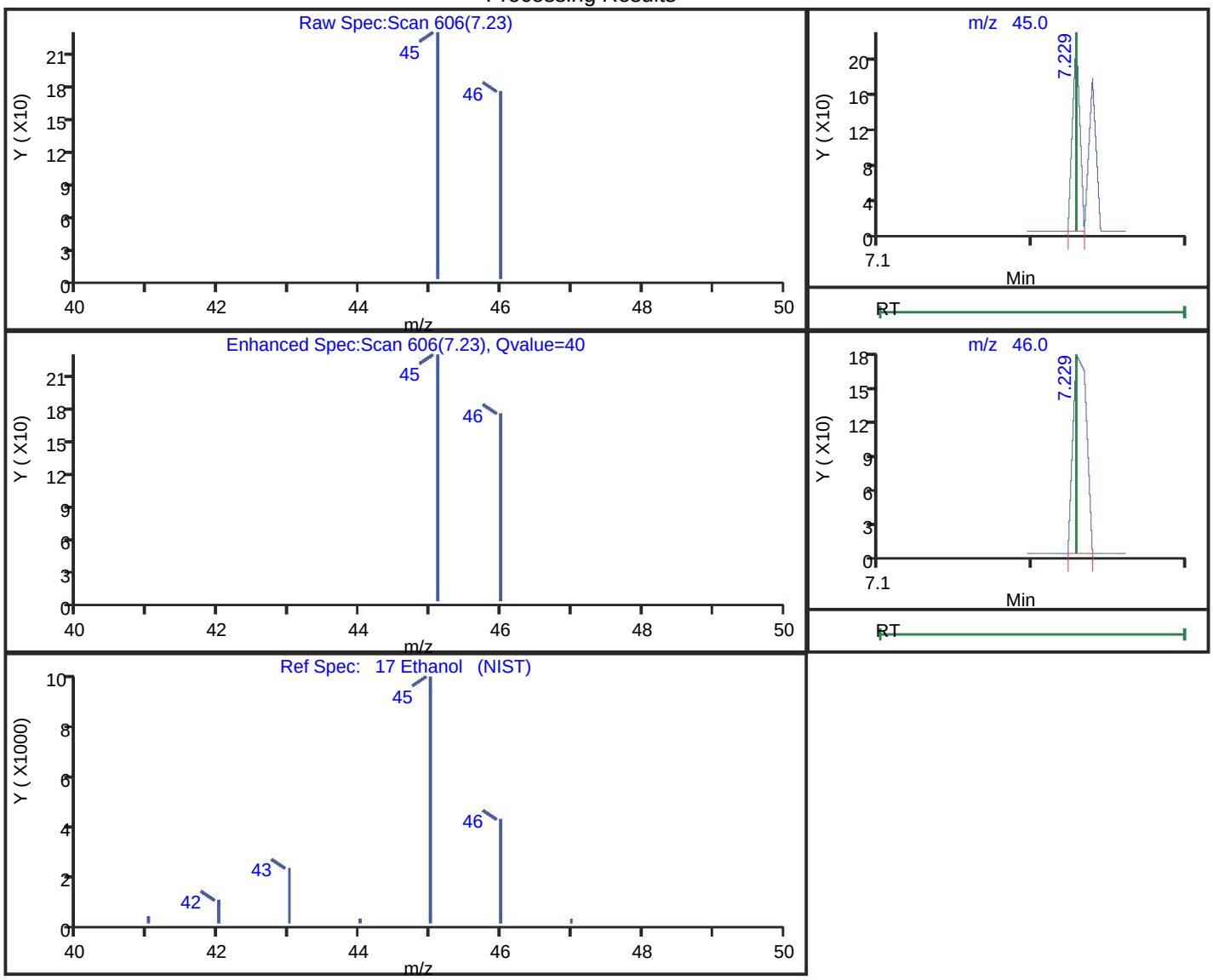
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

17 Ethanol, CAS: 64-17-5

Processing Results



RT	Mass	Response	Amount
7.23	45.00	72	0.016039
7.23	46.00	105	

Reviewer: bunmaa, 31-Jan-2019 10:43:19

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

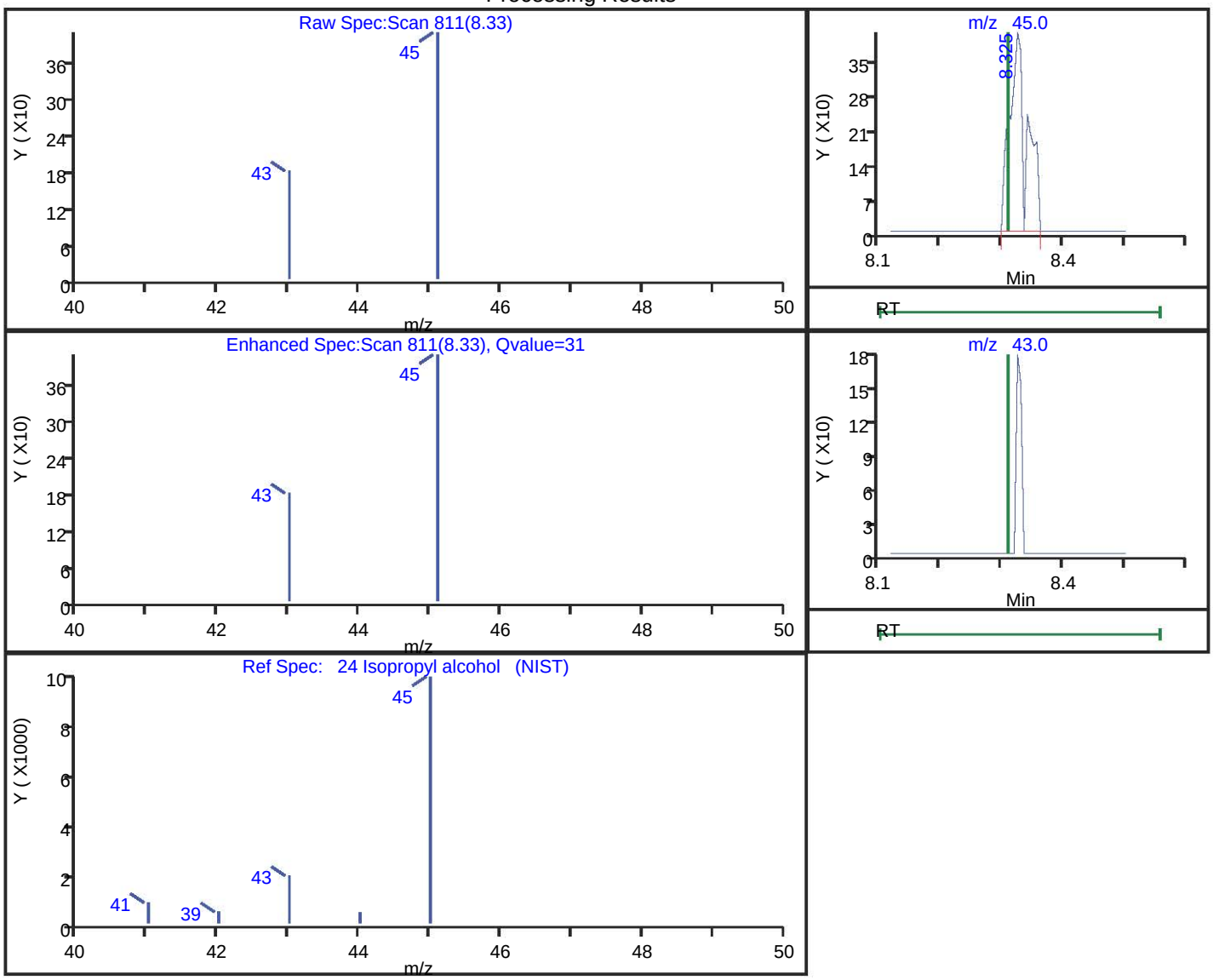
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

24 Isopropyl alcohol, CAS: 67-63-0

Processing Results



RT	Mass	Response	Amount
8.33	45.00	811	0.036465
8.31	43.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:43:30

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

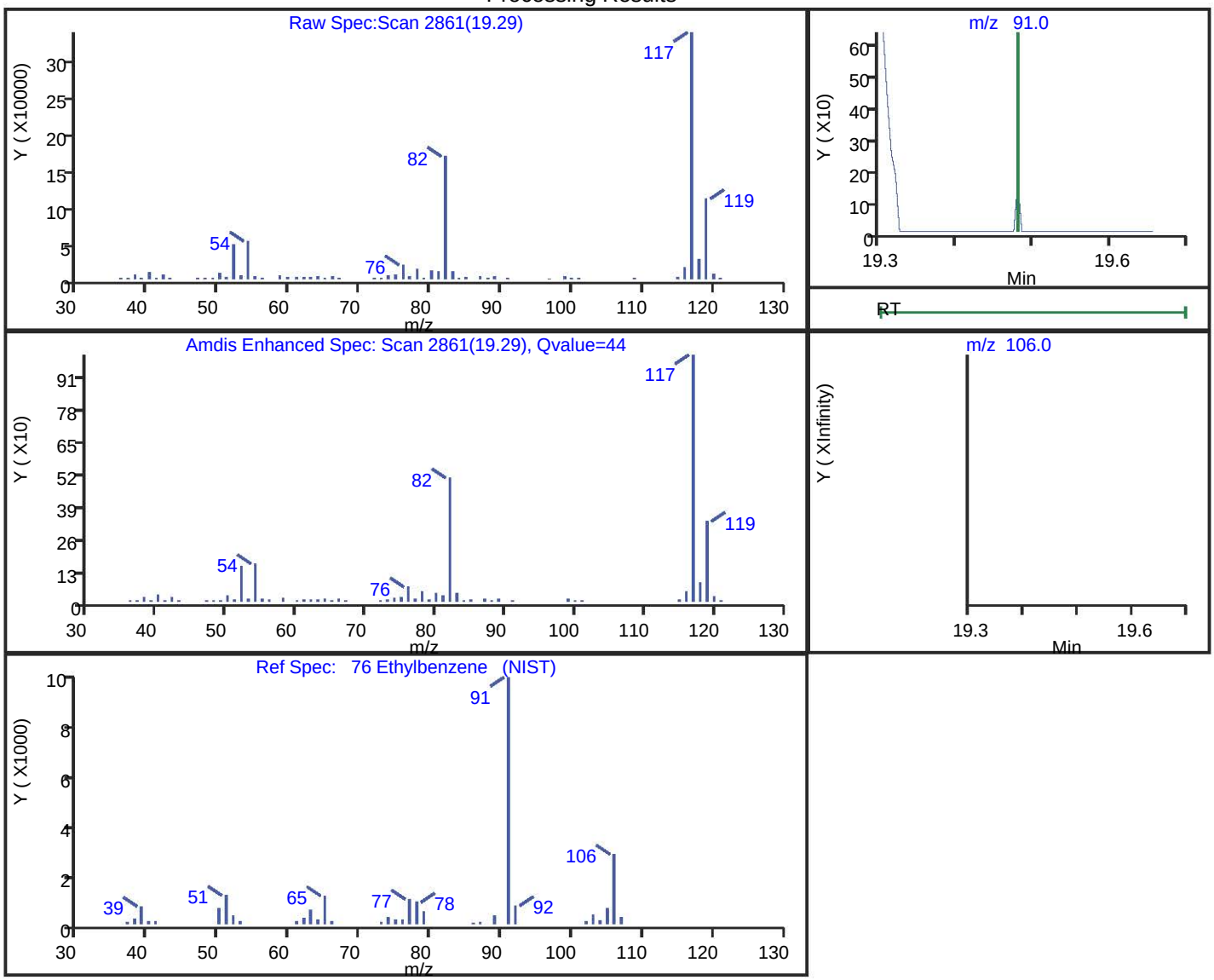
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

76 Ethylbenzene, CAS: 100-41-4

Processing Results



RT	Mass	Response	Amount
19.29	91.00	1583	0.011017
19.48	106.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:43:57

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

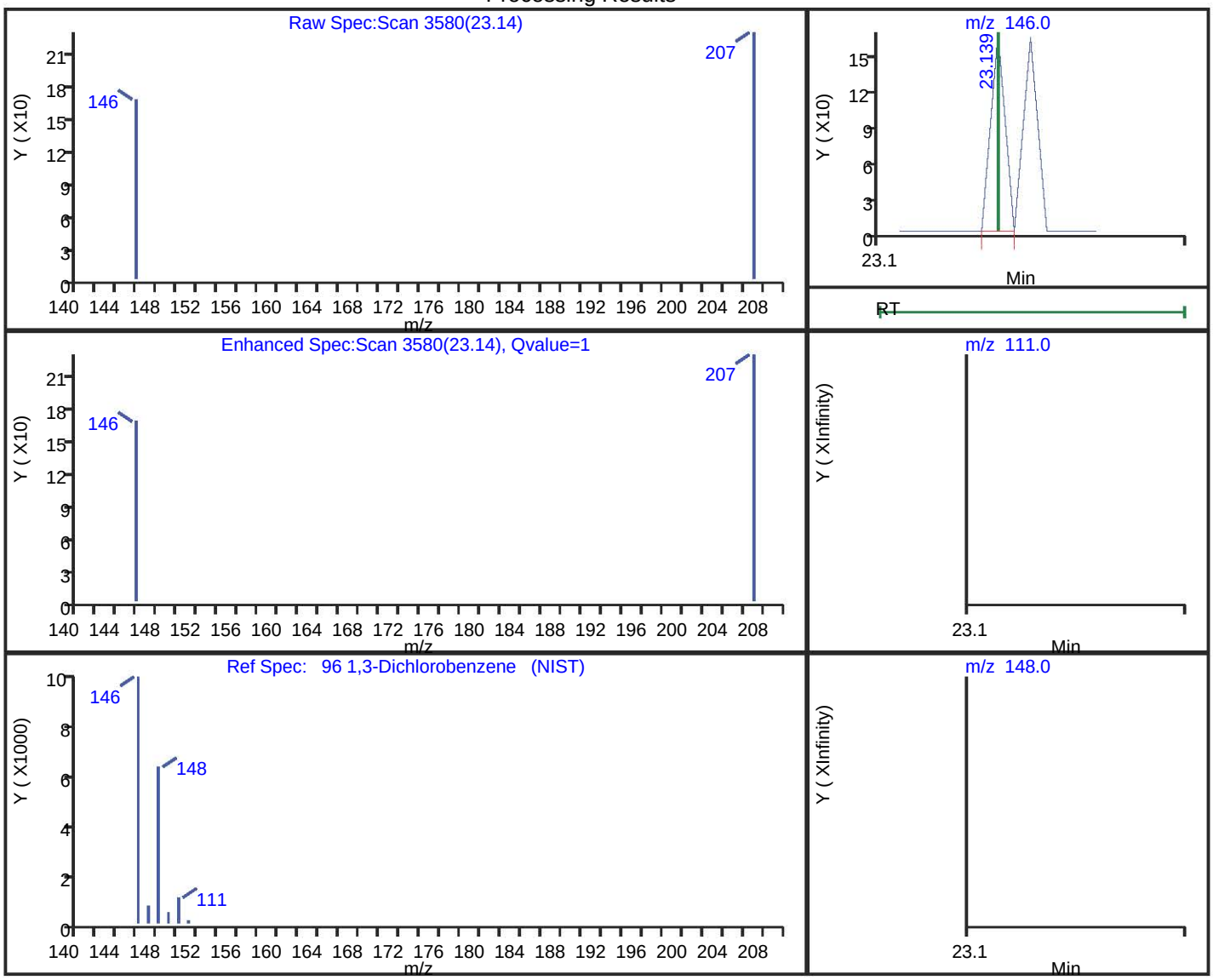
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

96 1,3-Dichlorobenzene, CAS: 541-73-1

Processing Results



RT	Mass	Response	Amount
23.14	146.00	52	0.000608
23.14	111.00	0	
23.14	148.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:44:08

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

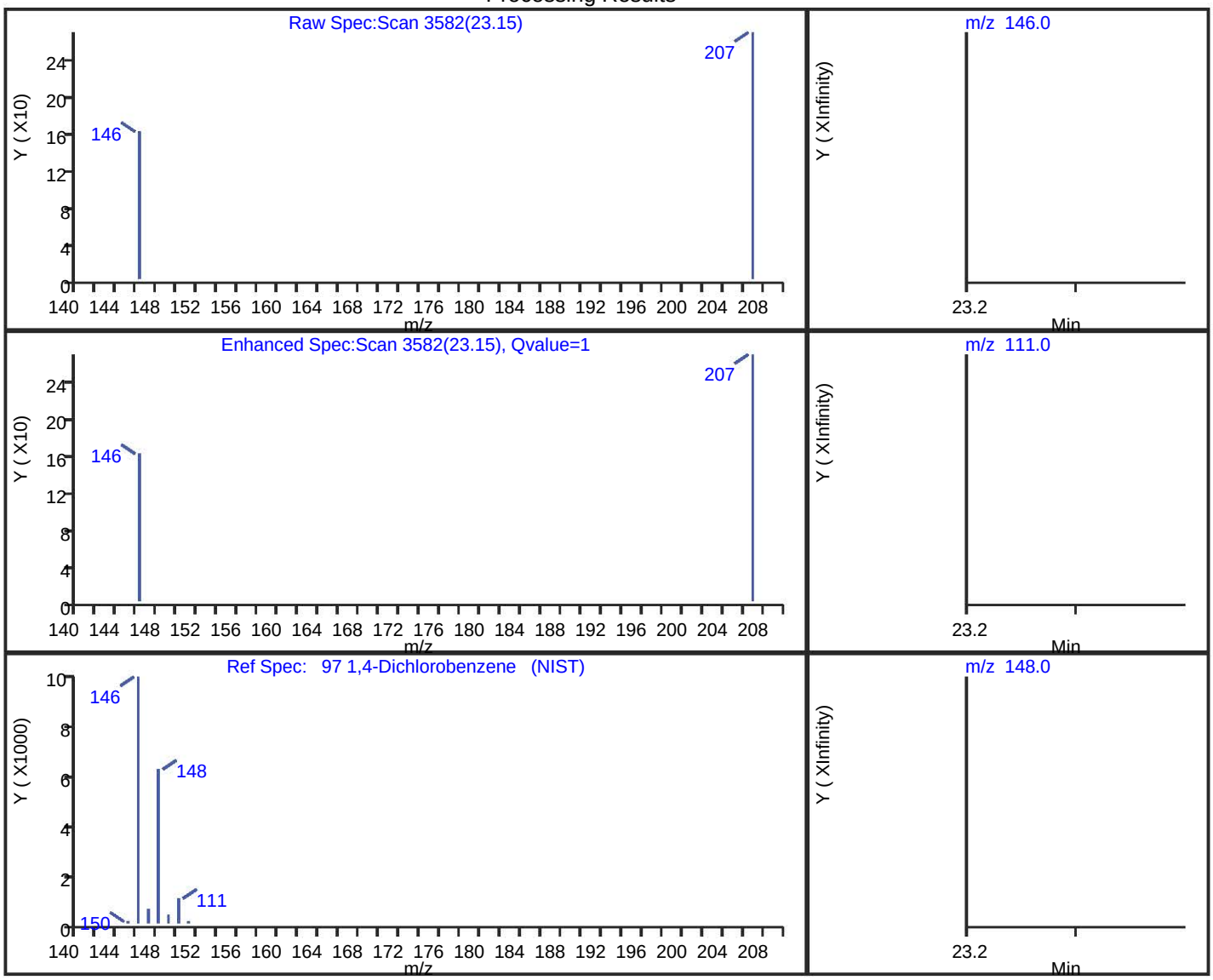
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHX.i\20190129-34351.b\34351-21.D				
Injection Date:	30-Jan-2019 09:17:30	Instrument ID:	CHX.i		
Lims ID:	200-47102-A-8	Lab Sample ID:	200-47102-8		
Client ID:	5727				
Operator ID:	ert	ALS Bottle#:	20	Worklist Smp#:	21
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_X.m	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

97 1,4-Dichlorobenzene, CAS: 106-46-7

Processing Results



RT	Mass	Response	Amount
23.15	146.00	50	0.000617
23.27	111.00	0	
23.27	148.00	0	

Reviewer: bunmaa, 31-Jan-2019 10:44:10

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47143-1

SDG No.:

Client Sample ID: 5034 Lab Sample ID: 200-47143-3

Matrix: Air Lab File ID: 34352-05.D

Analysis Method: TO-15 Date Collected: 01/23/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/29/2019 15:06

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139536 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
115-07-1	Propylene	1.0	U	1.0	1.0
75-71-8	Dichlorodifluoromethane	0.10	U	0.10	0.10
75-45-6	Freon 22	0.10	U	0.10	0.10
76-14-2	1,2-Dichlorotetrafluoroethane	0.040	U	0.040	0.040
74-87-3	Chloromethane	0.10	U	0.10	0.10
106-97-8	n-Butane	0.10	U	0.10	0.10
75-01-4	Vinyl chloride	0.040	U	0.040	0.040
106-99-0	1,3-Butadiene	0.040	U	0.040	0.040
74-83-9	Bromomethane	0.040	U	0.040	0.040
75-00-3	Chloroethane	0.10	U	0.10	0.10
593-60-2	Bromoethene(Vinyl Bromide)	0.040	U	0.040	0.040
75-69-4	Trichlorofluoromethane	0.040	U	0.040	0.040
64-17-5	Ethanol	1.0	U	1.0	1.0
76-13-1	Freon TF	0.040	U	0.040	0.040
75-35-4	1,1-Dichloroethene	0.040	U	0.040	0.040
67-64-1	Acetone	1.0	U	1.0	1.0
67-63-0	Isopropyl alcohol	1.0	U	1.0	1.0
75-15-0	Carbon disulfide	0.10	U	0.10	0.10
107-05-1	3-Chloropropene	0.10	U	0.10	0.10
75-09-2	Methylene Chloride	0.10	U	0.10	0.10
75-65-0	tert-Butyl alcohol	1.0	U	1.0	1.0
1634-04-4	Methyl tert-butyl ether	0.040	U	0.040	0.040
156-60-5	trans-1,2-Dichloroethene	0.040	U	0.040	0.040
110-54-3	n-Hexane	0.040	U	0.040	0.040
75-34-3	1,1-Dichloroethane	0.040	U	0.040	0.040
108-05-4	Vinyl acetate	1.0	U	1.0	1.0
141-78-6	Ethyl acetate	1.0	U	1.0	1.0
78-93-3	Methyl Ethyl Ketone	0.10	U	0.10	0.10
156-59-2	cis-1,2-Dichloroethene	0.040	U	0.040	0.040
540-59-0	1,2-Dichloroethene, Total	0.080	U	0.080	0.080
67-66-3	Chloroform	0.040	U	0.040	0.040
109-99-9	Tetrahydrofuran	1.0	U	1.0	1.0
71-55-6	1,1,1-Trichloroethane	0.040	U	0.040	0.040
110-82-7	Cyclohexane	0.040	U	0.040	0.040
56-23-5	Carbon tetrachloride	0.040	U	0.040	0.040
540-84-1	2,2,4-Trimethylpentane	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47143-1

SDG No.:

Client Sample ID: 5034 Lab Sample ID: 200-47143-3

Matrix: Air Lab File ID: 34352-05.D

Analysis Method: TO-15 Date Collected: 01/23/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/29/2019 15:06

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139536 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
71-43-2	Benzene	0.040	U	0.040	0.040
107-06-2	1,2-Dichloroethane	0.040	U	0.040	0.040
142-82-5	n-Heptane	0.040	U	0.040	0.040
79-01-6	Trichloroethene	0.040	U	0.040	0.040
80-62-6	Methyl methacrylate	0.10	U	0.10	0.10
78-87-5	1,2-Dichloropropane	0.040	U	0.040	0.040
123-91-1	1,4-Dioxane	1.0	U	1.0	1.0
75-27-4	Bromodichloromethane	0.040	U	0.040	0.040
10061-01-5	cis-1,3-Dichloropropene	0.040	U	0.040	0.040
108-10-1	methyl isobutyl ketone	0.10	U	0.10	0.10
108-88-3	Toluene	0.040	U	0.040	0.040
10061-02-6	trans-1,3-Dichloropropene	0.040	U	0.040	0.040
79-00-5	1,1,2-Trichloroethane	0.040	U	0.040	0.040
127-18-4	Tetrachloroethene	0.040	U	0.040	0.040
591-78-6	Methyl Butyl Ketone (2-Hexanone)	0.10	U	0.10	0.10
124-48-1	Dibromochloromethane	0.040	U	0.040	0.040
106-93-4	1,2-Dibromoethane	0.040	U	0.040	0.040
108-90-7	Chlorobenzene	0.040	U	0.040	0.040
100-41-4	Ethylbenzene	0.040	U	0.040	0.040
179601-23-1	m,p-Xylene	0.10	U	0.10	0.10
95-47-6	Xylene, o-	0.040	U	0.040	0.040
1330-20-7	Xylene (total)	0.14	U	0.14	0.14
100-42-5	Styrene	0.040	U	0.040	0.040
75-25-2	Bromoform	0.040	U	0.040	0.040
98-82-8	Cumene	0.040	U	0.040	0.040
79-34-5	1,1,2,2-Tetrachloroethane	0.040	U	0.040	0.040
103-65-1	n-Propylbenzene	0.040	U	0.040	0.040
622-96-8	4-Ethyltoluene	0.040	U	0.040	0.040
108-67-8	1,3,5-Trimethylbenzene	0.040	U	0.040	0.040
95-49-8	2-Chlorotoluene	0.040	U	0.040	0.040
98-06-6	tert-Butylbenzene	0.040	U	0.040	0.040
95-63-6	1,2,4-Trimethylbenzene	0.040	U	0.040	0.040
135-98-8	sec-Butylbenzene	0.040	U	0.040	0.040
99-87-6	4-Isopropyltoluene	0.040	U	0.040	0.040
541-73-1	1,3-Dichlorobenzene	0.040	U	0.040	0.040
106-46-7	1,4-Dichlorobenzene	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47143-1

SDG No.:

Client Sample ID: 5034 Lab Sample ID: 200-47143-3

Matrix: Air Lab File ID: 34352-05.D

Analysis Method: TO-15 Date Collected: 01/23/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/29/2019 15:06

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139536 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
100-44-7	Benzyl chloride	0.040	U	0.040	0.040
104-51-8	n-Butylbenzene	0.040	U	0.040	0.040
95-50-1	1,2-Dichlorobenzene	0.040	U	0.040	0.040
120-82-1	1,2,4-Trichlorobenzene	0.10	U	0.10	0.10
87-68-3	Hexachlorobutadiene	0.040	U	0.040	0.040
91-20-3	Naphthalene	0.10	U	0.10	0.10

TestAmerica Burlington
Target Compound Quantitation Report

Data File: \\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D
Lims ID: 200-47143-A-3
Client ID: 5034
Sample Type: Client
Inject. Date: 29-Jan-2019 15:06:30 ALS Bottle#: 4 Worklist Smp#: 5
Purge Vol: 200.000 mL Dil. Factor: 0.2000
Sample Info: 200-0034352-005
Misc. Info.: 47143-03
Operator ID: ggg Instrument ID: CHC.i

Method: \\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\TO15_MasterMethod_(v1)_CHC.i.m
Limit Group: AI_TO15_ICAL
Last Update: 30-Jan-2019 14:10:51 Calib Date: 28-Jan-2019 23:19:30
Integrator: RTE ID Type: Deconvolution ID
Quant Method: Internal Standard Quant By: Initial Calibration
Last ICal File: \\chromna\Burlington\ChromData\CHC.i\20190128-34340.b\34340-11.D

Column 1 : RTX-624 (0.32 mm) Det: MS SCAN
Process Host: CTX0311

First Level Reviewer: puangmaleek Date: 30-Jan-2019 14:10:51

Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
1 Propene	41	2.962	2.957	0.005	93	5026	0.2186	
2 Dichlorodifluoromethane	85	3.032	3.021	0.011	95	3804	0.0636	
3 Chlorodifluoromethane	51	3.080	3.074	0.006	99	4828	0.0958	
4 1,2-Dichloro-1,1,2,2-tetra	85	3.282	3.284	0.000	95	2643	0.0368	
5 Chloromethane	50	3.421	3.410	0.011	96	3106	0.1259	
6 Butane	43		3.608				ND	
7 Vinyl chloride	62	3.656	3.647	0.011	94	2083	0.0841	
8 Butadiene	54	3.725	3.722	0.005	87	1487	0.0811	
10 Bromomethane	94	4.387	4.384	0.005	88	1594	0.0815	
11 Chloroethane	64		4.622				ND	U
13 Vinyl bromide	106	5.017	5.009	0.011	91	1269	0.0670	
14 Trichlorofluoromethane	101	5.124	5.129	0.006	96	5536	0.0788	
17 Ethanol	45	5.727	5.689	0.038	90	2498	0.2458	
20 1,1,2-Trichloro-1,2,2-trif	101	6.218	6.207	0.011	69	3718	0.0839	
21 1,1-Dichloroethene	96	6.239	6.237	0.005	89	1483	0.0785	
22 Acetone	43		6.447				ND	
23 Carbon disulfide	76	6.607	6.607	0.000	75	5316	0.0812	
24 Isopropyl alcohol	45		6.773				ND	
25 3-Chloro-1-propene	41	7.024	7.018	0.006	90	2301	0.0847	
27 Methylene Chloride	49	7.312	7.312	0.000	93	3218	0.0927	
28 2-Methyl-2-propanol	59		7.546				ND	U
29 Methyl tert-butyl ether	73	7.755	7.728	0.027	84	5581	0.0722	
31 trans-1,2-Dichloroethene	61	7.760	7.760	-0.005	91	3126	0.0743	M
33 Hexane	57	8.176	8.171	0.005	89	3141	0.0775	
34 1,1-Dichloroethane	63	8.625	8.634	-0.005	96	4132	0.0799	
35 Vinyl acetate	43		8.715				ND	U
37 cis-1,2-Dichloroethene	96	9.740	9.745	0.000	95	1943	0.0791	
38 2-Butanone (MEK)	72	9.820	9.777	0.043	93	834	0.0599	
39 Ethyl acetate	88		9.847				ND	
* 40 Chlorobromomethane	128	10.199	10.199	0.000	91	330803	10.0	
S 30 1,2-Dichloroethene, Total	61				0		0.1534	

Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
41 Tetrahydrofuran	42		10.210				ND	
42 Chloroform	83	10.332	10.332	-0.016	90	4517	0.0730	M
43 Cyclohexane	84	10.610	10.610	0.006	82	2837	0.0804	M
44 1,1,1-Trichloroethane	97	10.615	10.615	0.000	87	3828	0.0569	
45 Carbon tetrachloride	117	10.877	10.877	0.000	89	4194	0.0653	
47 Benzene	78	11.325	11.336	0.000	90	7498	0.0844	
46 Isooctane	57	11.341	11.341	0.011	80	12963	0.0753	M
48 1,2-Dichloroethane	62		11.501				ND	
49 n-Heptane	43	11.736	11.736	0.000	94	6767	0.0813	
* 50 1,4-Difluorobenzene	114	12.184	12.184	0.000	98	1810206	10.0	
53 Trichloroethene	95	12.670	12.670	0.011	60	2908	0.0752	M
54 1,2-Dichloropropane	63	13.198	13.193	0.005	78	2725	0.0637	
55 Methyl methacrylate	69	13.396	13.396	0.006	39	2219	0.0552	M
56 1,4-Dioxane	88		13.428				ND	
57 Dibromomethane	174	13.449	13.454	-0.005	83	1691	0.0630	
58 Dichlorobromomethane	83	13.775	13.769	0.006	92	4659	0.0622	
60 cis-1,3-Dichloropropene	75	14.725	14.719	0.006	85	4276	0.0706	
61 4-Methyl-2-pentanone (MIBK	43		15.002				ND	U
65 Toluene	92	15.312	15.312	-0.005	88	5101	0.0780	M
66 trans-1,3-Dichloropropene	75	15.920	15.920	0.000	84	4764	0.0732	
67 1,1,2-Trichloroethane	83	16.283	16.283	-0.005	48	2669	0.0759	M
68 Tetrachloroethene	166	16.416	16.416	0.000	81	3173	0.0764	M
69 2-Hexanone	43		16.737				ND	
71 Chlorodibromomethane	129	17.046	17.052	-0.005	76	3159	0.0589	
72 Ethylene Dibromide	107	17.318	17.313	0.005	94	3374	0.0655	
* 74 Chlorobenzene-d5	117	18.220	18.220	0.000	98	1720887	10.0	
75 Chlorobenzene	112	18.284	18.279	0.005	83	6444	0.0860	
76 Ethylbenzene	91	18.444	18.439	0.005	97	11816	0.0795	
78 m-Xylene & p-Xylene	106	18.690	18.690	0.000	0	7686	0.1529	
79 o-Xylene	106	19.523	19.523	0.001	94	3890	0.0806	
80 Styrene	104	19.576	19.576	0.000	94	5058	0.0685	
81 Bromoform	173	20.019	20.019	0.011	86	2033	0.0476	M
S 73 Xylenes, Total	106				0		0.2334	
82 Isopropylbenzene	105	20.243	20.243	0.000	97	12765	0.0862	
84 1,1,2,2-Tetrachloroethane	83	20.910	20.910	0.000	94	7504	0.0871	
85 N-Propylbenzene	91	20.990	20.990	0.000	95	17424	0.0869	
88 4-Ethyltoluene	105	21.182	21.182	0.000	82	12931	0.0841	
89 2-Chlorotoluene	91	21.188	21.187	0.000	88	13004	0.0921	
90 1,3,5-Trimethylbenzene	105	21.289	21.294	-0.005	89	11724	0.0975	
92 tert-Butylbenzene	119	21.791	21.790	0.000	81	10833	0.1024	
93 1,2,4-Trimethylbenzene	105	21.892	21.887	0.005	97	11793	0.1008	
94 sec-Butylbenzene	105	22.127	22.127	0.000	96	17147	0.1009	
95 4-Isopropyltoluene	119	22.335	22.329	0.005	92	13871	0.1015	
96 1,3-Dichlorobenzene	146	22.356	22.351	0.005	90	7451	0.1092	
97 1,4-Dichlorobenzene	146	22.495	22.501	0.005	81	7596	0.1151	
98 Benzyl chloride	91	22.682	22.698	0.000	93	9531	0.0839	
100 n-Butylbenzene	91	22.901	22.901	0.000	95	14243	0.0978	
101 1,2-Dichlorobenzene	146	23.013	23.013	0.000	84	7185	0.1157	
103 1,2,4-Trichlorobenzene	180	25.430	25.414	0.016	85	2773	0.0645	
104 Hexachlorobutadiene	225	25.607	25.606	0.000	87	6723	0.1431	
105 Naphthalene	128	25.863	25.863	0.006	96	3988	0.0366	M

QC Flag Legend

Review Flags

M - Manually Integrated

U - Marked Undetected

Reagents:

ATTO15CISs_00010 Amount Added: 20.00 Units: mL Run Reagent

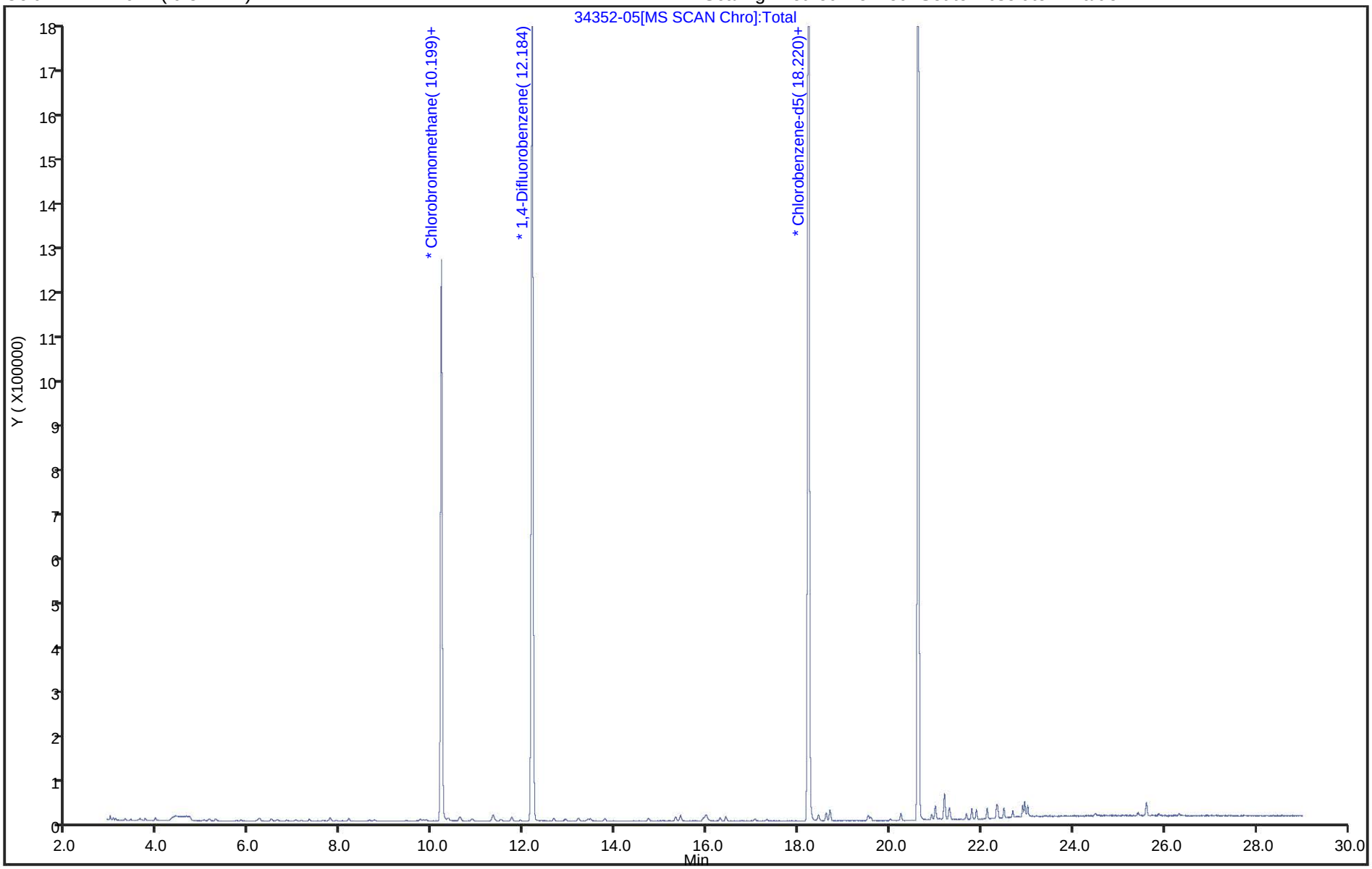
Report Date: 30-Jan-2019 14:10:52 Chrom Revision: 2.3 15-Jan-2019 08:51:34

TestAmerica Burlington

Data File: \\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D

Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i	Operator ID:	ggg
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3	Worklist Smp#:	5
Client ID:	5034				
Purge Vol:	200.000 mL	Dil. Factor:	0.2000	ALS Bottle#:	4
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		

Column: RTX-624 (0.32 mm) Y Scaling: Method Defined: Set to Absolute Y Value



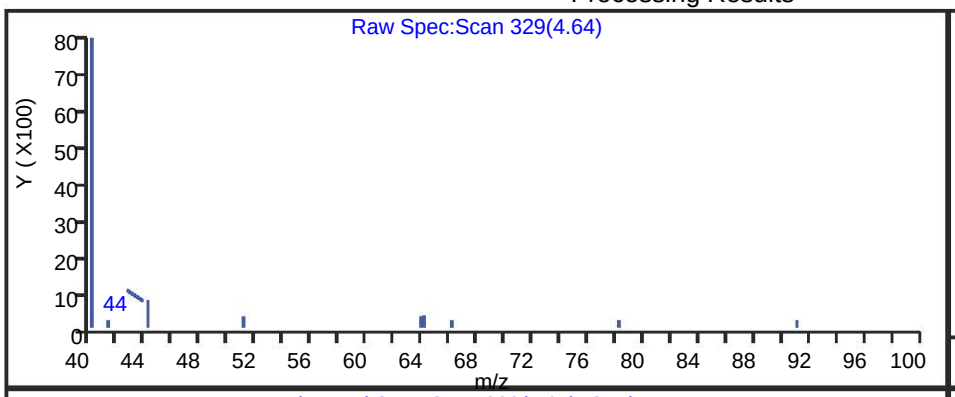
User Disabled Compound Report

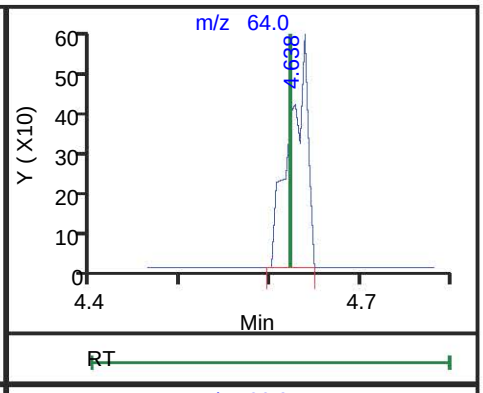
TestAmerica Burlington

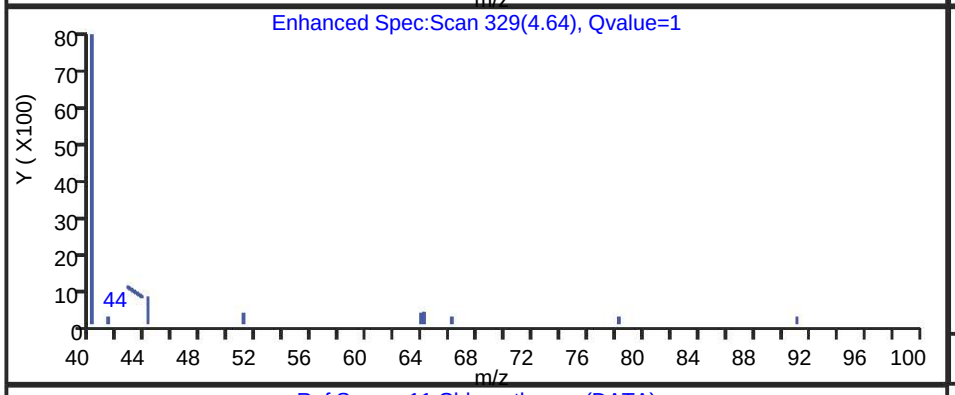
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

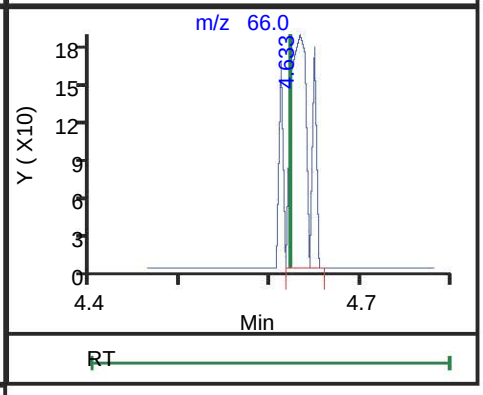
11 Chloroethane, CAS: 75-00-3

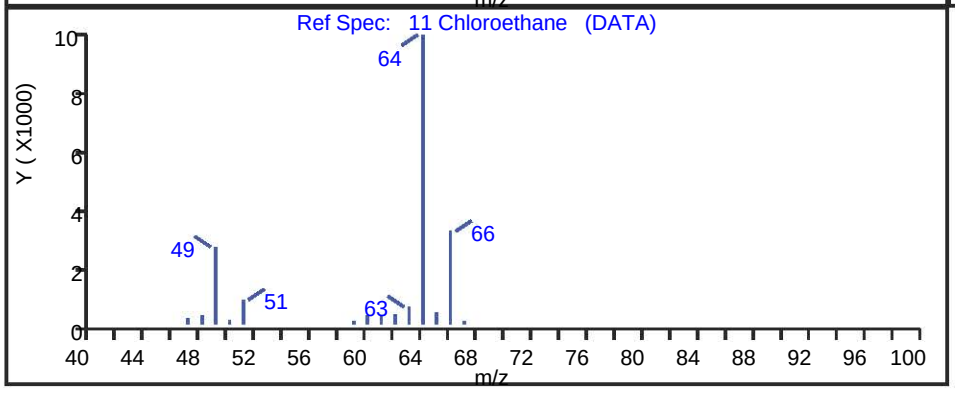
Processing Results











RT	Mass	Response	Amount
4.64	64.00	839	0.074238
4.63	66.00	273	

Reviewer: puangmaleek, 30-Jan-2019 14:03:54

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

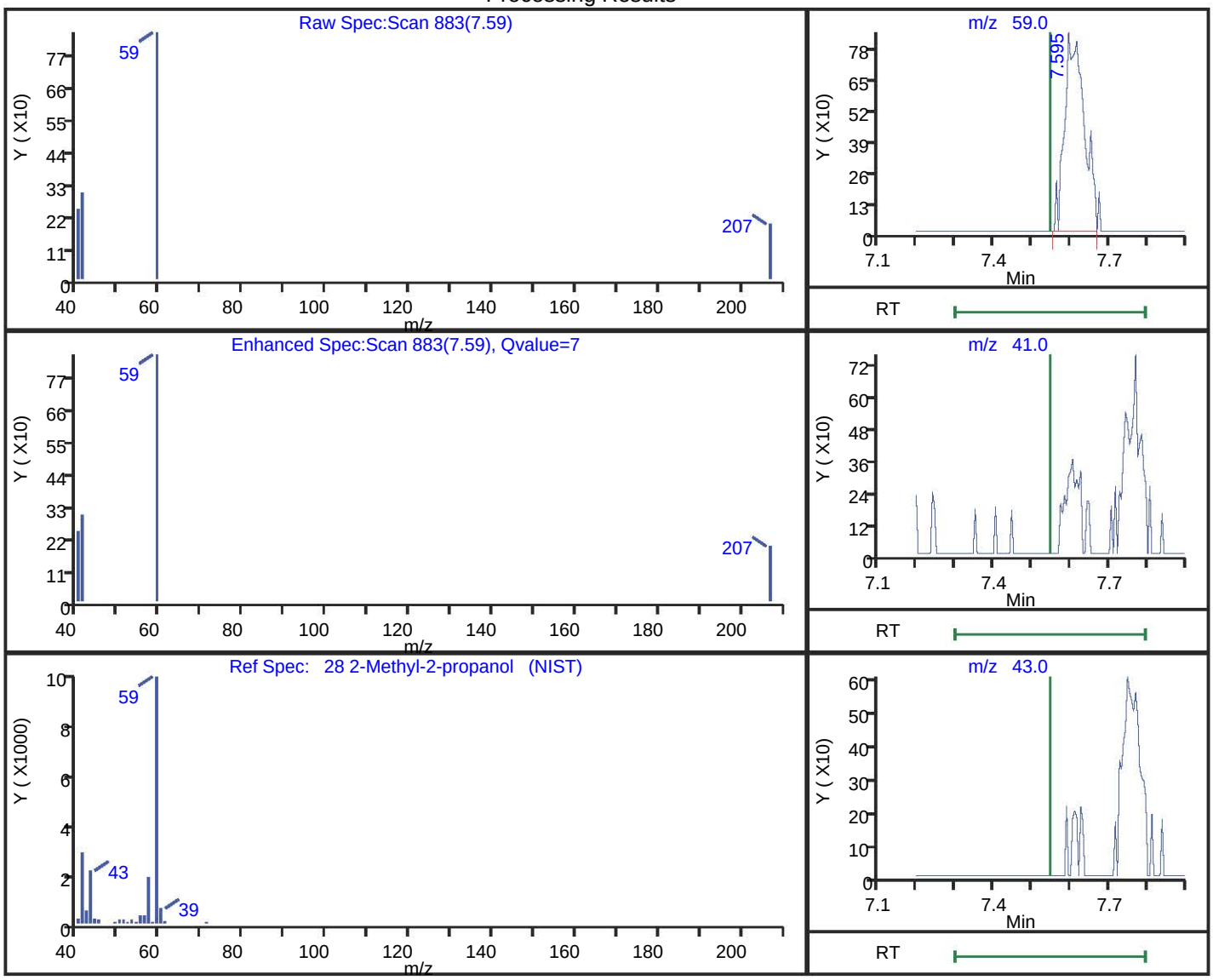
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

28 2-Methyl-2-propanol, CAS: 75-65-0

Processing Results



RT	Mass	Response	Amount
7.59	59.00	3018	0.045788
7.55	41.00	0	
7.55	43.00	0	

Reviewer: puangmaleek, 30-Jan-2019 14:04:16

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

TestAmerica Burlington

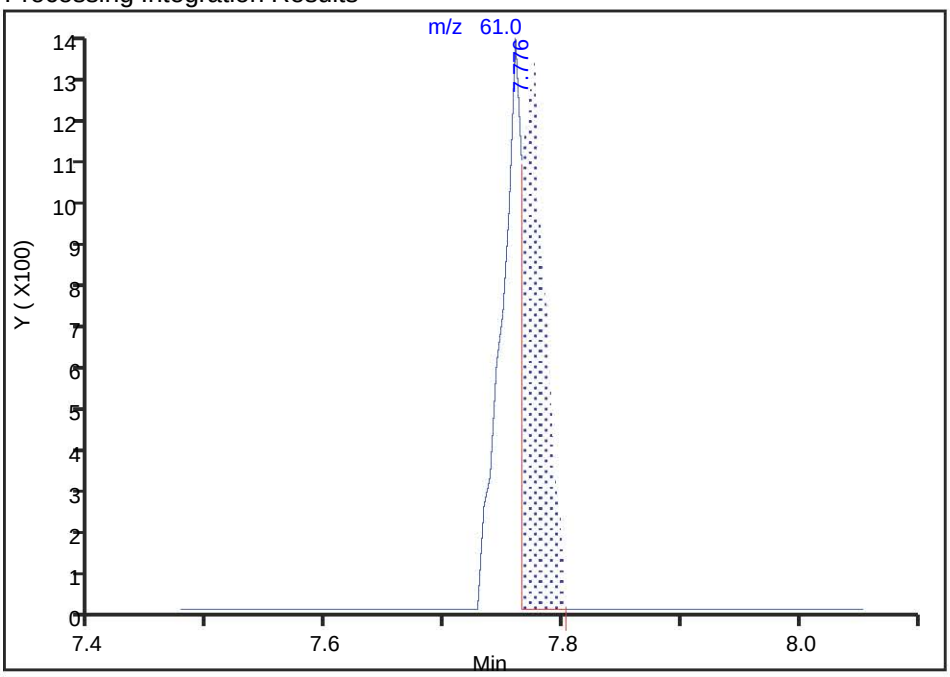
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

31 trans-1,2-Dichloroethene, CAS: 156-60-5

Signal: 1

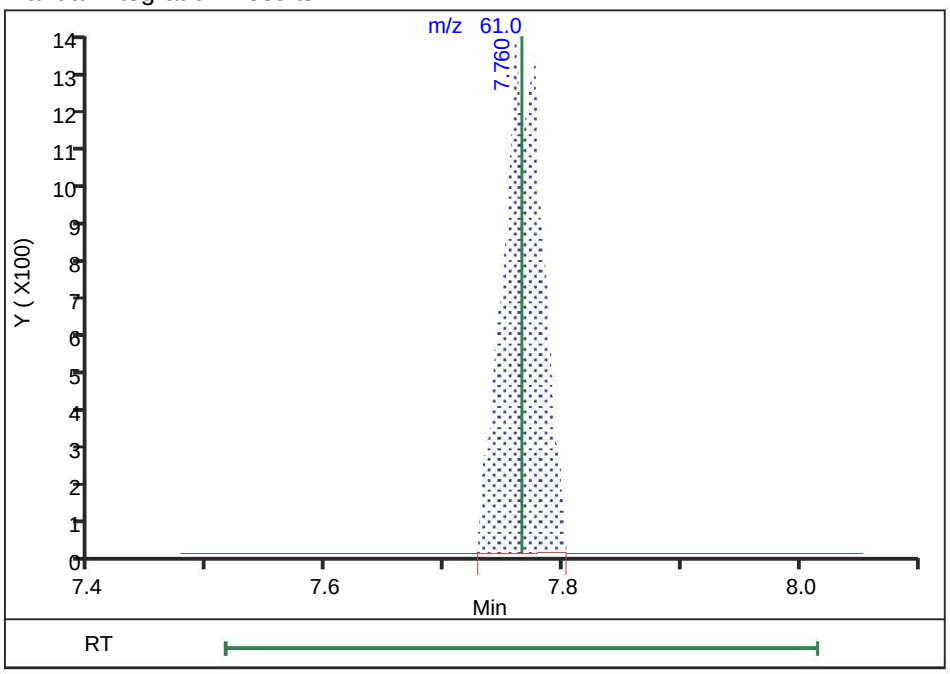
Processing Integration Results

RT: 7.78
Area: 1802
Amount: 0.042837
Amount Units: ppb v/v



Manual Integration Results

RT: 7.76
Area: 3126
Amount: 0.074312
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:04:26
Audit Action: Manually Integrated Audit Reason: Assign Peak

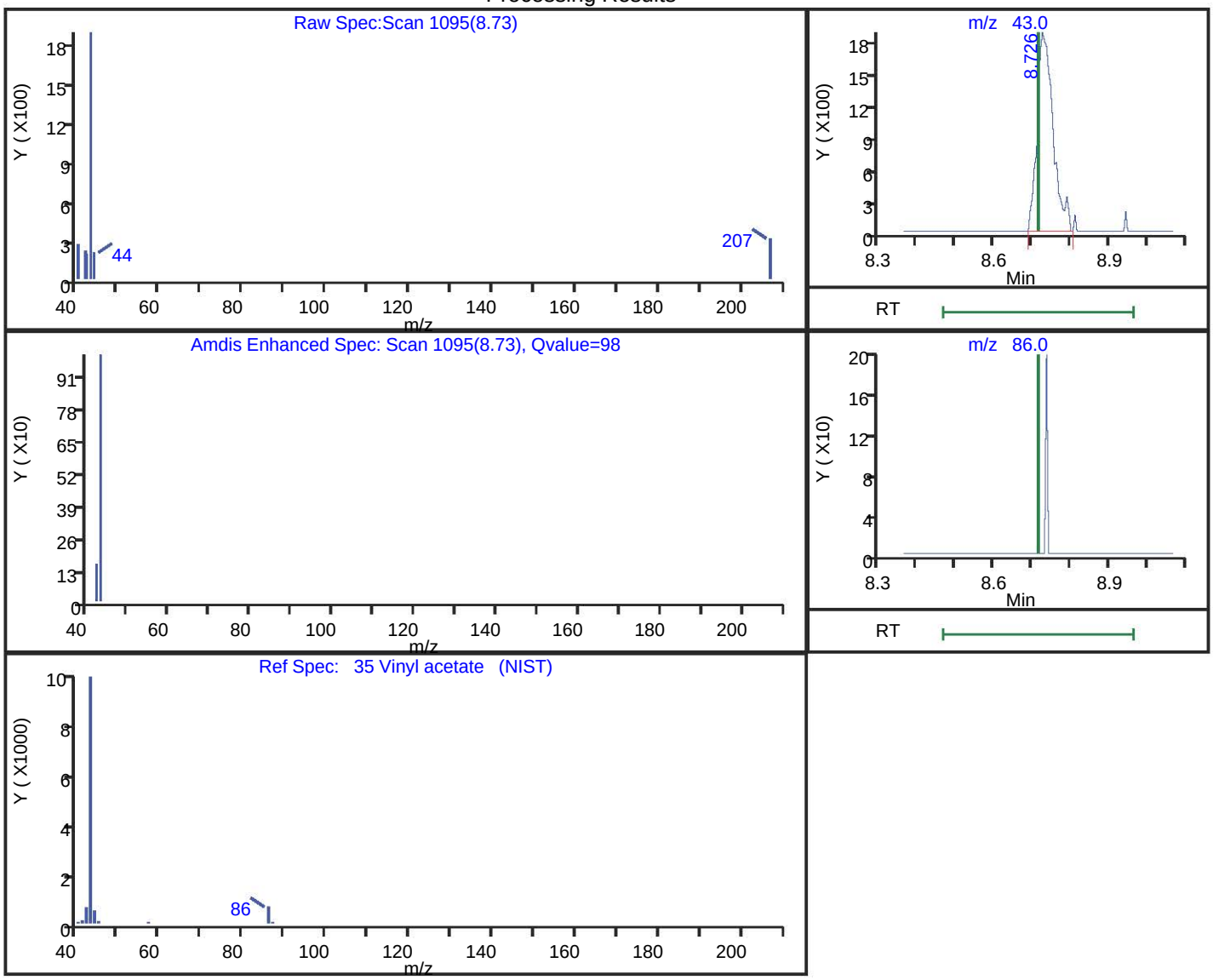
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

35 Vinyl acetate, CAS: 108-05-4

Processing Results



RT	Mass	Response	Amount
8.73	43.00	5339	0.058619
8.72	86.00	0	

Reviewer: puangmaleek, 30-Jan-2019 14:04:33

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

Manual Integration/User Assign Peak Report

TestAmerica Burlington

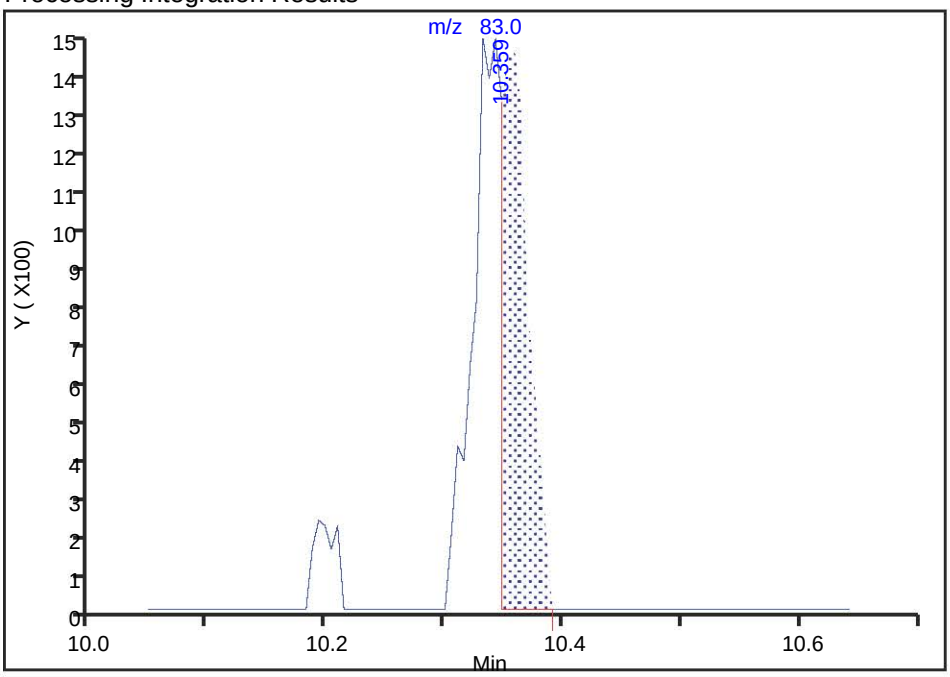
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

42 Chloroform, CAS: 67-66-3

Signal: 1

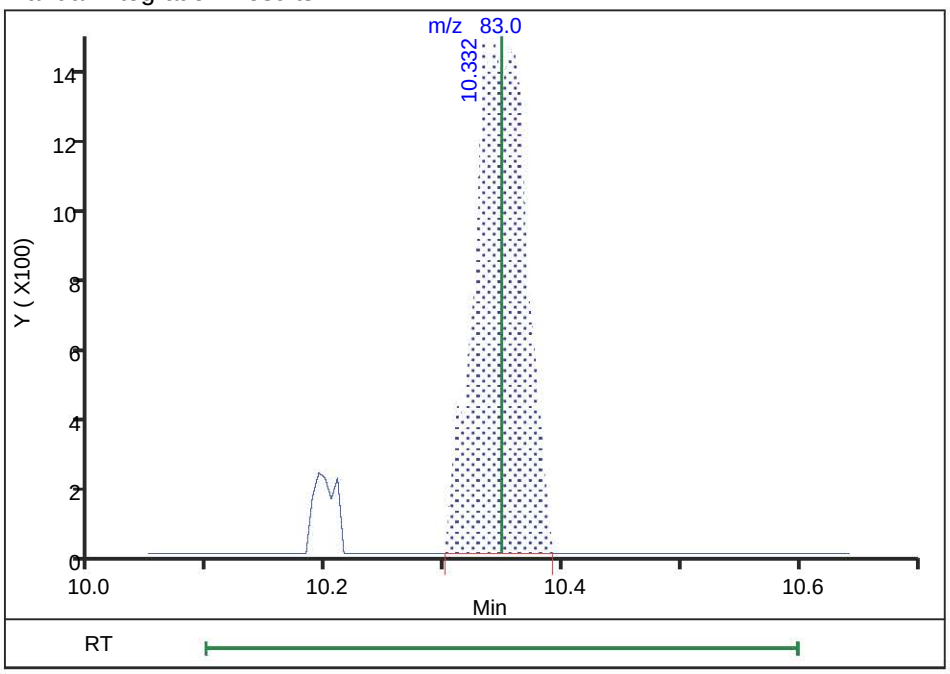
Processing Integration Results

RT: 10.36
Area: 2367
Amount: 0.038243
Amount Units: ppb v/v



Manual Integration Results

RT: 10.33
Area: 4517
Amount: 0.072980
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:04:55

Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

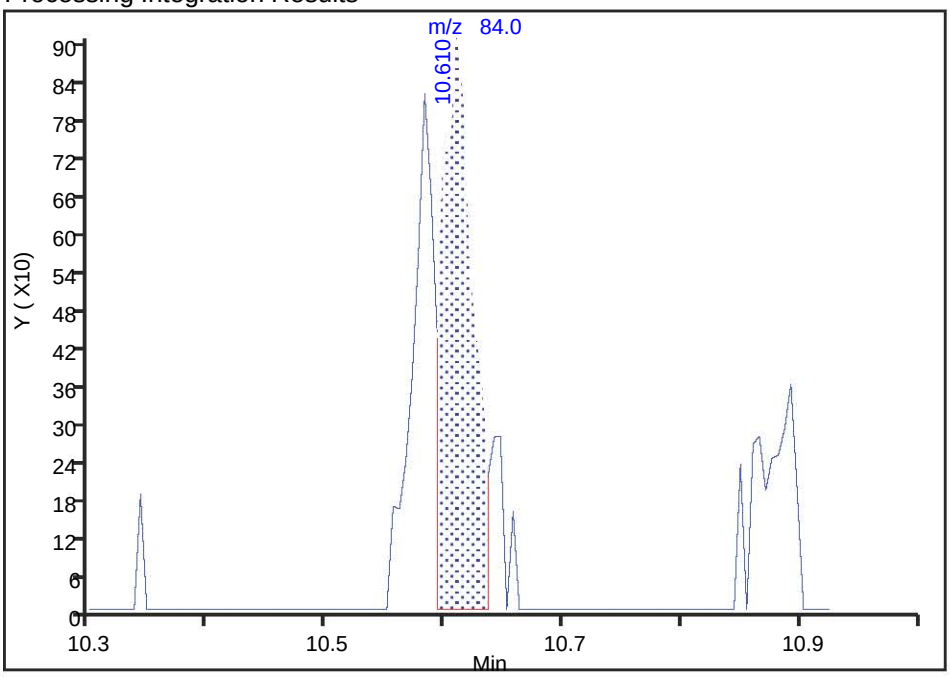
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

43 Cyclohexane, CAS: 110-82-7

Signal: 1

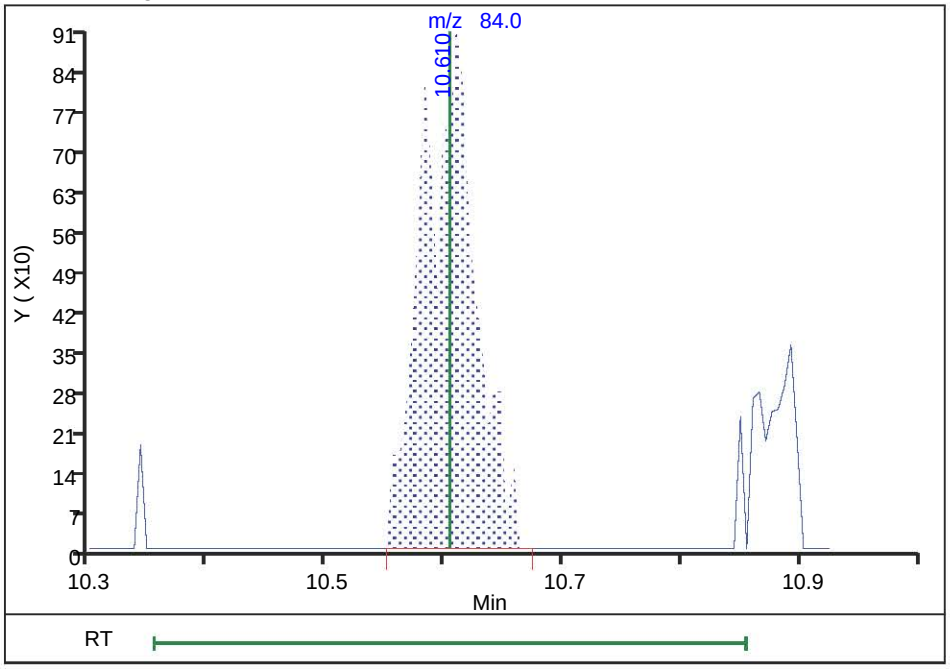
Processing Integration Results

RT: 10.61
Area: 1660
Amount: 0.047017
Amount Units: ppb v/v



Manual Integration Results

RT: 10.61
Area: 2837
Amount: 0.080353
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:05:02
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

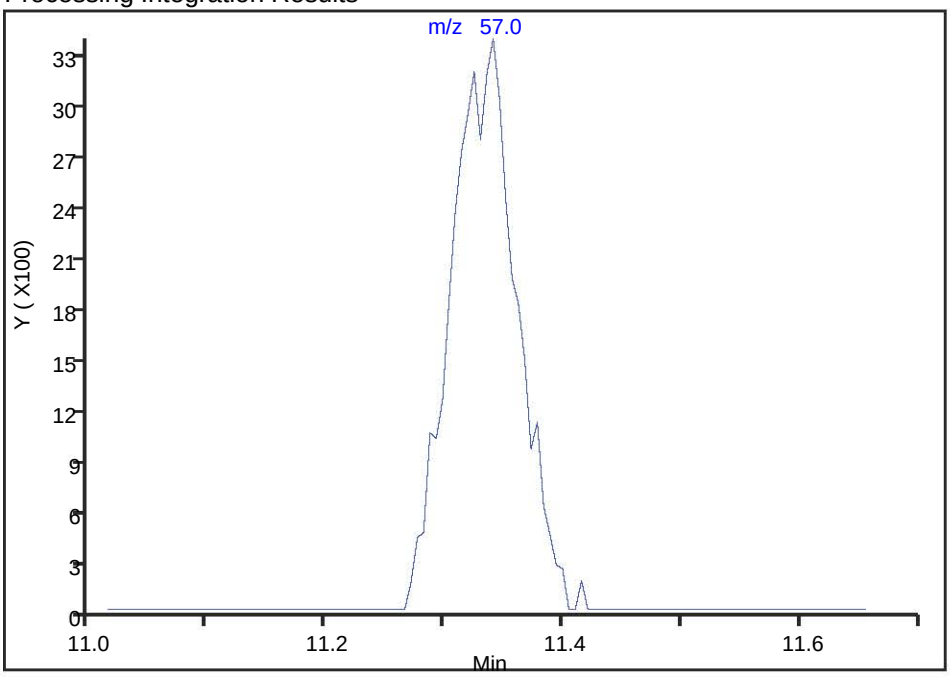
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

46 Isooctane, CAS: 540-84-1

Signal: 1

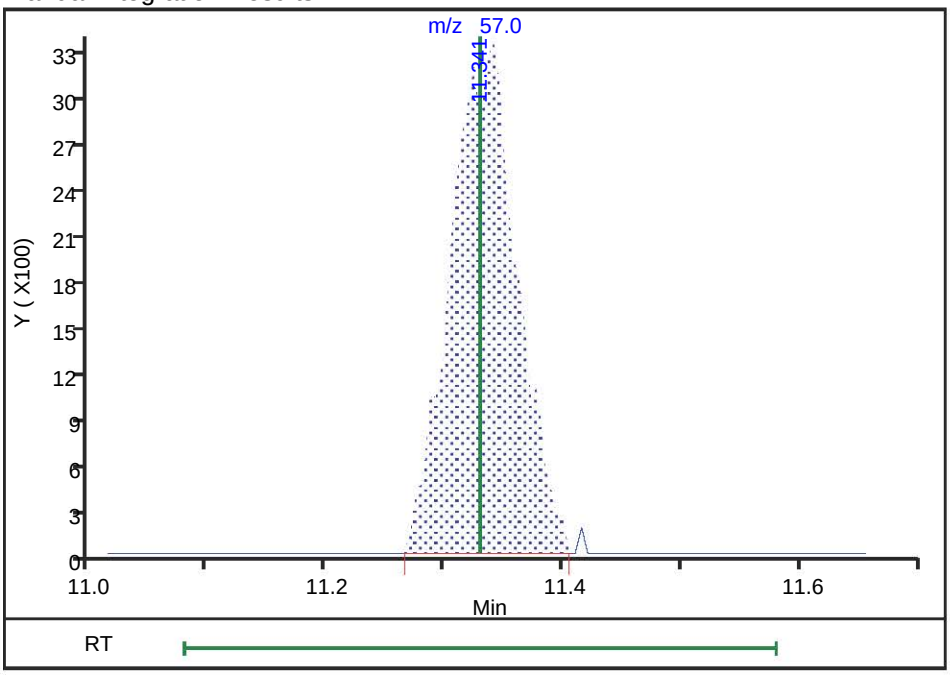
Not Detected
Expected RT: 11.33

Processing Integration Results



Manual Integration Results

RT: 11.34
Area: 12963
Amount: 0.075326
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:05:15
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

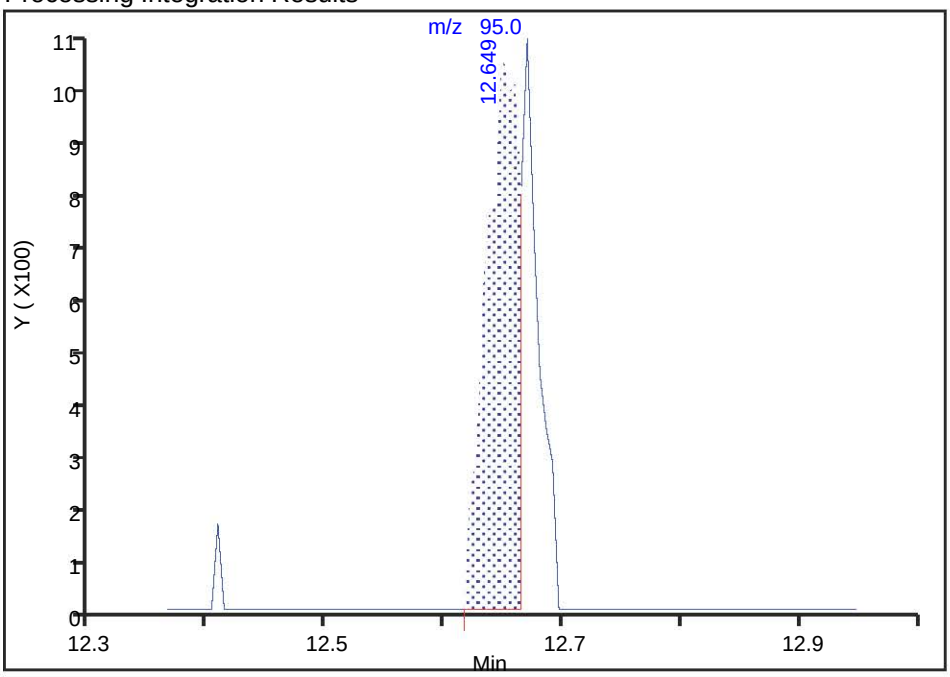
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

53 Trichloroethene, CAS: 79-01-6

Signal: 1

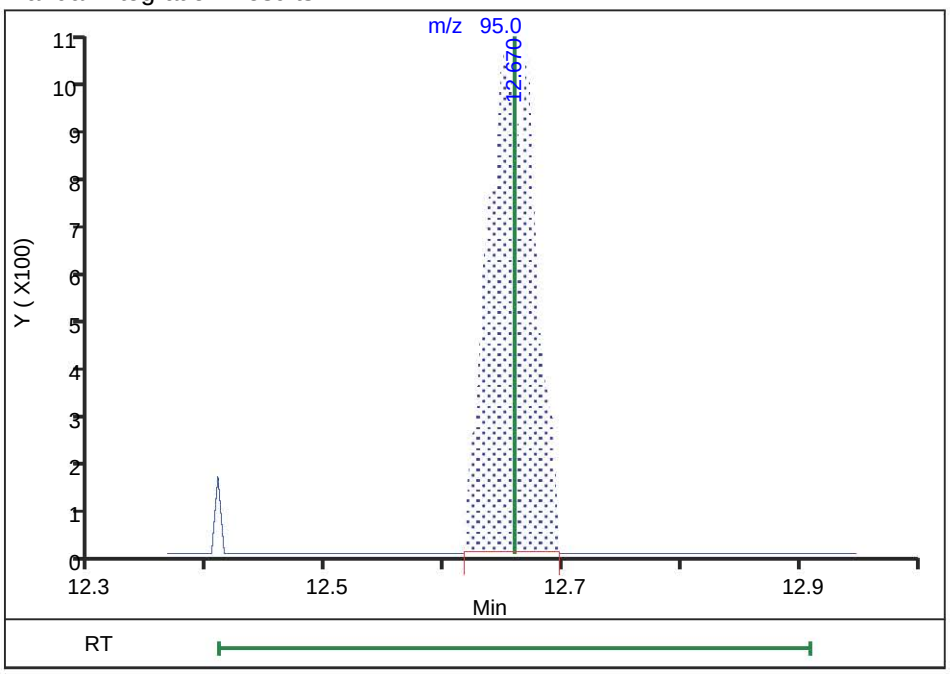
Processing Integration Results

RT: 12.65
Area: 2027
Amount: 0.052419
Amount Units: ppb v/v



Manual Integration Results

RT: 12.67
Area: 2908
Amount: 0.075201
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:05:24
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

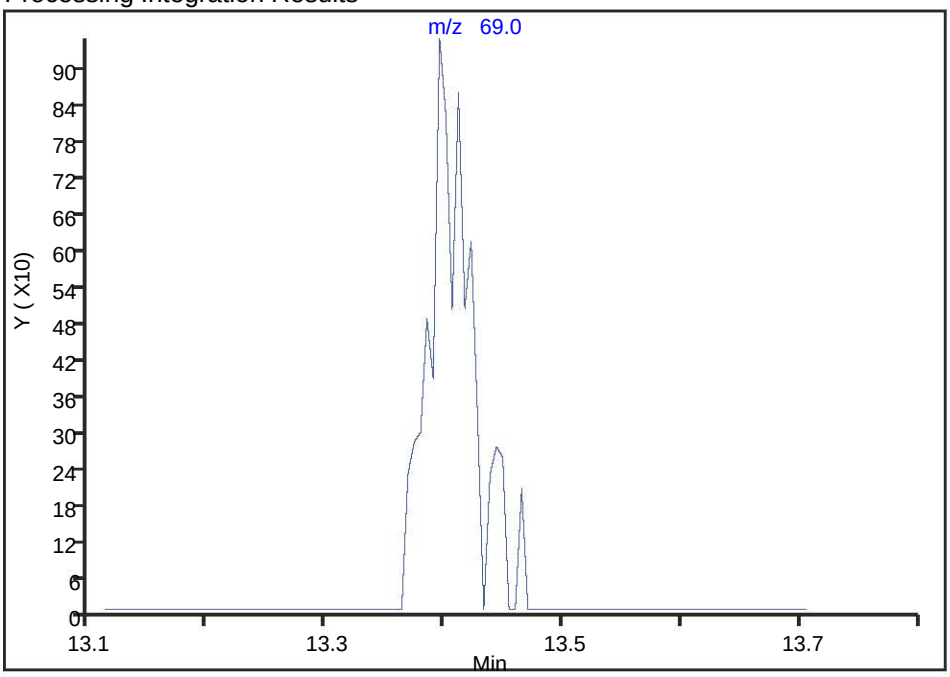
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

55 Methyl methacrylate, CAS: 80-62-6

Signal: 1

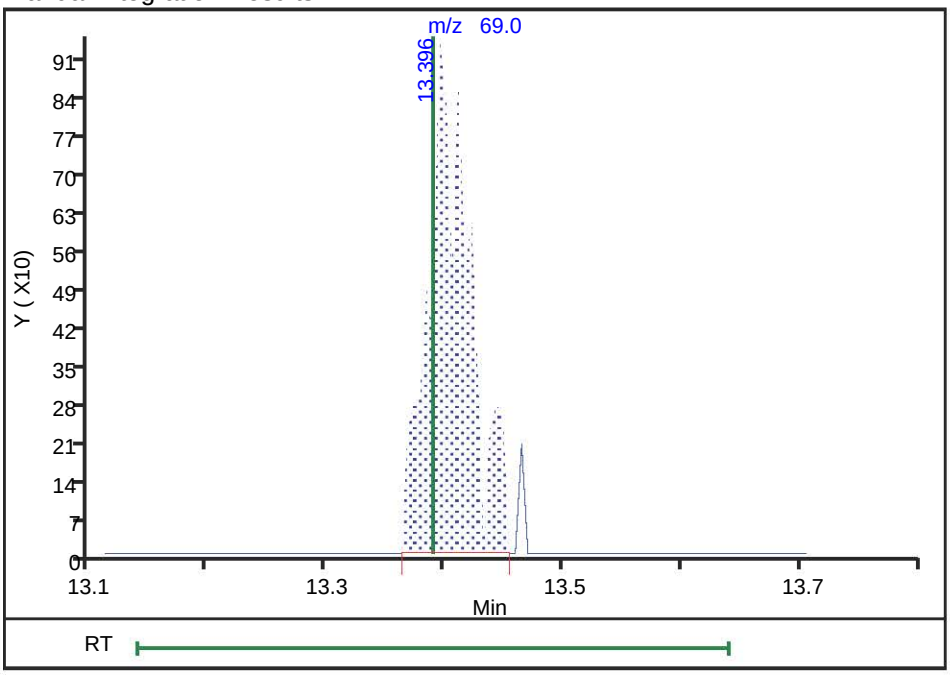
Not Detected
Expected RT: 13.39

Processing Integration Results



Manual Integration Results

RT: 13.40
Area: 2219
Amount: 0.055212
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:05:35
Audit Action: Manually Integrated Audit Reason: Assign Peak

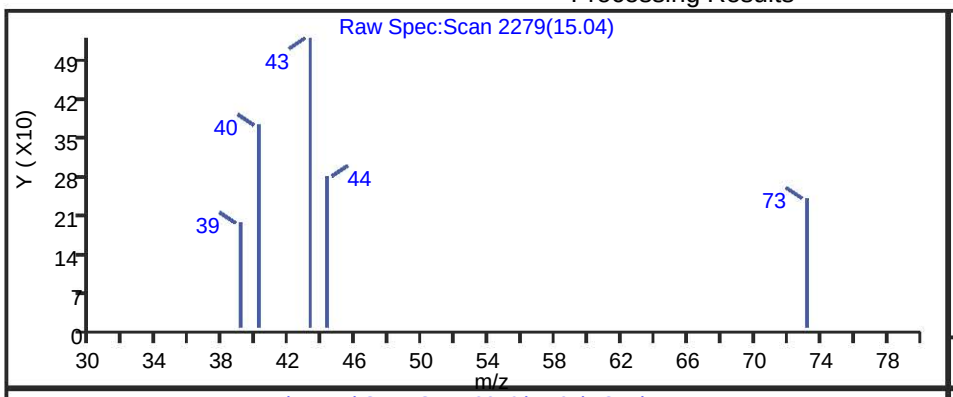
User Disabled Compound Report

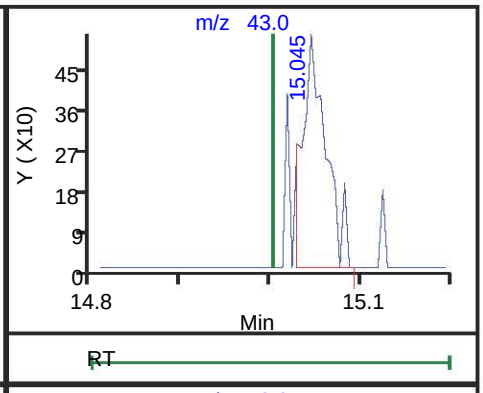
TestAmerica Burlington

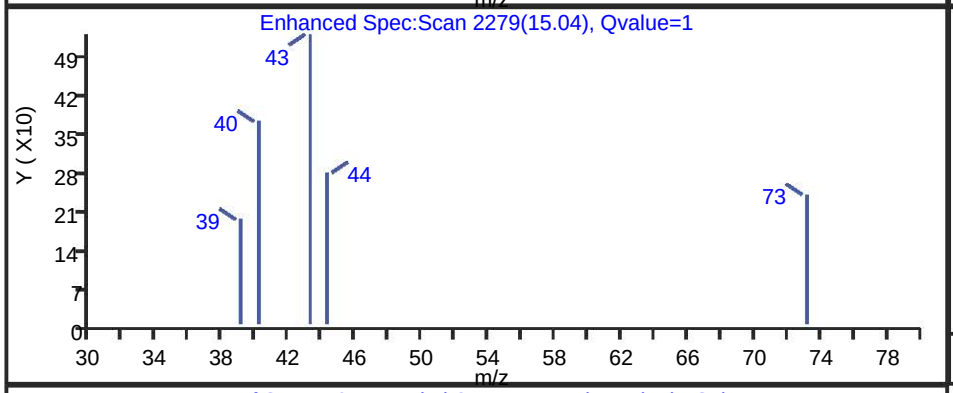
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

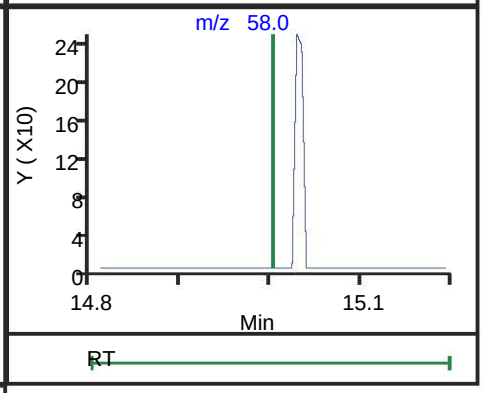
61 4-Methyl-2-pentanone (MIBK), CAS: 108-10-1

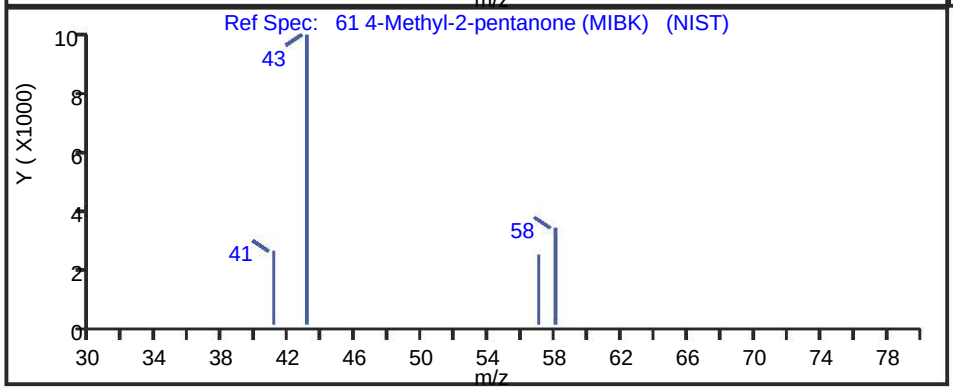
Processing Results











RT	Mass	Response	Amount
15.04	43.00	975	0.006807
15.00	58.00	0	

Reviewer: puangmaleek, 30-Jan-2019 14:05:51

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

Manual Integration/User Assign Peak Report

TestAmerica Burlington

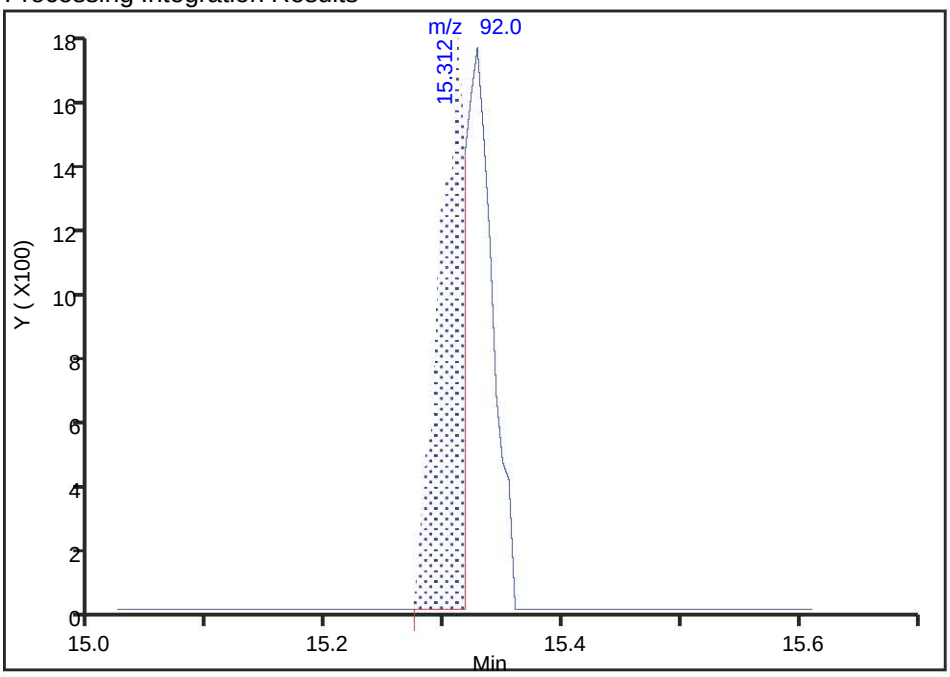
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

65 Toluene, CAS: 108-88-3

Signal: 1

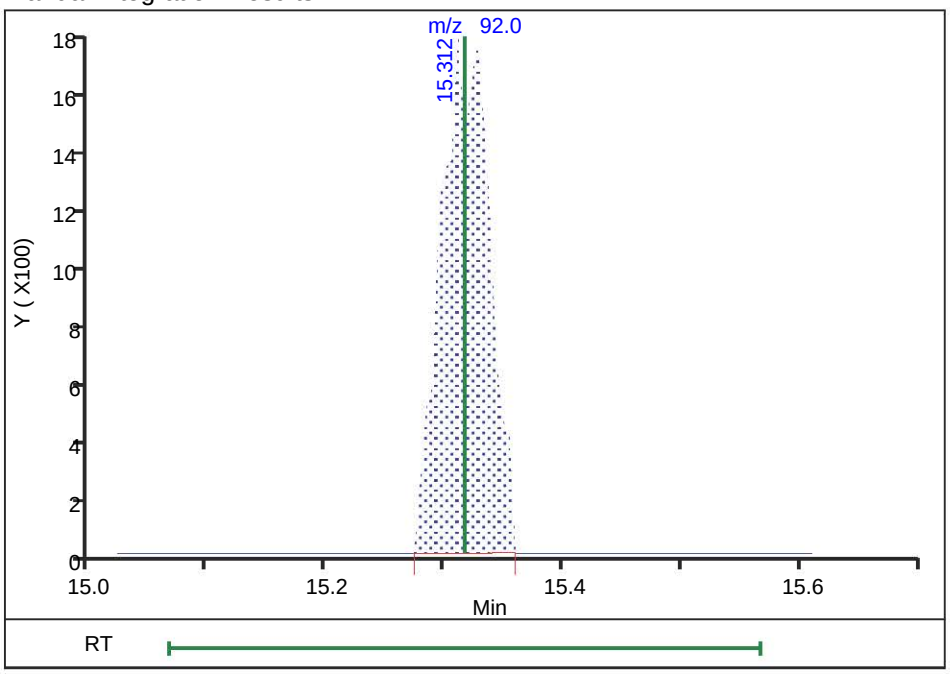
Processing Integration Results

RT: 15.31
Area: 2700
Amount: 0.041291
Amount Units: ppb v/v



Manual Integration Results

RT: 15.31
Area: 5101
Amount: 0.078010
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:08:04
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

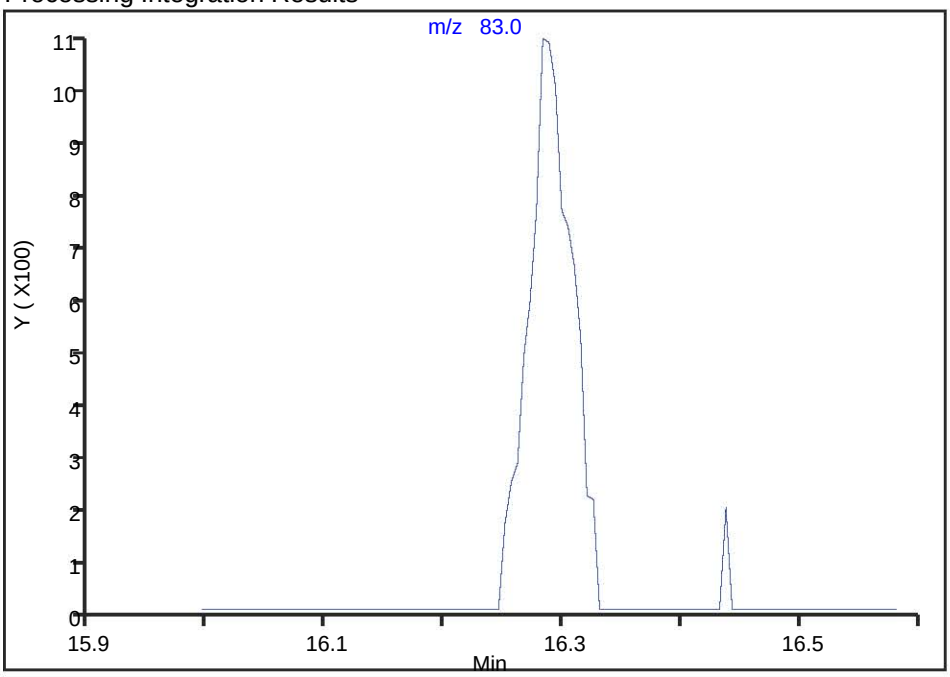
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

67 1,1,2-Trichloroethane, CAS: 79-00-5

Signal: 1

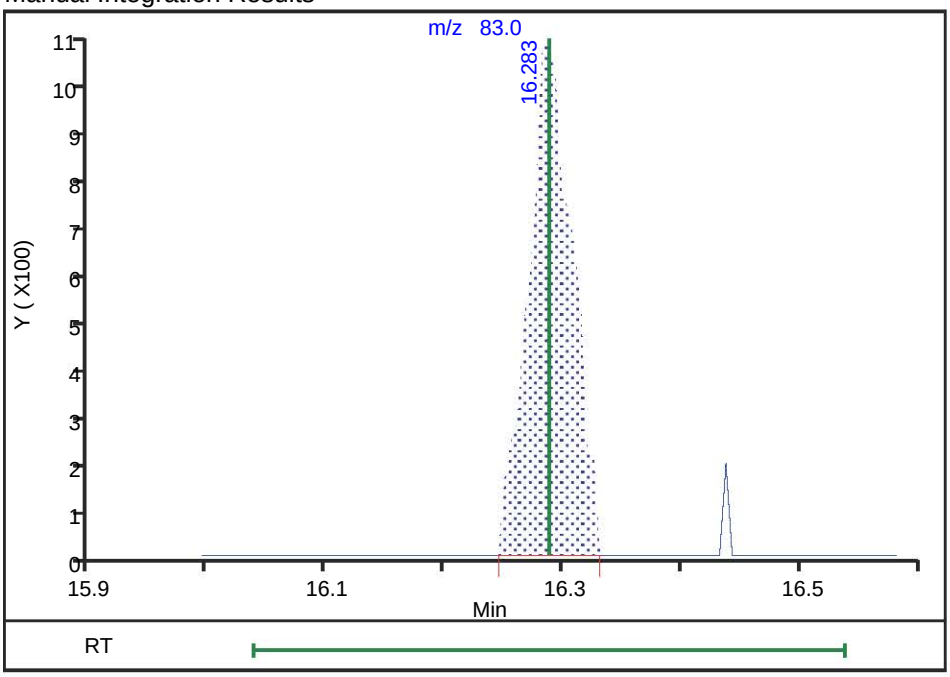
Not Detected
Expected RT: 16.29

Processing Integration Results



Manual Integration Results

RT: 16.28
Area: 2669
Amount: 0.075935
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:08:13
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

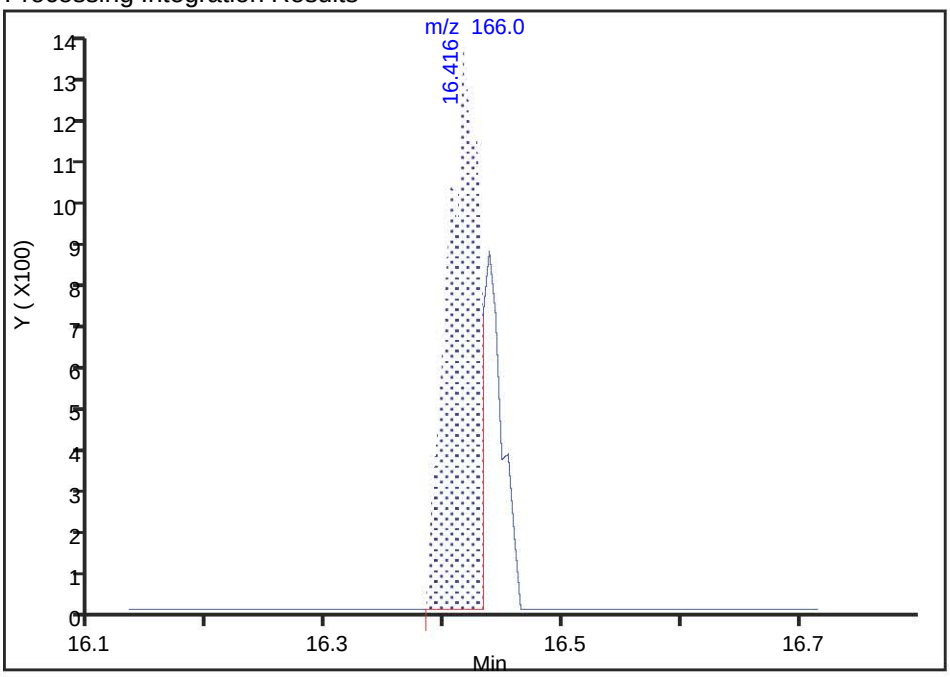
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

68 Tetrachloroethene, CAS: 127-18-4

Signal: 1

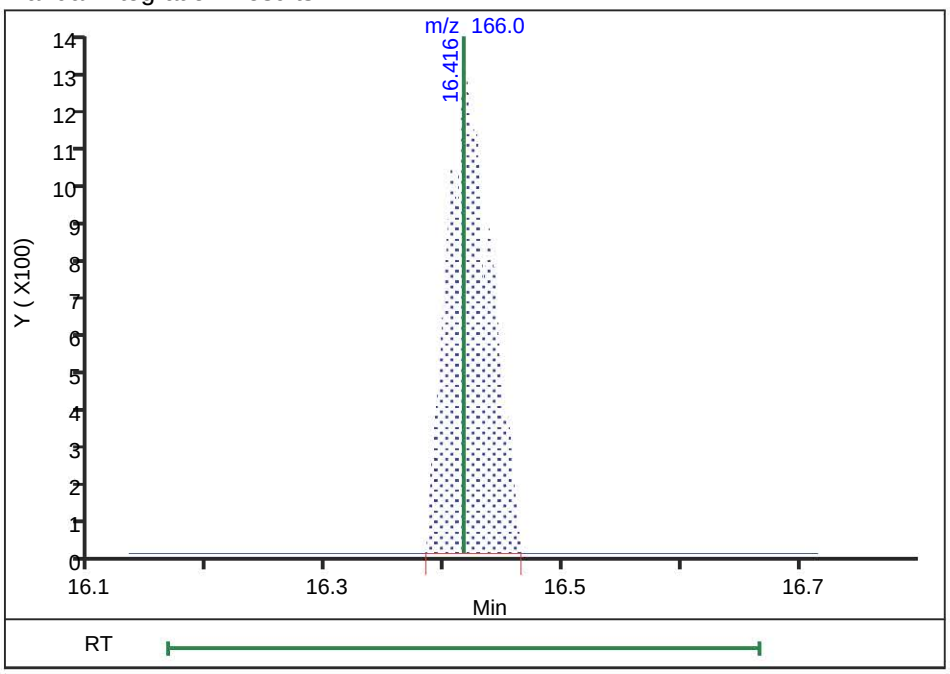
Processing Integration Results

RT: 16.42
Area: 2401
Amount: 0.057778
Amount Units: ppb v/v



Manual Integration Results

RT: 16.42
Area: 3173
Amount: 0.076356
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:08:20
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

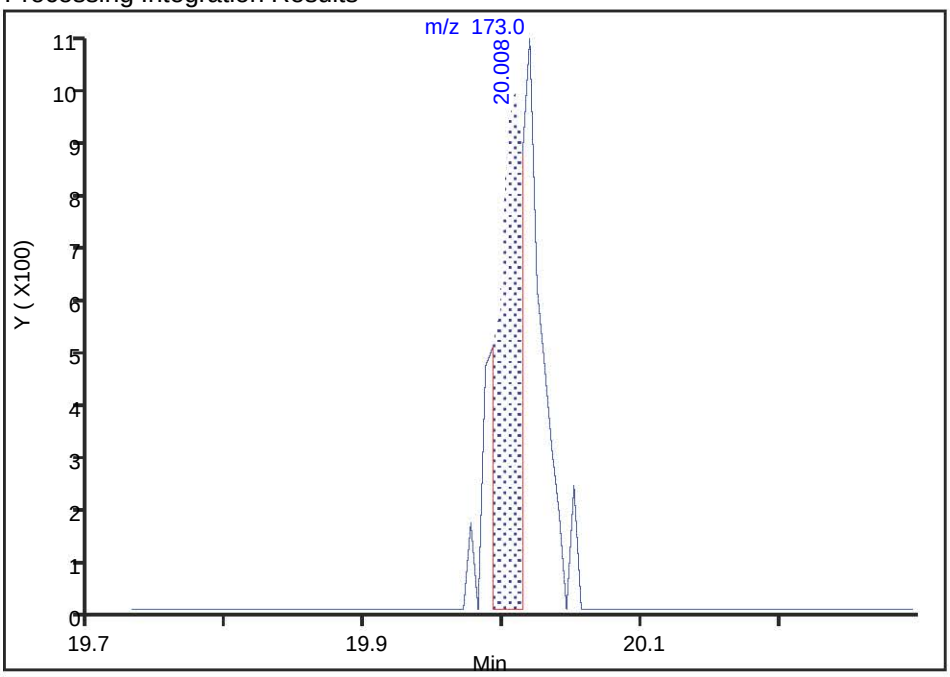
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

81 Bromoform, CAS: 75-25-2

Signal: 1

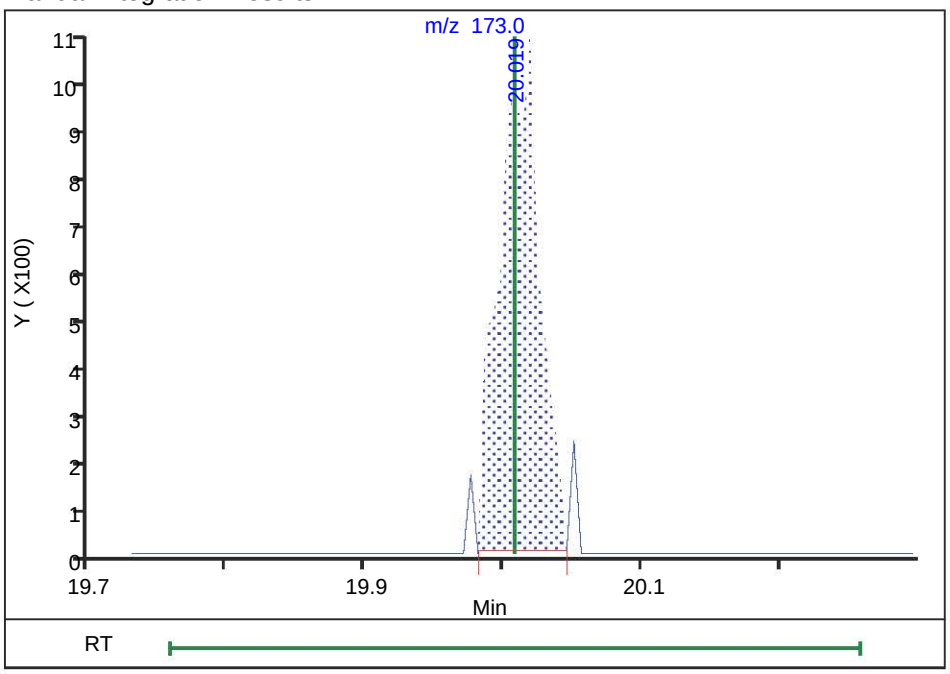
Processing Integration Results

RT: 20.01
Area: 1133
Amount: 0.026548
Amount Units: ppb v/v



Manual Integration Results

RT: 20.02
Area: 2033
Amount: 0.047637
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:08:34
Audit Action: Manually Integrated Audit Reason: Assign Peak

Manual Integration/User Assign Peak Report

TestAmerica Burlington

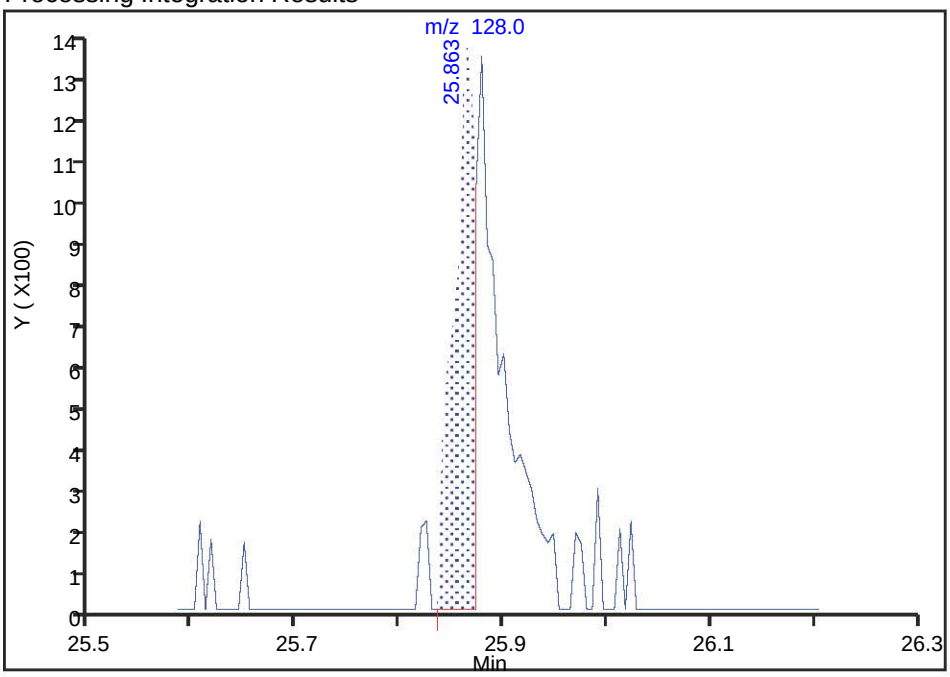
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190129-34352.b\34352-05.D				
Injection Date:	29-Jan-2019 15:06:30	Instrument ID:	CHC.i		
Lims ID:	200-47143-A-3	Lab Sample ID:	200-47143-3		
Client ID:	5034				
Operator ID:	ggg	ALS Bottle#:	4	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

105 Naphthalene, CAS: 91-20-3

Signal: 1

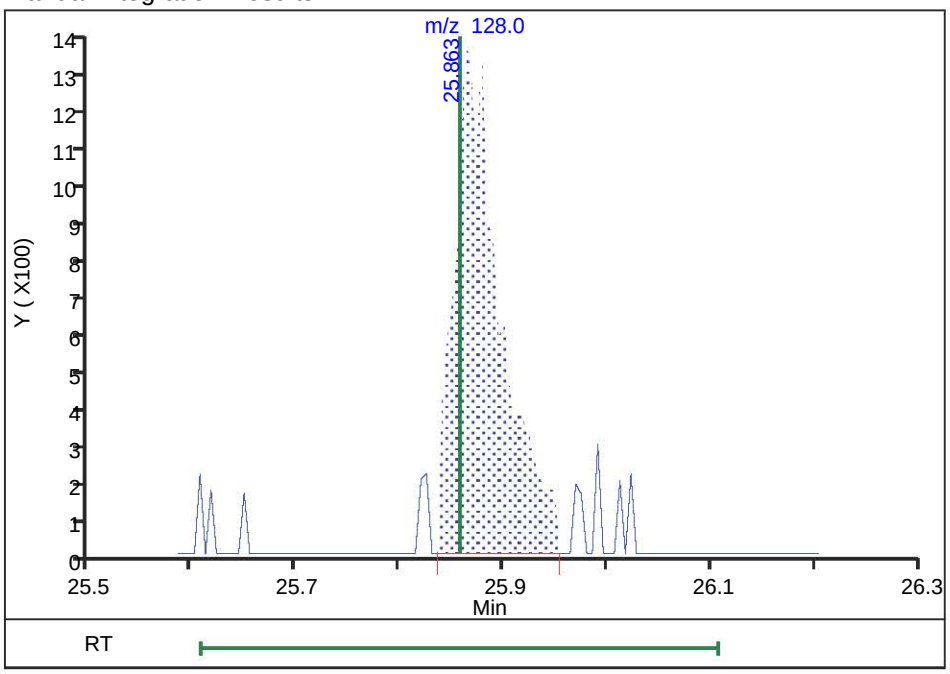
Processing Integration Results

RT: 25.86
Area: 1928
Amount: 0.017716
Amount Units: ppb v/v



Manual Integration Results

RT: 25.86
Area: 3988
Amount: 0.036644
Amount Units: ppb v/v



Reviewer: puangmaleek, 30-Jan-2019 14:03:31

Audit Action: Manually Integrated Audit Reason: Assign Peak

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47202-1

SDG No.:

Client Sample ID: 3667 Lab Sample ID: 200-47202-7

Matrix: Air Lab File ID: 34379-06.D

Analysis Method: TO-15 Date Collected: 01/29/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/31/2019 17:29

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139590 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
115-07-1	Propylene	1.0	U	1.0	1.0
75-71-8	Dichlorodifluoromethane	0.10	U	0.10	0.10
75-45-6	Freon 22	0.10	U	0.10	0.10
76-14-2	1,2-Dichlorotetrafluoroethane	0.040	U	0.040	0.040
74-87-3	Chloromethane	0.10	U	0.10	0.10
106-97-8	n-Butane	0.10	U	0.10	0.10
75-01-4	Vinyl chloride	0.040	U	0.040	0.040
106-99-0	1,3-Butadiene	0.040	U	0.040	0.040
74-83-9	Bromomethane	0.040	U	0.040	0.040
75-00-3	Chloroethane	0.10	U	0.10	0.10
593-60-2	Bromoethene(Vinyl Bromide)	0.040	U	0.040	0.040
75-69-4	Trichlorofluoromethane	0.040	U	0.040	0.040
64-17-5	Ethanol	1.0	U	1.0	1.0
76-13-1	Freon TF	0.040	U	0.040	0.040
75-35-4	1,1-Dichloroethene	0.040	U	0.040	0.040
67-64-1	Acetone	1.0	U	1.0	1.0
67-63-0	Isopropyl alcohol	1.0	U	1.0	1.0
75-15-0	Carbon disulfide	0.10	U *	0.10	0.10
107-05-1	3-Chloropropene	0.10	U	0.10	0.10
75-09-2	Methylene Chloride	0.10	U	0.10	0.10
75-65-0	tert-Butyl alcohol	1.0	U	1.0	1.0
1634-04-4	Methyl tert-butyl ether	0.040	U	0.040	0.040
156-60-5	trans-1,2-Dichloroethene	0.040	U	0.040	0.040
110-54-3	n-Hexane	0.040	U	0.040	0.040
75-34-3	1,1-Dichloroethane	0.040	U	0.040	0.040
108-05-4	Vinyl acetate	1.0	U	1.0	1.0
141-78-6	Ethyl acetate	1.0	U	1.0	1.0
78-93-3	Methyl Ethyl Ketone	0.10	U	0.10	0.10
156-59-2	cis-1,2-Dichloroethene	0.040	U	0.040	0.040
540-59-0	1,2-Dichloroethene, Total	0.080	U	0.080	0.080
67-66-3	Chloroform	0.040	U	0.040	0.040
109-99-9	Tetrahydrofuran	1.0	U	1.0	1.0
71-55-6	1,1,1-Trichloroethane	0.040	U	0.040	0.040
110-82-7	Cyclohexane	0.040	U	0.040	0.040
56-23-5	Carbon tetrachloride	0.040	U	0.040	0.040
540-84-1	2,2,4-Trimethylpentane	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47202-1

SDG No.:

Client Sample ID: 3667 Lab Sample ID: 200-47202-7

Matrix: Air Lab File ID: 34379-06.D

Analysis Method: TO-15 Date Collected: 01/29/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/31/2019 17:29

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139590 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
71-43-2	Benzene	0.040	U	0.040	0.040
107-06-2	1,2-Dichloroethane	0.040	U	0.040	0.040
142-82-5	n-Heptane	0.040	U	0.040	0.040
79-01-6	Trichloroethene	0.040	U	0.040	0.040
80-62-6	Methyl methacrylate	0.10	U	0.10	0.10
78-87-5	1,2-Dichloropropane	0.040	U	0.040	0.040
123-91-1	1,4-Dioxane	1.0	U	1.0	1.0
75-27-4	Bromodichloromethane	0.040	U	0.040	0.040
10061-01-5	cis-1,3-Dichloropropene	0.040	U	0.040	0.040
108-10-1	methyl isobutyl ketone	0.10	U	0.10	0.10
108-88-3	Toluene	0.040	U	0.040	0.040
10061-02-6	trans-1,3-Dichloropropene	0.040	U	0.040	0.040
79-00-5	1,1,2-Trichloroethane	0.040	U	0.040	0.040
127-18-4	Tetrachloroethene	0.040	U	0.040	0.040
591-78-6	Methyl Butyl Ketone (2-Hexanone)	0.10	U	0.10	0.10
124-48-1	Dibromochloromethane	0.040	U	0.040	0.040
106-93-4	1,2-Dibromoethane	0.040	U	0.040	0.040
108-90-7	Chlorobenzene	0.040	U	0.040	0.040
100-41-4	Ethylbenzene	0.040	U	0.040	0.040
179601-23-1	m,p-Xylene	0.10	U	0.10	0.10
95-47-6	Xylene, o-	0.040	U	0.040	0.040
1330-20-7	Xylene (total)	0.14	U	0.14	0.14
100-42-5	Styrene	0.040	U	0.040	0.040
75-25-2	Bromoform	0.040	U	0.040	0.040
98-82-8	Cumene	0.040	U	0.040	0.040
79-34-5	1,1,2,2-Tetrachloroethane	0.040	U	0.040	0.040
103-65-1	n-Propylbenzene	0.040	U	0.040	0.040
622-96-8	4-Ethyltoluene	0.040	U	0.040	0.040
108-67-8	1,3,5-Trimethylbenzene	0.040	U	0.040	0.040
95-49-8	2-Chlorotoluene	0.040	U	0.040	0.040
98-06-6	tert-Butylbenzene	0.040	U	0.040	0.040
95-63-6	1,2,4-Trimethylbenzene	0.040	U	0.040	0.040
135-98-8	sec-Butylbenzene	0.040	U	0.040	0.040
99-87-6	4-Isopropyltoluene	0.040	U	0.040	0.040
541-73-1	1,3-Dichlorobenzene	0.040	U	0.040	0.040
106-46-7	1,4-Dichlorobenzene	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47202-1

SDG No.:

Client Sample ID: 3667 Lab Sample ID: 200-47202-7

Matrix: Air Lab File ID: 34379-06.D

Analysis Method: TO-15 Date Collected: 01/29/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 01/31/2019 17:29

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 139590 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
100-44-7	Benzyl chloride	0.040	U	0.040	0.040
104-51-8	n-Butylbenzene	0.040	U	0.040	0.040
95-50-1	1,2-Dichlorobenzene	0.040	U	0.040	0.040
120-82-1	1,2,4-Trichlorobenzene	0.10	U	0.10	0.10
87-68-3	Hexachlorobutadiene	0.040	U	0.040	0.040
91-20-3	Naphthalene	0.10	U	0.10	0.10

TestAmerica Burlington
Target Compound Quantitation Report

Data File: \\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D
Lims ID: 200-47202-A-7
Client ID: 3667
Sample Type: Client
Inject. Date: 31-Jan-2019 17:29:30 ALS Bottle#: 5 Worklist Smp#: 6
Purge Vol: 200.000 mL Dil. Factor: 0.2000
Sample Info: 200-0034379-006
Misc. Info.: 47202-07
Operator ID: ert Instrument ID: CHB.i

Method: \\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\TO15_LLNJ_TO3.m
Limit Group: AI_TO15_ICAL
Last Update: 01-Feb-2019 10:30:53 Calib Date: 10-Jan-2019 13:03:30
Integrator: RTE ID Type: Deconvolution ID
Quant Method: Internal/External Standard Quant By: Initial Calibration
Last ICal File: \\chromna\Burlington\ChromData\CHB.i\20190109-34081.b\34081-16.D

Column 1 : RTX-624 (0.32 mm) Det: MS SCAN
Process Host: CTX0314

First Level Reviewer: puangmaleek Date: 01-Feb-2019 10:30:52

Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
1 Propene	41		3.134				ND	
2 Dichlorodifluoromethane	85		3.193				ND	
3 Chlorodifluoromethane	51		3.225				ND	
4 1,2-Dichloro-1,1,2,2-tetra	85		3.407				ND	
5 Chloromethane	50		3.529				ND	U
6 Butane	43		3.706				ND	
7 Vinyl chloride	62		3.743				ND	
8 Butadiene	54		3.807				ND	
10 Bromomethane	94		4.463				ND	
11 Chloroethane	64		4.688				ND	
13 Vinyl bromide	106		5.098				ND	
14 Trichlorofluoromethane	101		5.195				ND	
16 Ethanol	45	5.717	5.717	0.057	36	1730	0.1585	7M
19 1,1,2-Trichloro-1,2,2-trif	101		6.219				ND	U
20 1,1-Dichloroethene	96		6.289				ND	
21 Acetone	43		6.433				ND	
22 Isopropyl alcohol	45		6.657				ND	U
23 Carbon disulfide	76	6.737	6.737	0.016	97	5327	0.0416	7M
24 3-Chloro-1-propene	41		6.983				ND	U
27 Methylene Chloride	49	7.239	7.239	-0.001	79	1079	0.0265	7M
28 2-Methyl-2-propanol	59		7.356				ND	
29 Methyl tert-butyl ether	73		7.591				ND	
30 trans-1,2-Dichloroethene	61		7.655				ND	
32 Hexane	57	7.991	7.986	0.005	90	8718	0.1195	
33 1,1-Dichloroethane	63		8.386				ND	
34 Vinyl acetate	43		8.542				ND	
36 2-Butanone (MEK)	72		9.277				ND	
37 cis-1,2-Dichloroethene	96		9.288				ND	
35 Ethyl acetate	88		9.299				ND	
* 39 Chlorobromomethane	128	9.656	9.656	0.000	76	395392	10.0	
38 Tetrahydrofuran	42		9.672				ND	

	Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
	40 Chloroform	83		9.736				ND	
	42 1,1,1-Trichloroethane	97		9.992				ND	
S	41 1,2-Dichloroethene, Total	61		10.000				ND	
	43 Cyclohexane	84		10.008				ND	
	44 Carbon tetrachloride	117		10.201				ND	
	45 Isooctane	57		10.483				ND	
	46 Benzene	78		10.521				ND	
	47 1,2-Dichloroethane	62		10.617				ND	
	48 n-Heptane	43		10.740				ND	
*	50 1,4-Difluorobenzene	114	11.060	11.065	-0.005	93	1701243	10.0	
	53 Trichloroethene	95		11.433				ND	
	54 1,2-Dichloropropane	63		11.802				ND	
	55 Methyl methacrylate	69		11.839				ND	
	56 1,4-Dioxane	88		11.930				ND	U
	57 Dibromomethane	174		11.988				ND	
	58 Dichlorobromomethane	83		12.159				ND	
	60 cis-1,3-Dichloropropene	75		12.784				ND	
	61 4-Methyl-2-pentanone (MIBK	43		12.933				ND	
	64 Toluene	92		13.216				ND	
	66 trans-1,3-Dichloropropene	75		13.573				ND	
	67 1,1,2-Trichloroethane	83		13.846				ND	
	68 Tetrachloroethene	166		13.995				ND	
	69 2-Hexanone	43		14.107				ND	U
	70 Chlorodibromomethane	129		14.406				ND	
	71 Ethylene Dibromide	107		14.609				ND	
*	72 Chlorobenzene-d5	117	15.169	15.175	-0.006	82	1473918	10.0	
	73 Chlorobenzene	112		15.212				ND	
	74 Ethylbenzene	91	15.287	15.281	0.006	94	6562	0.0311	
	76 m-Xylene & p-Xylene	106		15.431				ND	
	78 o-Xylene	106		15.943				ND	
	79 Styrene	104		15.964				ND	U
S	77 Xylenes, Total	106		16.000				ND	
	80 Bromoform	173		16.258				ND	
	81 Isopropylbenzene	105		16.354				ND	U
	83 1,1,2,2-Tetrachloroethane	83		16.760				ND	
	84 N-Propylbenzene	91		16.834				ND	U
	87 4-Ethyltoluene	105		16.962				ND	U
	88 2-Chlorotoluene	91		17.000				ND	U
	89 1,3,5-Trimethylbenzene	105		17.026				ND	
	91 tert-Butylbenzene	119		17.400				ND	U
	92 1,2,4-Trimethylbenzene	105	17.480	17.480	0.005	1	692	0.003662	7a
	93 sec-Butylbenzene	105		17.656				ND	U
	94 4-Isopropyltoluene	119		17.811				ND	U
	95 1,3-Dichlorobenzene	146		17.886				ND	
	96 1,4-Dichlorobenzene	146		17.998				ND	
	97 Benzyl chloride	91		18.147				ND	
	99 n-Butylbenzene	91		18.313				ND	
	100 1,2-Dichlorobenzene	146		18.478				ND	
	103 1,2,4-Trichlorobenzene	180		20.826				ND	
	104 Hexachlorobutadiene	225		20.992				ND	
	105 Naphthalene	128		21.301				ND	

QC Flag Legend

Processing Flags

7 - Failed Limit of Detection

Review Flags

M - Manually Integrated

U - Marked Undetected

a - User Assigned ID

Reagents:

ATTO15BISs_00006 Amount Added: 20.00 Units: mL Run Reagent

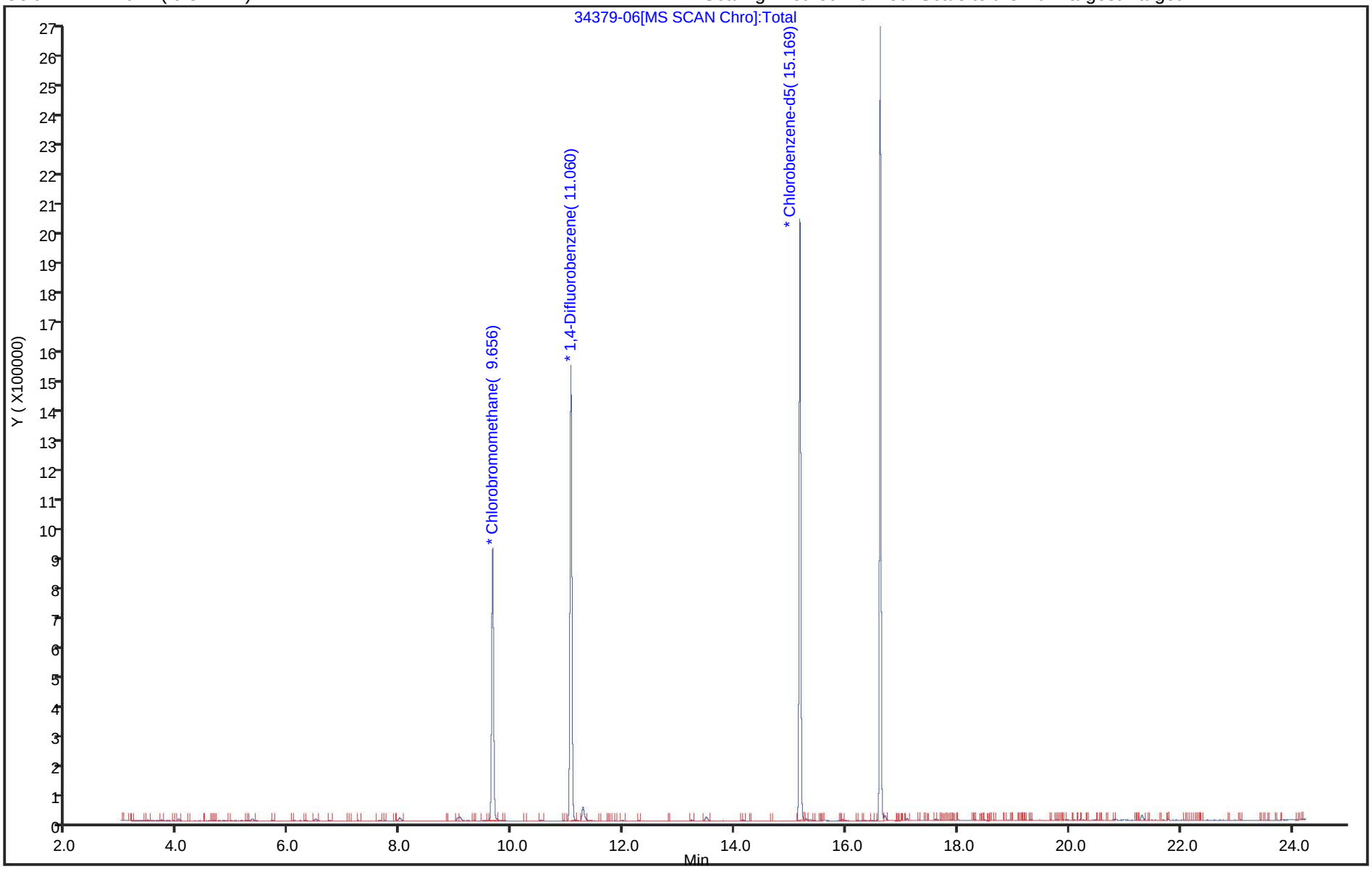
Report Date: 01-Feb-2019 10:30:54 Chrom Revision: 2.3 15-Jan-2019 08:51:34

TestAmerica Burlington

Data File: \\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D

Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i	Operator ID:	ert
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7	Worklist Smp#:	6
Client ID:	3667				
Purge Vol:	200.000 mL	Dil. Factor:	0.2000	ALS Bottle#:	5
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		

Column: RTX-624 (0.32 mm) Y Scaling: Method Defined: Scale to the Nth Largest Target: 1



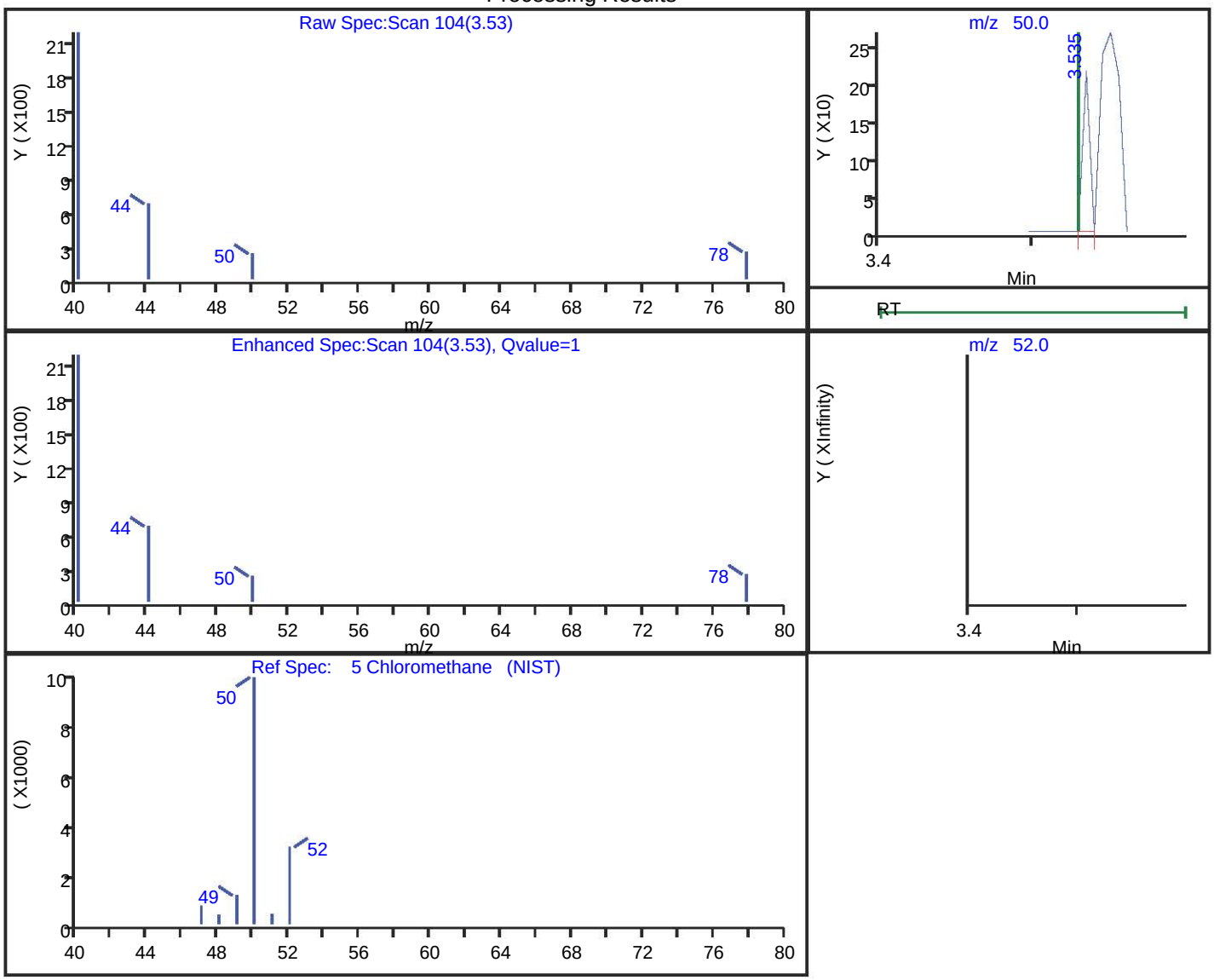
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

5 Chloromethane, CAS: 74-87-3

Processing Results



RT	Mass	Response	Amount
3.53	50.00	68	0.002715
3.53	52.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:25:40

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

Manual Integration/User Assign Peak Report

TestAmerica Burlington

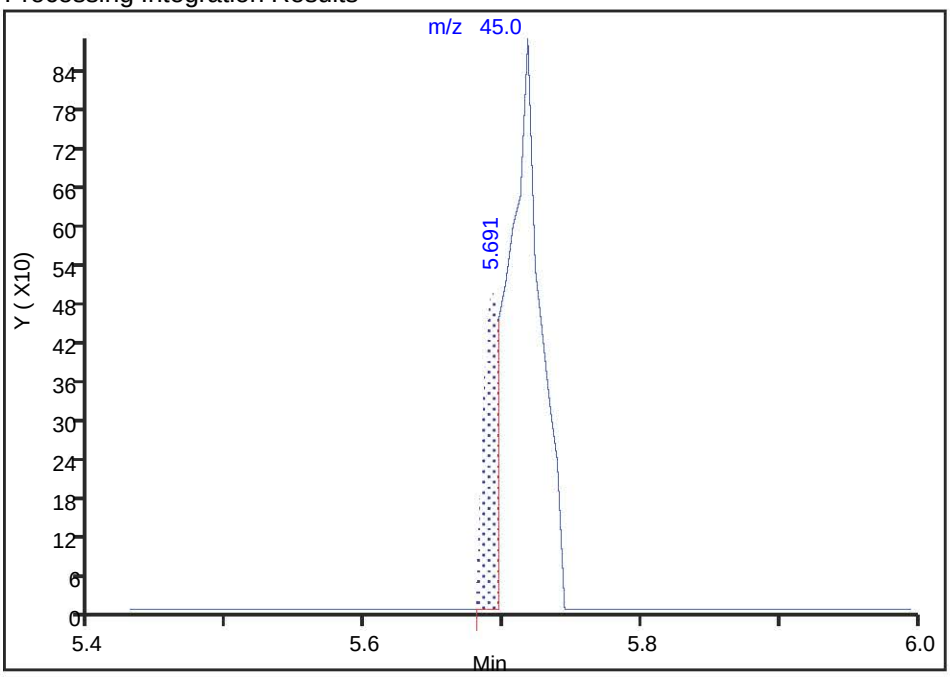
Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

16 Ethanol, CAS: 64-17-5

Signal: 1

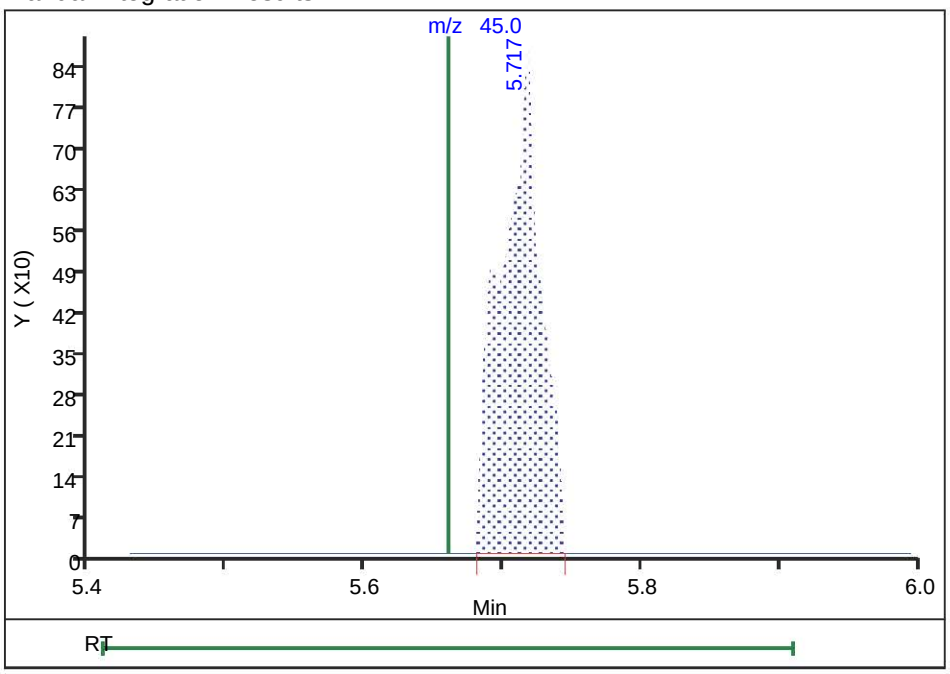
Processing Integration Results

RT: 5.69
Area: 409
Amount: 0.037481
Amount Units: ppb v/v



Manual Integration Results

RT: 5.72
Area: 1730
Amount: 0.158538
Amount Units: ppb v/v



Reviewer: puangmaleek, 01-Feb-2019 10:25:54

Audit Action: Manually Integrated Audit Reason: Assign Peak

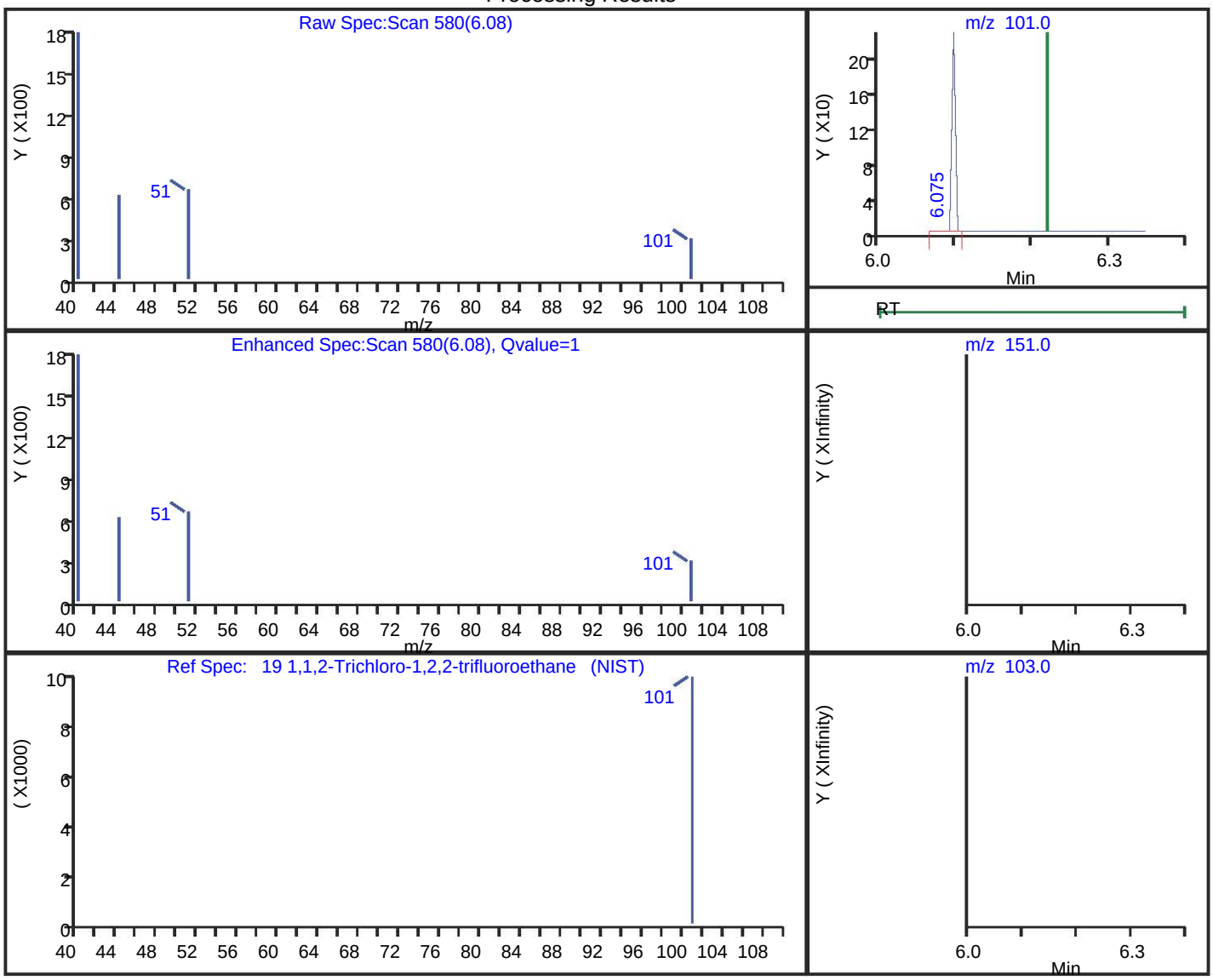
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

19 1,1,2-Trichloro-1,2,2-trifluoroethane, CAS: 76-13-1

Processing Results



RT	Mass	Response	Amount
6.08	101.00	231	0.002474
6.22	151.00	0	
6.22	103.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:25:57

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

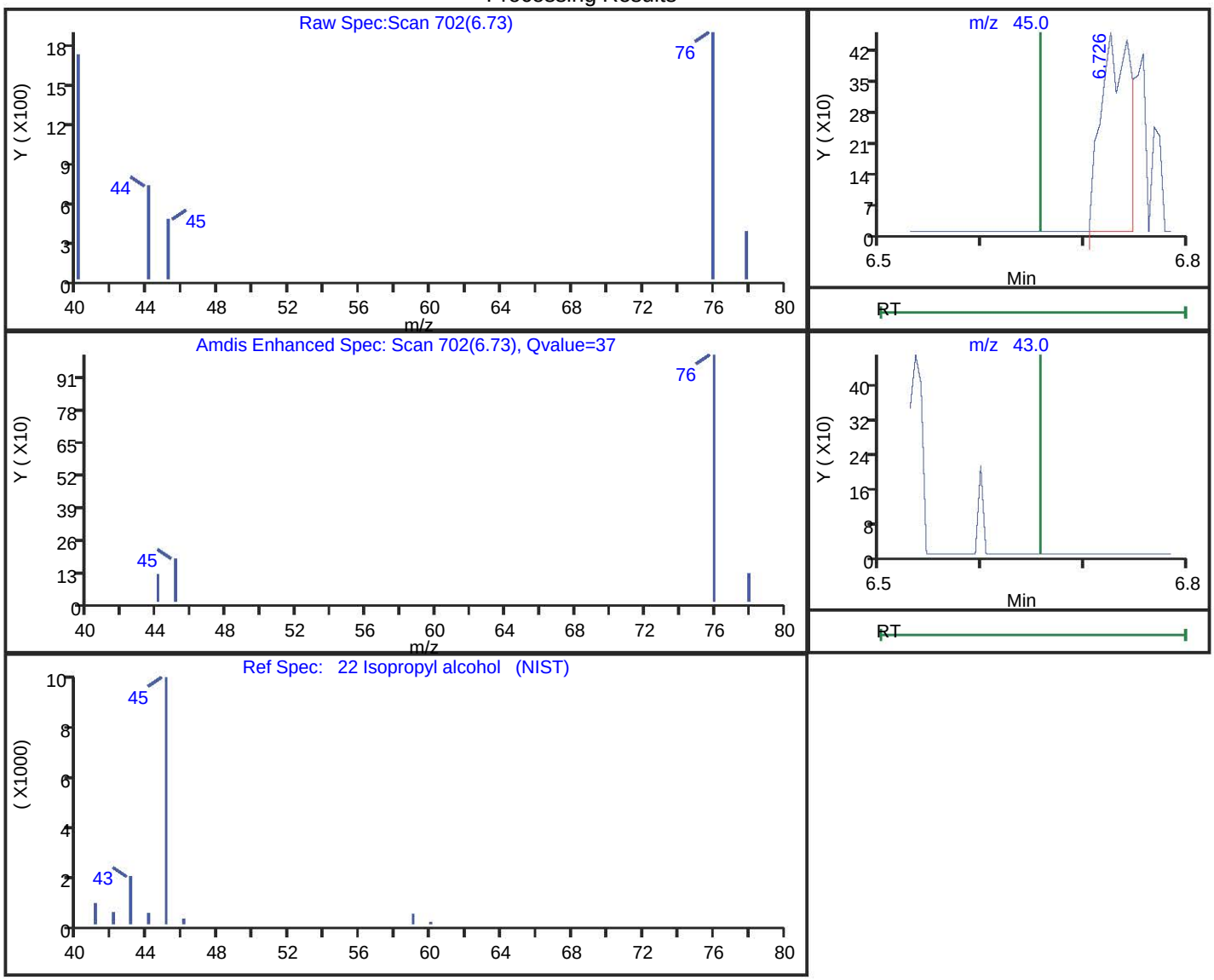
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

22 Isopropyl alcohol, CAS: 67-63-0

Processing Results



RT	Mass	Response	Amount
6.73	45.00	873	0.016943
6.66	43.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:26:01

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

Manual Integration/User Assign Peak Report

TestAmerica Burlington

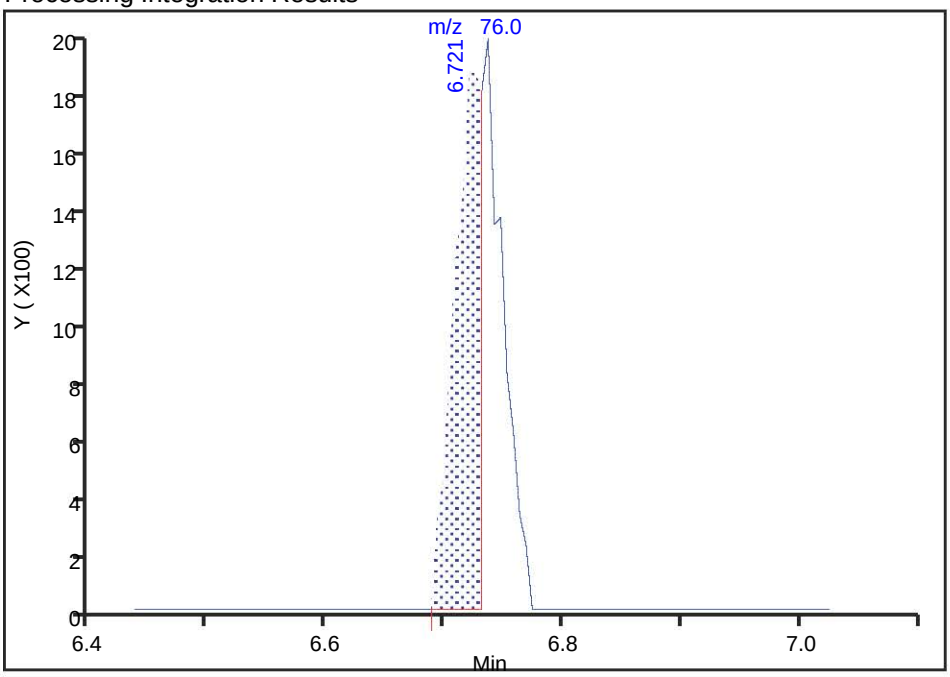
Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

23 Carbon disulfide, CAS: 75-15-0

Signal: 1

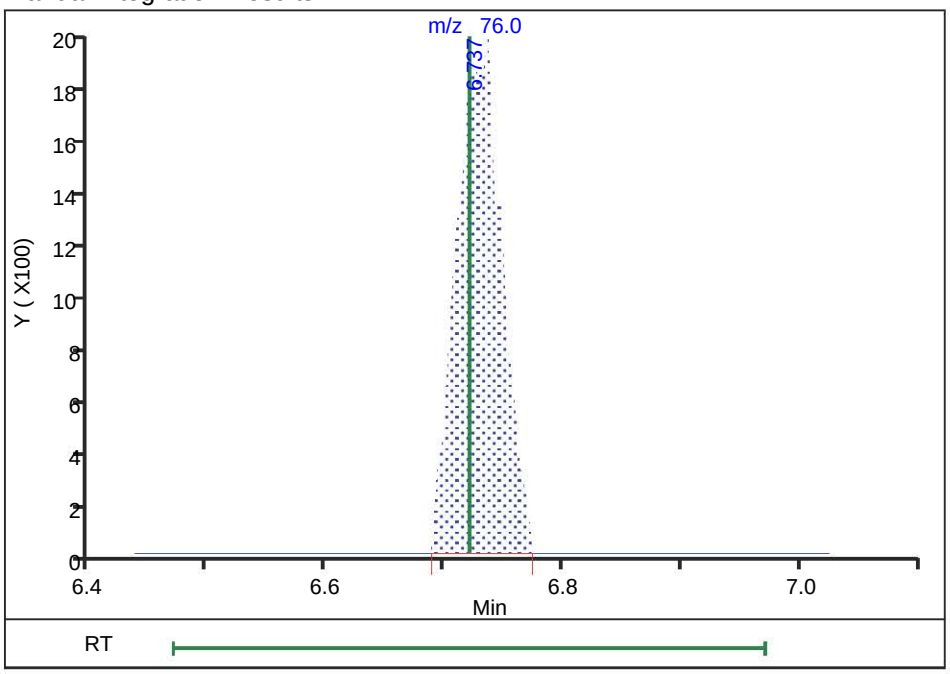
Processing Integration Results

RT: 6.72
Area: 3182
Amount: 0.024870
Amount Units: ppb v/v



Manual Integration Results

RT: 6.74
Area: 5327
Amount: 0.041635
Amount Units: ppb v/v



Reviewer: puangmaleek, 01-Feb-2019 10:26:08
Audit Action: Manually Integrated Audit Reason: Assign Peak

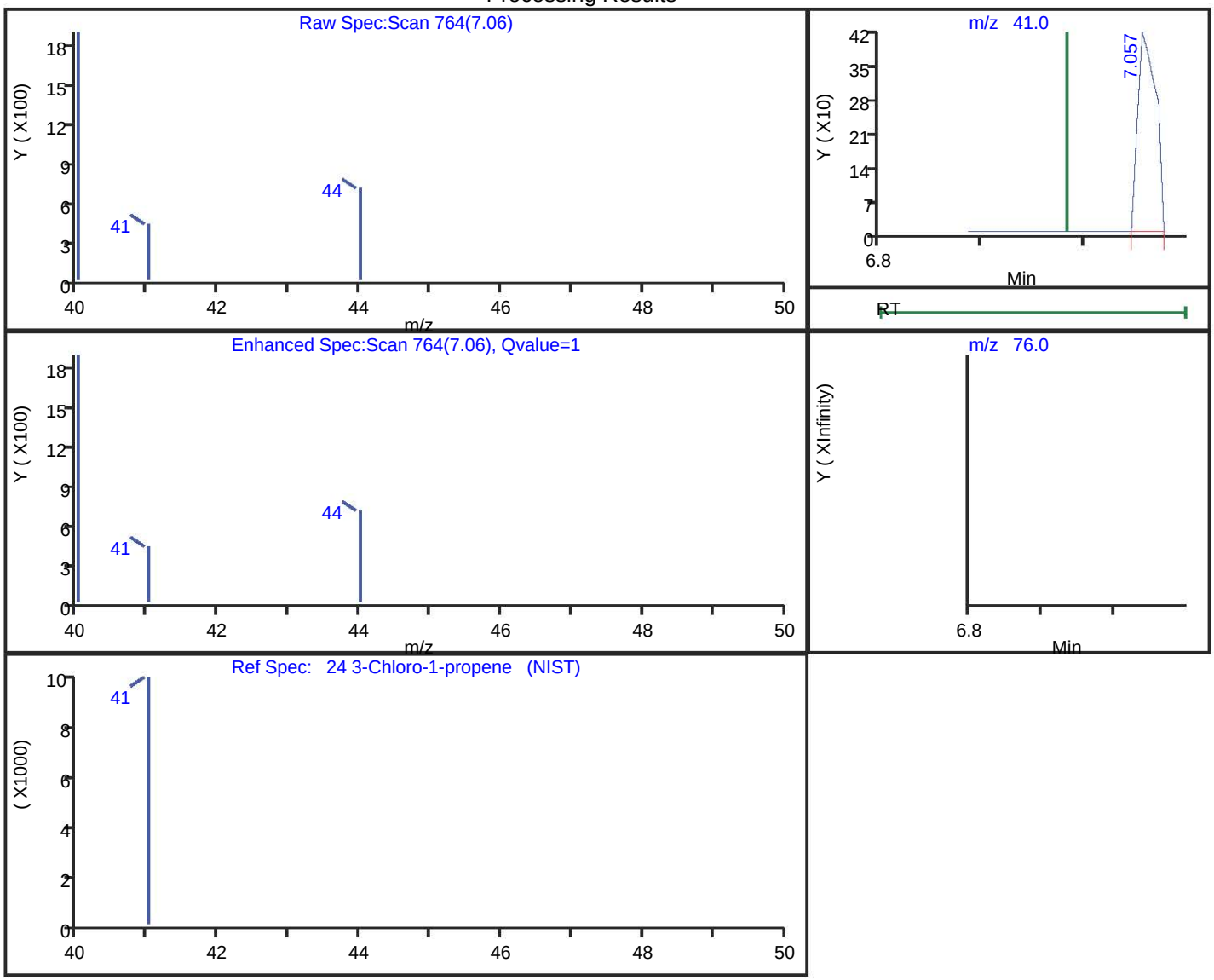
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

24 3-Chloro-1-propene, CAS: 107-05-1

Processing Results



RT	Mass	Response	Amount
7.06	41.00	509	0.011792
6.98	76.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:26:10

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

TestAmerica Burlington

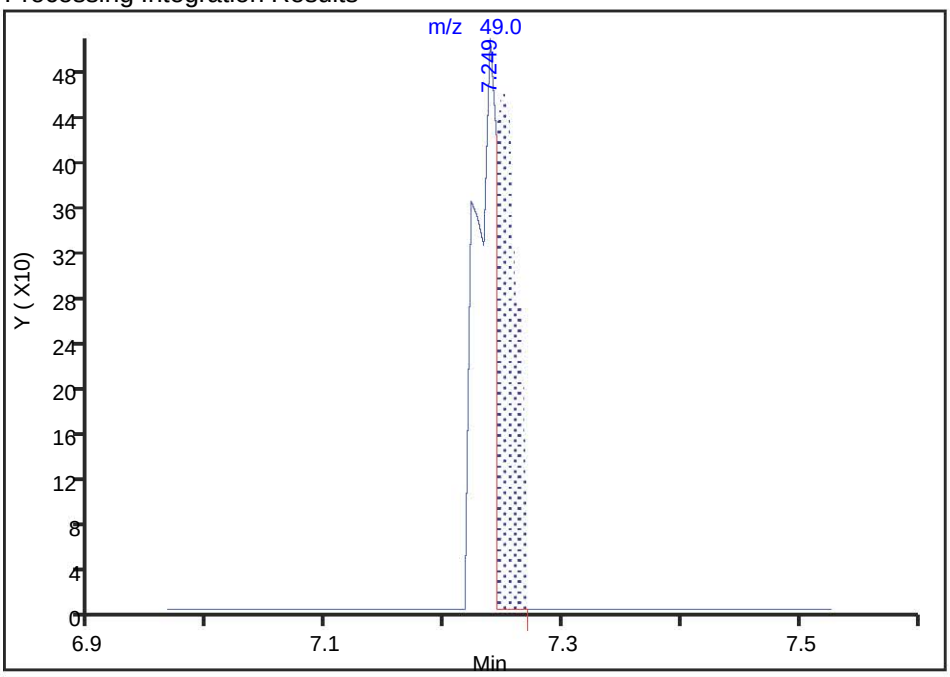
Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

27 Methylene Chloride, CAS: 75-09-2

Signal: 1

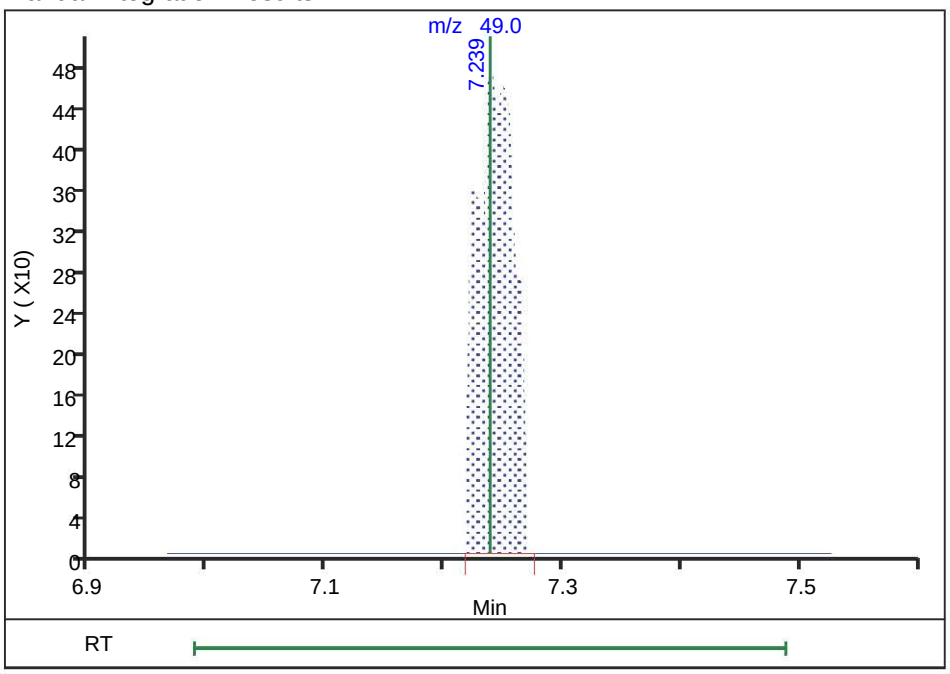
Processing Integration Results

RT: 7.25
Area: 591
Amount: 0.014504
Amount Units: ppb v/v



Manual Integration Results

RT: 7.24
Area: 1079
Amount: 0.026481
Amount Units: ppb v/v



Reviewer: puangmaleek, 01-Feb-2019 10:26:26
Audit Action: Manually Integrated Audit Reason: Assign Peak

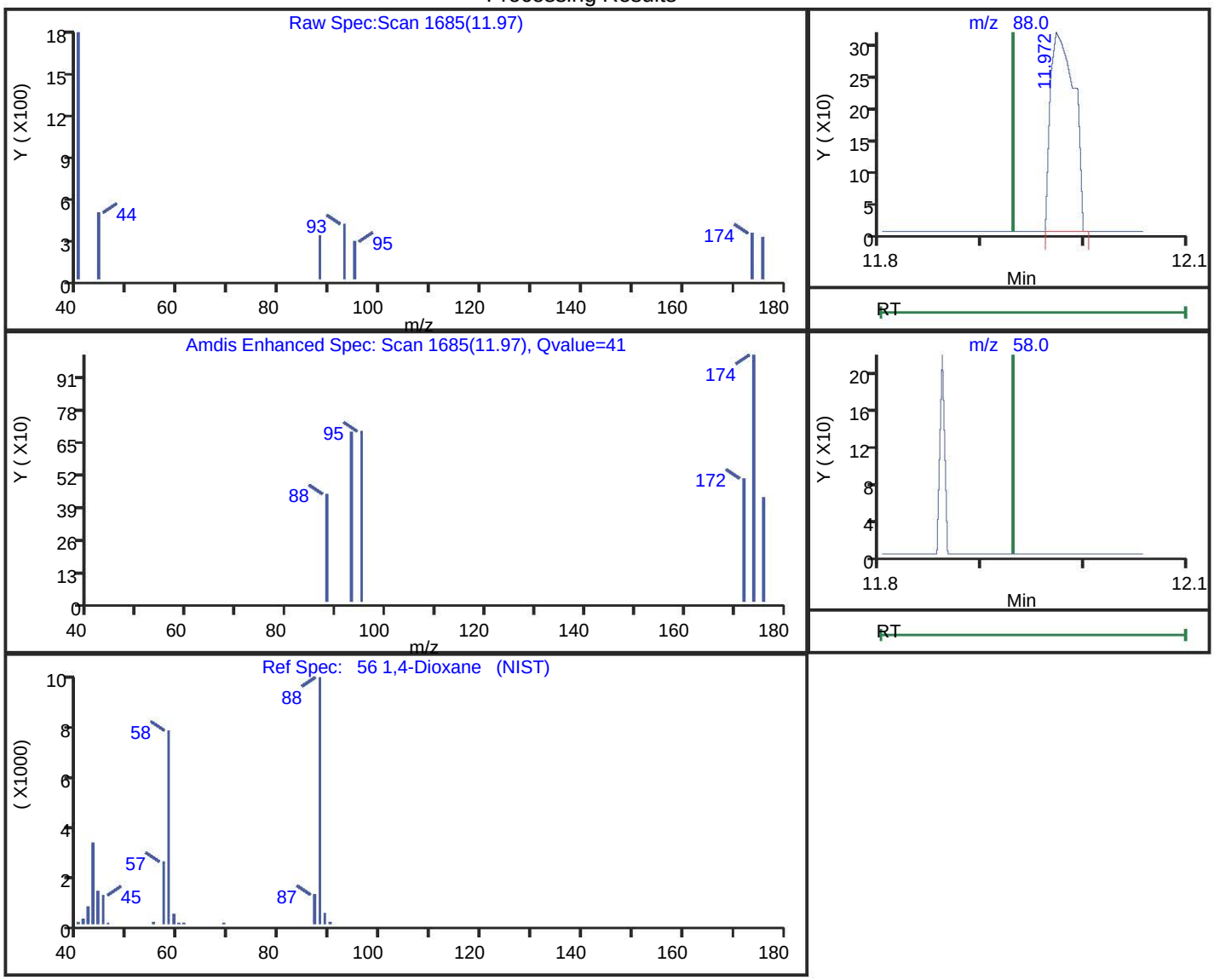
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

56 1,4-Dioxane, CAS: 123-91-1

Processing Results



RT	Mass	Response	Amount
11.97	88.00	502	0.020619
11.93	58.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:27:06

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

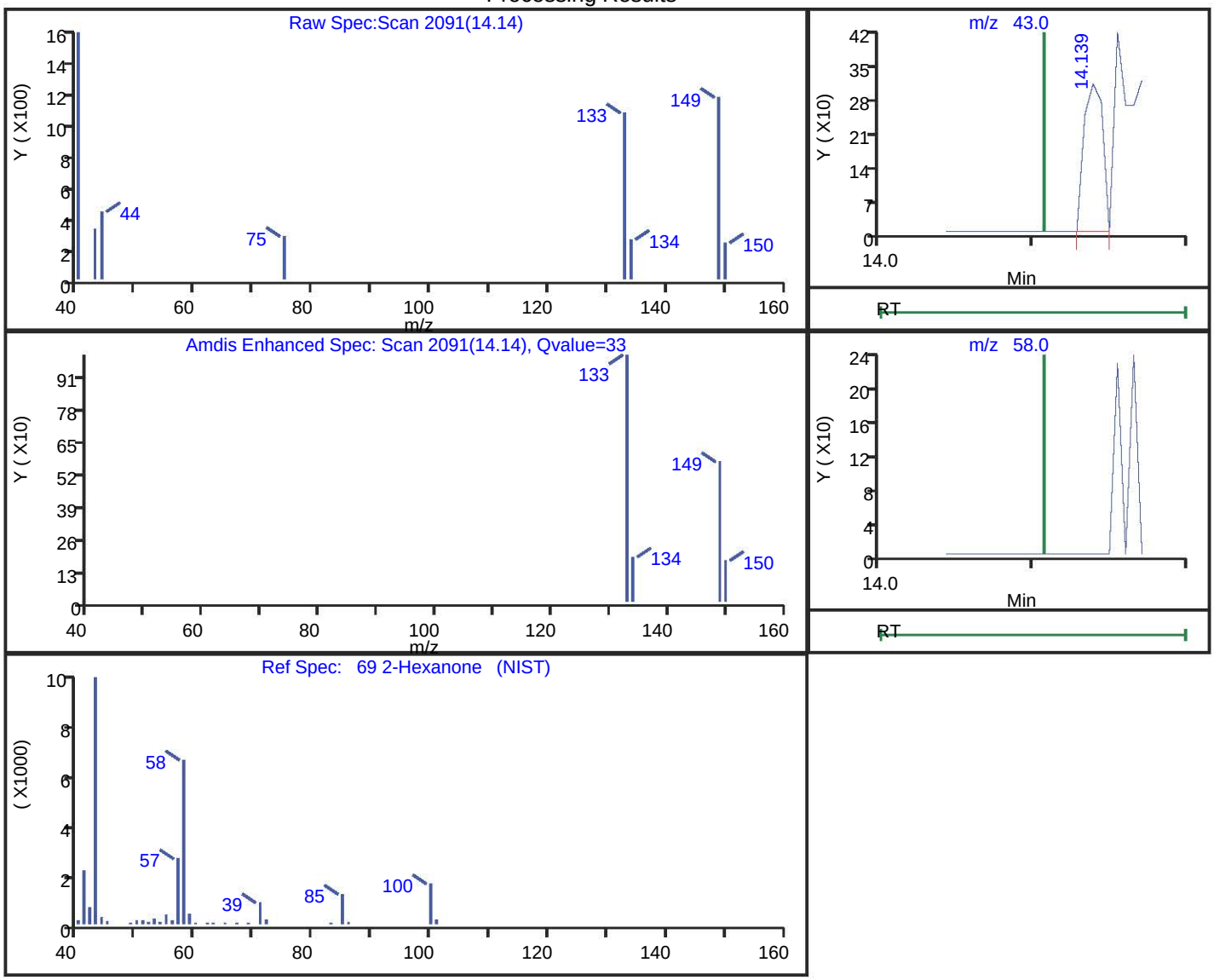
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

69 2-Hexanone, CAS: 591-78-6

Processing Results



RT	Mass	Response	Amount
14.14	43.00	263	0.003810
14.11	58.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:29:46

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

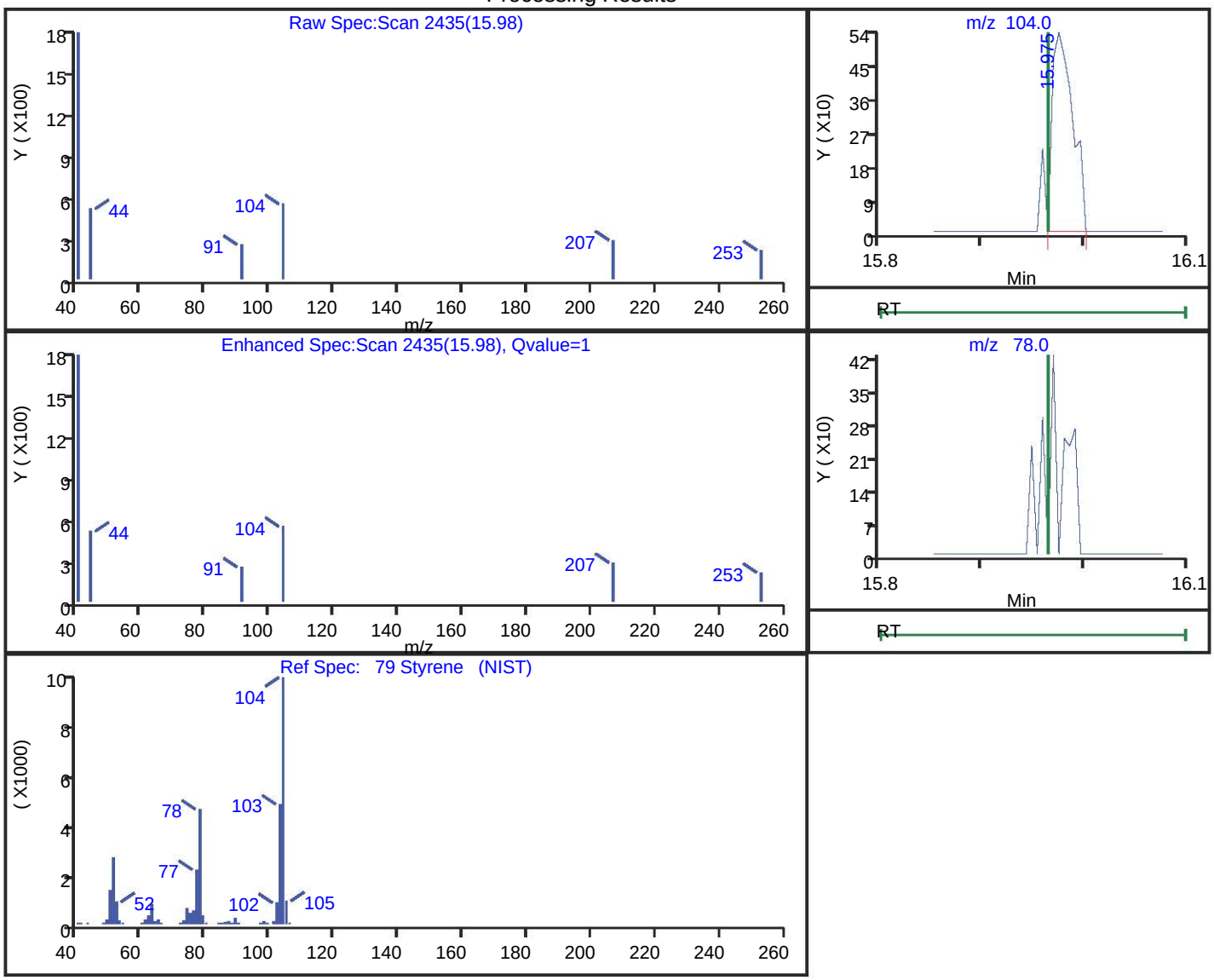
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

79 Styrene, CAS: 100-42-5

Processing Results



RT	Mass	Response	Amount
15.98	104.00	750	0.005632
15.96	78.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:00

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

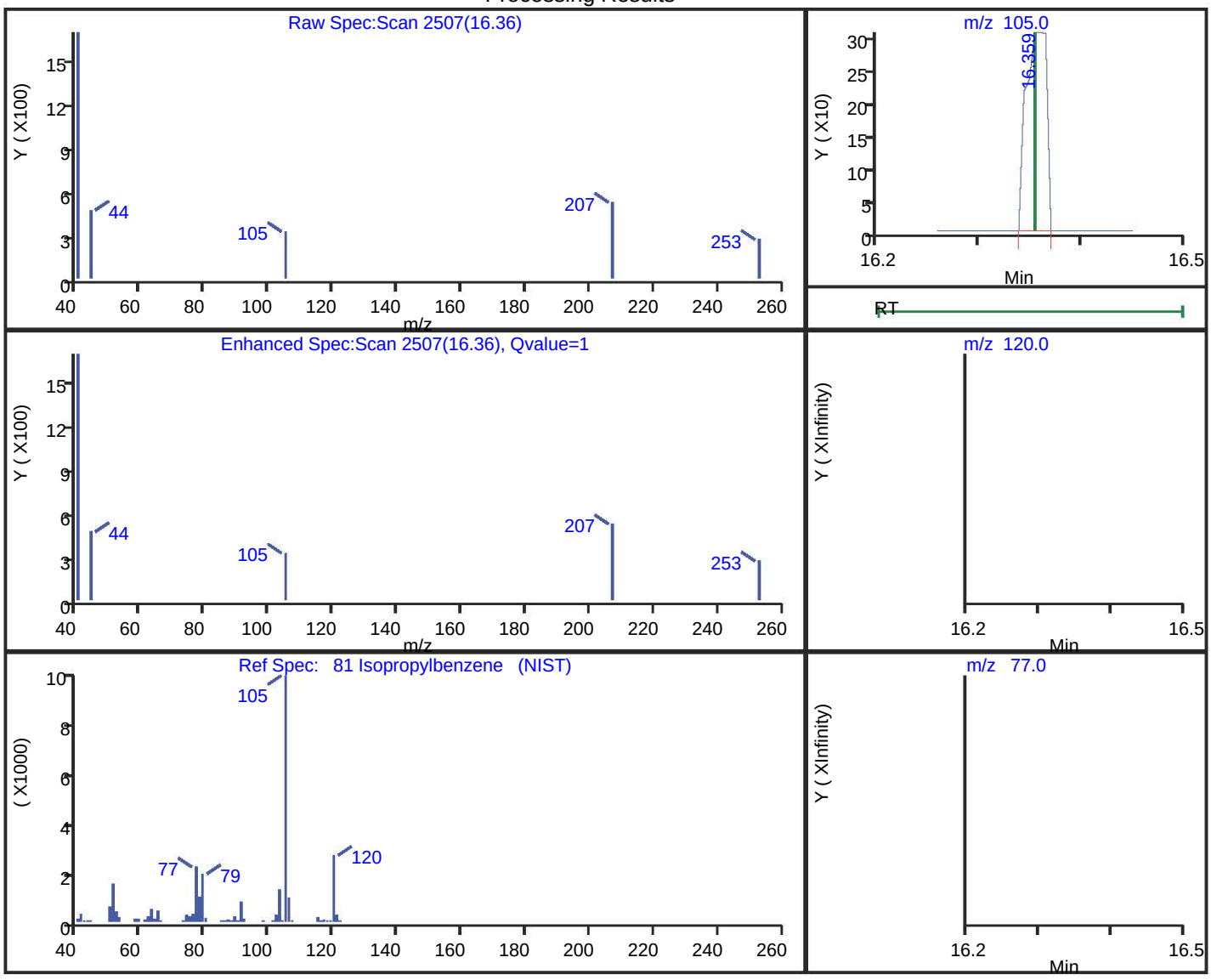
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

81 Isopropylbenzene, CAS: 98-82-8

Processing Results



RT	Mass	Response	Amount
16.36	105.00	437	0.001868
16.35	120.00	0	
16.35	77.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:04

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

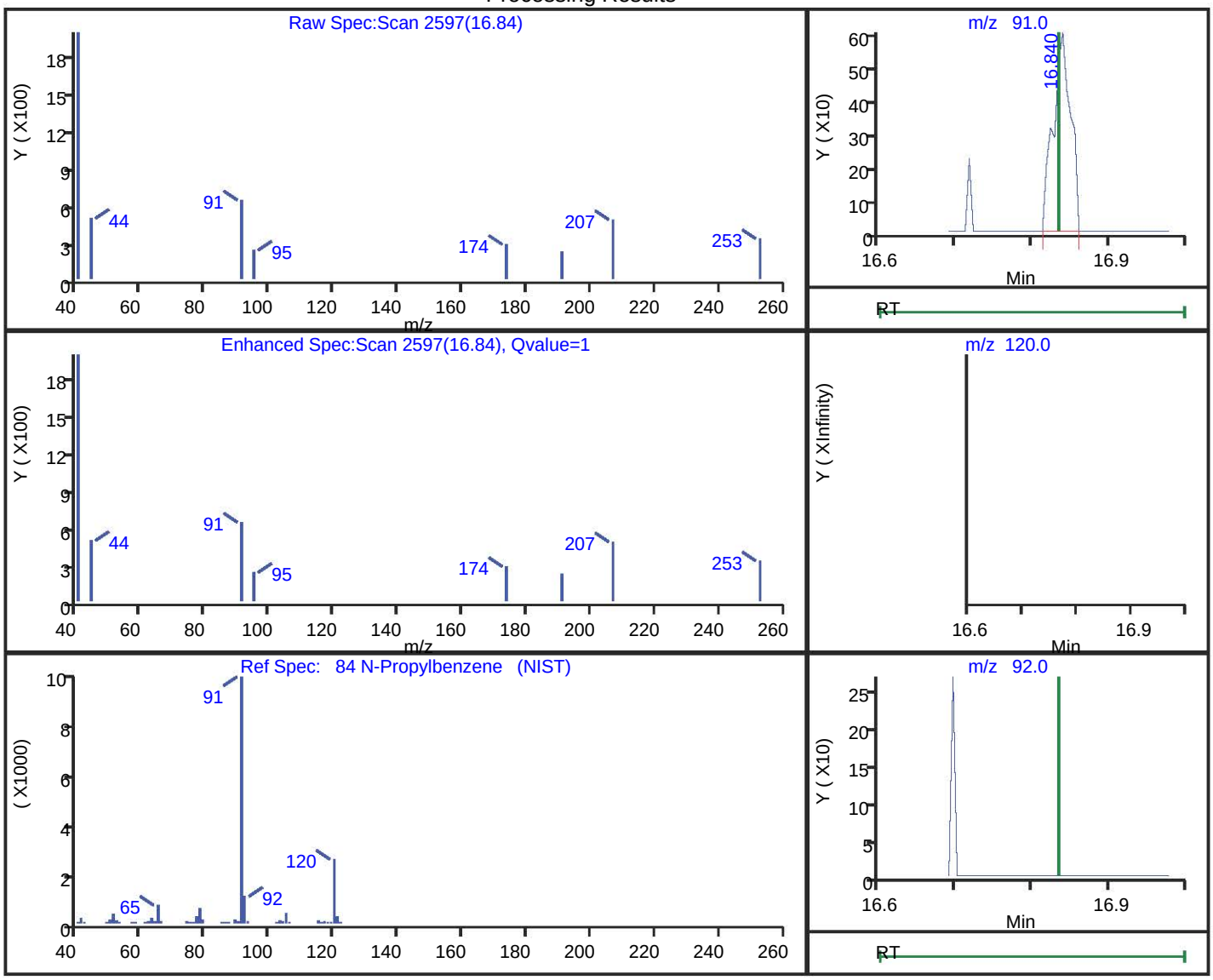
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

84 N-Propylbenzene, CAS: 103-65-1

Processing Results



RT	Mass	Response	Amount
16.84	91.00	969	0.003586
16.83	120.00	0	
16.83	92.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:08

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

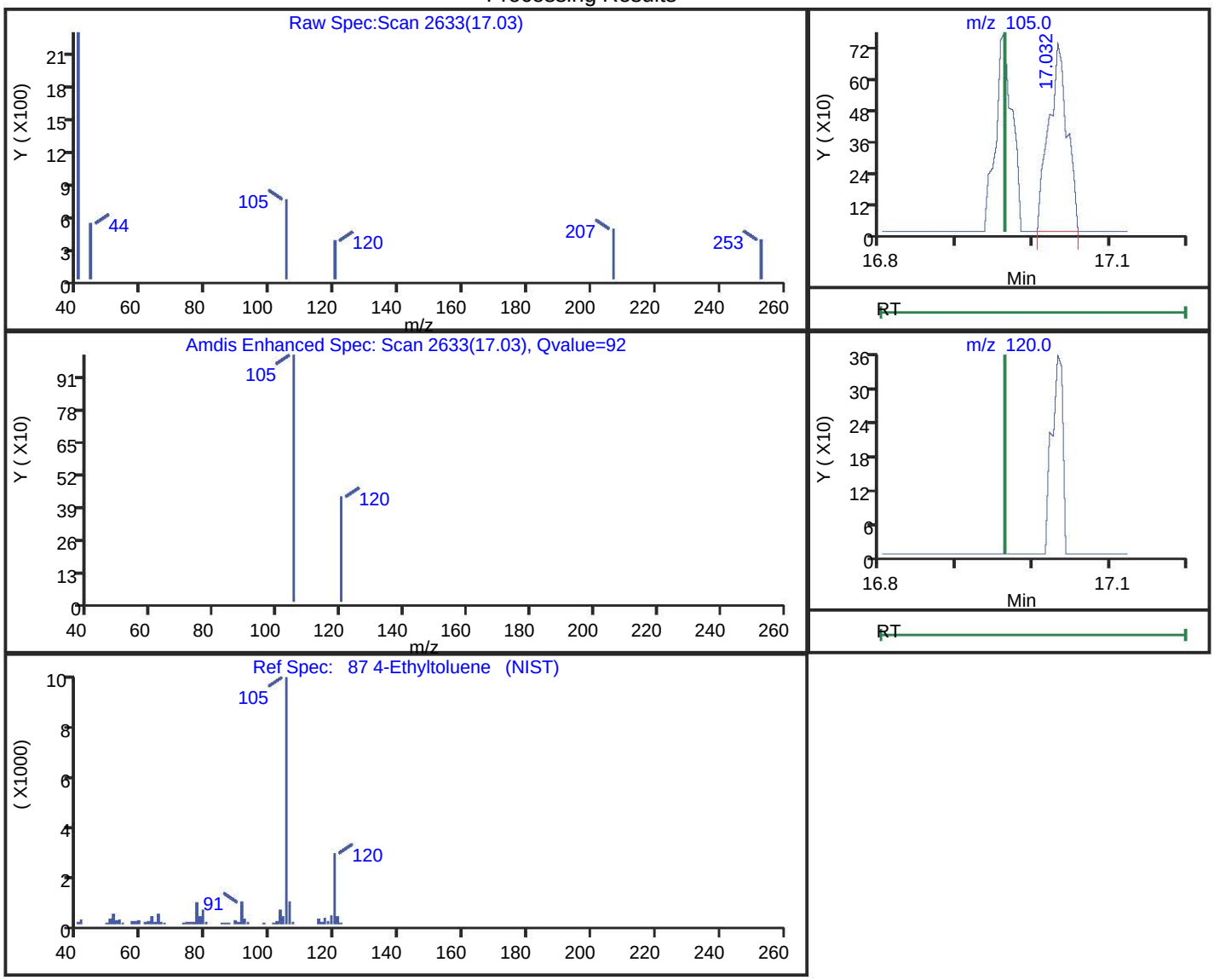
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

87 4-Ethyltoluene, CAS: 622-96-8

Processing Results



RT	Mass	Response	Amount
17.03	105.00	1227	0.005278
16.96	120.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:12

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

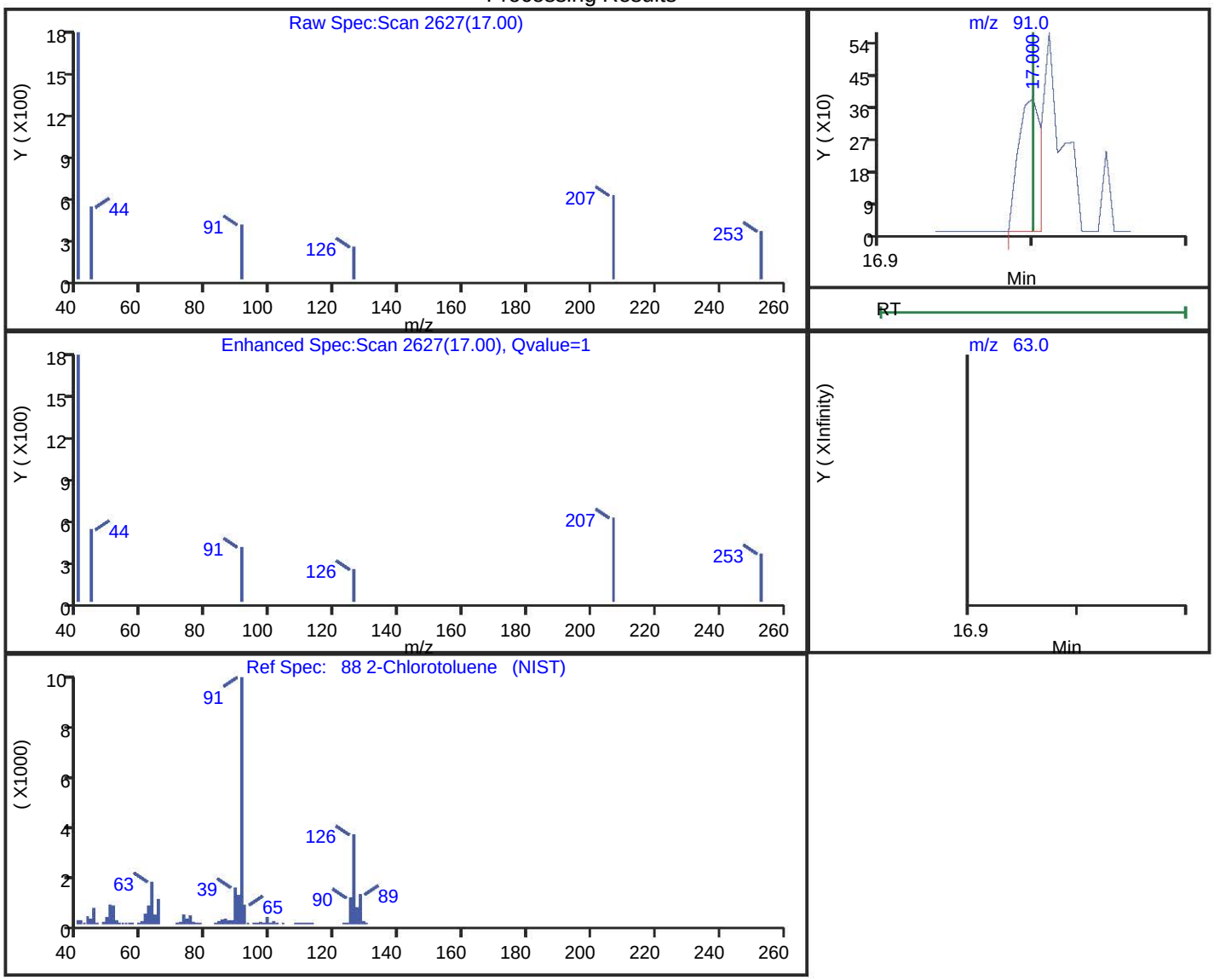
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

88 2-Chlorotoluene, CAS: 95-49-8

Processing Results



RT	Mass	Response	Amount
17.00	91.00	399	0.002183
17.00	63.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:14

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

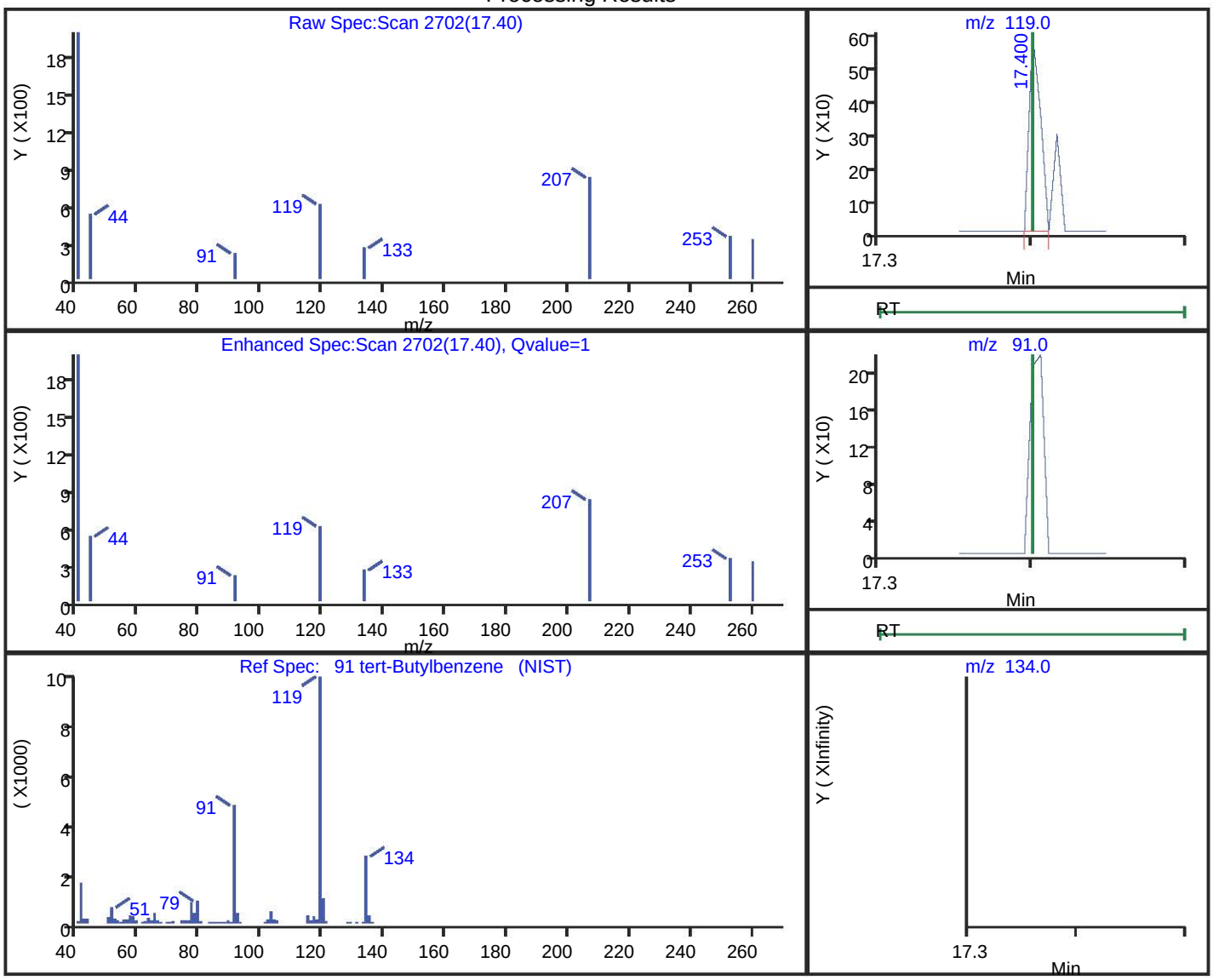
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

91 tert-Butylbenzene, CAS: 98-06-6

Processing Results



RT	Mass	Response	Amount
17.40	119.00	306	0.001661
17.40	91.00	0	
17.40	134.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:18

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

Manual Integration/User Assign Peak Report

TestAmerica Burlington

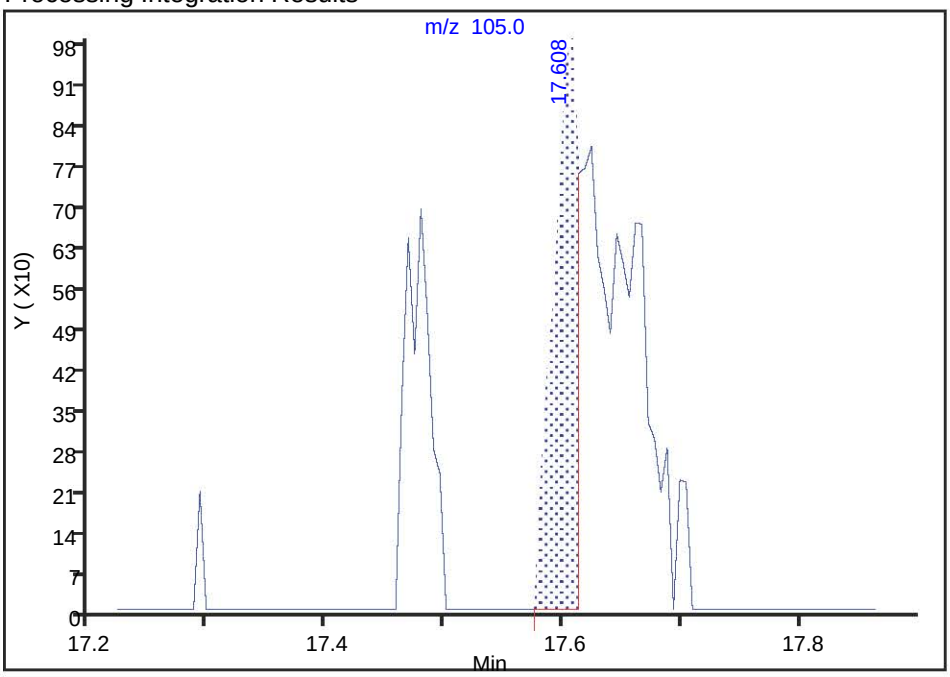
Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

92 1,2,4-Trimethylbenzene, CAS: 95-63-6

Signal: 1

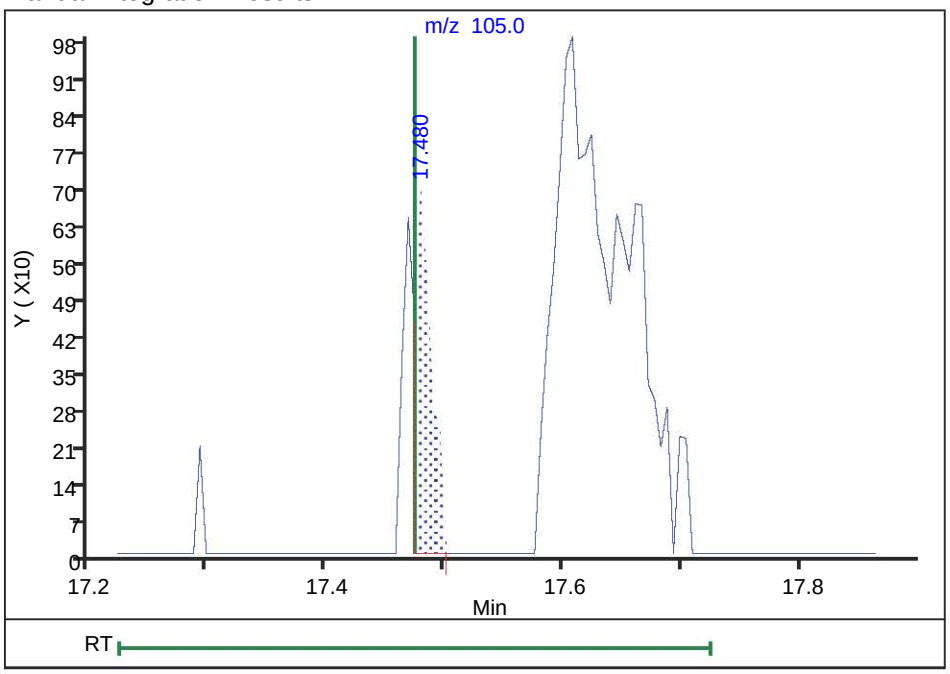
Processing Integration Results

RT: 17.61
Area: 1476
Amount: 0.007811
Amount Units: ppb v/v



Manual Integration Results

RT: 17.48
Area: 692
Amount: 0.003662
Amount Units: ppb v/v



Reviewer: puangmaleek, 01-Feb-2019 10:30:25

Audit Action: Assigned Compound ID Audit Reason: Assign Peak

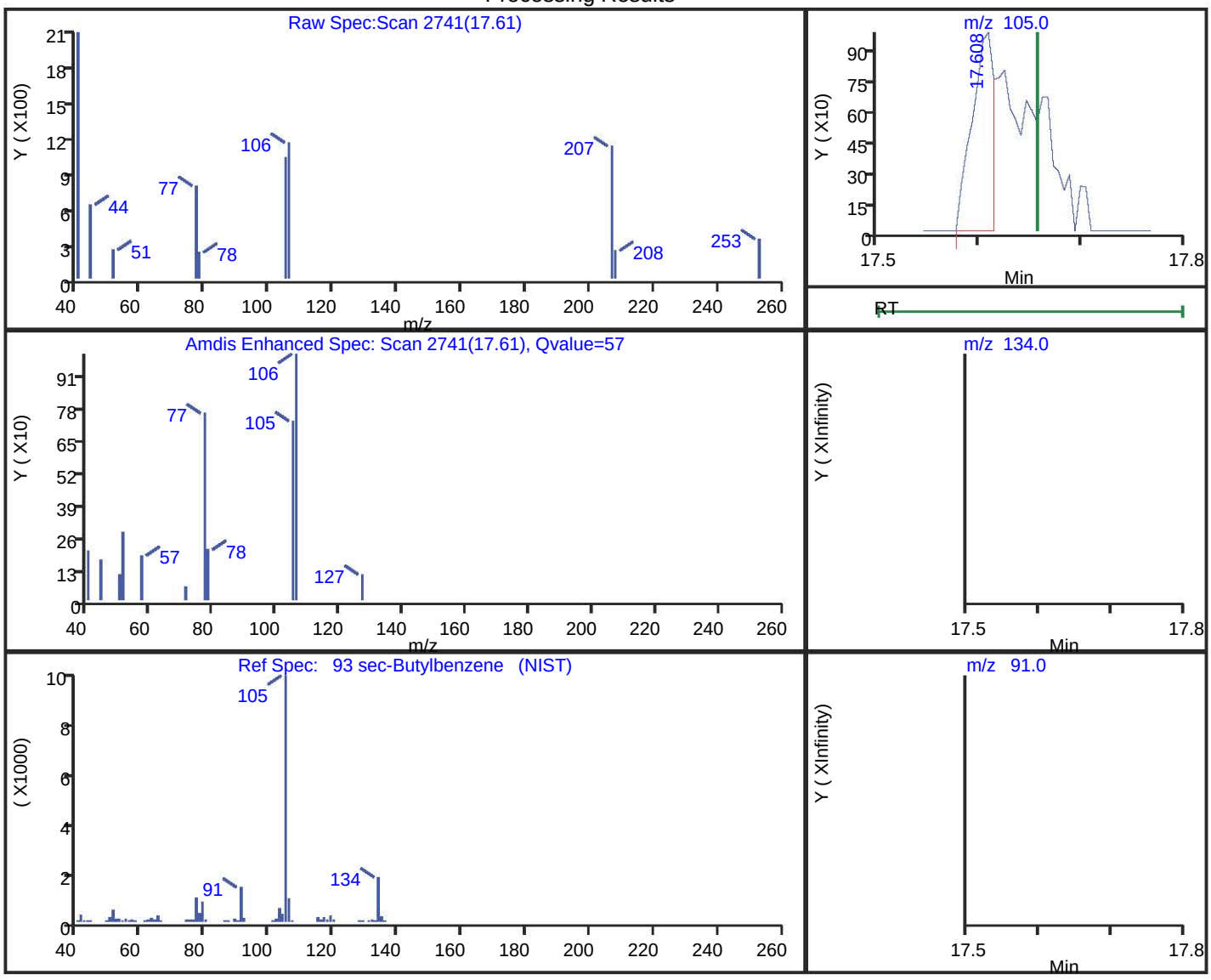
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

93 sec-Butylbenzene, CAS: 135-98-8

Processing Results



RT	Mass	Response	Amount
17.61	105.00	1476	0.005194
17.66	134.00	0	
17.66	91.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:31

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

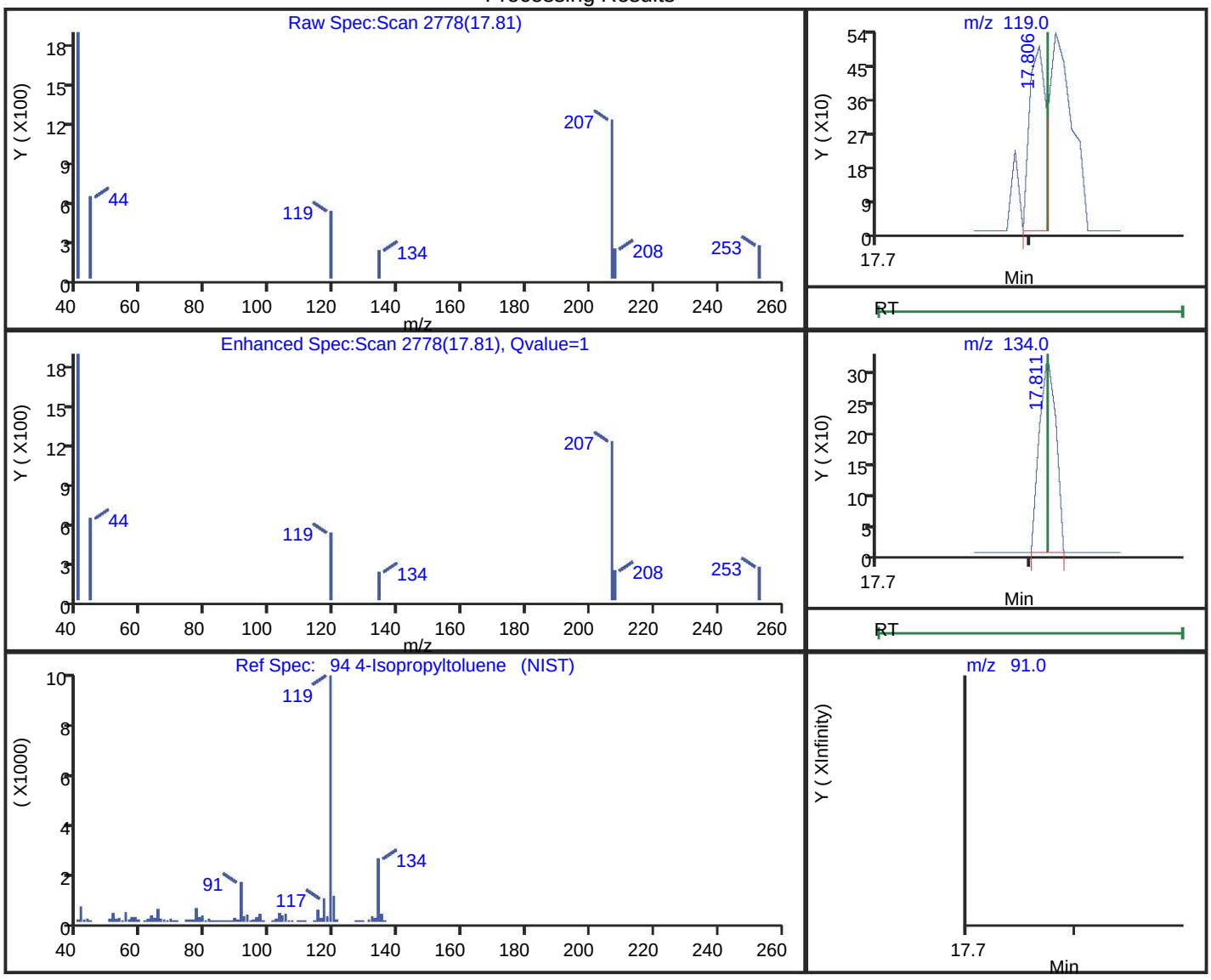
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHB.i\20190131-34379.b\34379-06.D				
Injection Date:	31-Jan-2019 17:29:30	Instrument ID:	CHB.i		
Lims ID:	200-47202-A-7	Lab Sample ID:	200-47202-7		
Client ID:	3667				
Operator ID:	ert	ALS Bottle#:	5	Worklist Smp#:	6
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_LLNJ_TO3	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

94 4-Isopropyltoluene, CAS: 99-87-6

Processing Results



RT	Mass	Response	Amount
17.81	119.00	391	0.001619
17.81	134.00	240	
17.81	91.00	0	

Reviewer: puangmaleek, 01-Feb-2019 10:30:34

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47390-1

SDG No.:

Client Sample ID: 3348 Lab Sample ID: 200-47390-2

Matrix: Air Lab File ID: 34613-05.D

Analysis Method: TO-15 Date Collected: 02/13/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 02/16/2019 16:28

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 140052 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
115-07-1	Propylene	1.0	U ^	1.0	1.0
75-71-8	Dichlorodifluoromethane	0.10	U	0.10	0.10
75-45-6	Freon 22	0.10	U	0.10	0.10
76-14-2	1,2-Dichlorotetrafluoroethane	0.040	U	0.040	0.040
74-87-3	Chloromethane	0.10	U	0.10	0.10
106-97-8	n-Butane	0.10	U	0.10	0.10
75-01-4	Vinyl chloride	0.040	U	0.040	0.040
106-99-0	1,3-Butadiene	0.040	U	0.040	0.040
74-83-9	Bromomethane	0.040	U	0.040	0.040
75-00-3	Chloroethane	0.10	U	0.10	0.10
593-60-2	Bromoethene(Vinyl Bromide)	0.040	U	0.040	0.040
75-69-4	Trichlorofluoromethane	0.040	U	0.040	0.040
64-17-5	Ethanol	1.0	U	1.0	1.0
76-13-1	Freon TF	0.040	U	0.040	0.040
75-35-4	1,1-Dichloroethene	0.040	U	0.040	0.040
67-64-1	Acetone	1.0	U	1.0	1.0
67-63-0	Isopropyl alcohol	1.0	U	1.0	1.0
75-15-0	Carbon disulfide	0.10	U	0.10	0.10
107-05-1	3-Chloropropene	0.10	U	0.10	0.10
75-09-2	Methylene Chloride	0.10	U	0.10	0.10
75-65-0	tert-Butyl alcohol	1.0	U	1.0	1.0
1634-04-4	Methyl tert-butyl ether	0.040	U	0.040	0.040
156-60-5	trans-1,2-Dichloroethene	0.040	U	0.040	0.040
110-54-3	n-Hexane	0.040	U	0.040	0.040
75-34-3	1,1-Dichloroethane	0.040	U	0.040	0.040
108-05-4	Vinyl acetate	1.0	U	1.0	1.0
141-78-6	Ethyl acetate	1.0	U	1.0	1.0
78-93-3	Methyl Ethyl Ketone	0.10	U	0.10	0.10
156-59-2	cis-1,2-Dichloroethene	0.040	U	0.040	0.040
540-59-0	1,2-Dichloroethene, Total	0.080	U	0.080	0.080
67-66-3	Chloroform	0.040	U	0.040	0.040
109-99-9	Tetrahydrofuran	1.0	U	1.0	1.0
71-55-6	1,1,1-Trichloroethane	0.040	U	0.040	0.040
110-82-7	Cyclohexane	0.040	U	0.040	0.040
56-23-5	Carbon tetrachloride	0.040	U	0.040	0.040
540-84-1	2,2,4-Trimethylpentane	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47390-1

SDG No.:

Client Sample ID: 3348 Lab Sample ID: 200-47390-2

Matrix: Air Lab File ID: 34613-05.D

Analysis Method: TO-15 Date Collected: 02/13/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 02/16/2019 16:28

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 140052 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
71-43-2	Benzene	0.040	U	0.040	0.040
107-06-2	1,2-Dichloroethane	0.040	U	0.040	0.040
142-82-5	n-Heptane	0.040	U	0.040	0.040
79-01-6	Trichloroethene	0.040	U	0.040	0.040
80-62-6	Methyl methacrylate	0.10	U	0.10	0.10
78-87-5	1,2-Dichloropropane	0.040	U	0.040	0.040
123-91-1	1,4-Dioxane	1.0	U	1.0	1.0
75-27-4	Bromodichloromethane	0.040	U	0.040	0.040
10061-01-5	cis-1,3-Dichloropropene	0.040	U	0.040	0.040
108-10-1	methyl isobutyl ketone	0.10	U	0.10	0.10
108-88-3	Toluene	0.040	U	0.040	0.040
10061-02-6	trans-1,3-Dichloropropene	0.040	U	0.040	0.040
79-00-5	1,1,2-Trichloroethane	0.040	U	0.040	0.040
127-18-4	Tetrachloroethene	0.040	U	0.040	0.040
591-78-6	Methyl Butyl Ketone (2-Hexanone)	0.10	U	0.10	0.10
124-48-1	Dibromochloromethane	0.040	U	0.040	0.040
106-93-4	1,2-Dibromoethane	0.040	U	0.040	0.040
108-90-7	Chlorobenzene	0.040	U	0.040	0.040
100-41-4	Ethylbenzene	0.040	U	0.040	0.040
179601-23-1	m,p-Xylene	0.10	U	0.10	0.10
95-47-6	Xylene, o-	0.040	U	0.040	0.040
1330-20-7	Xylene (total)	0.14	U	0.14	0.14
100-42-5	Styrene	0.040	U	0.040	0.040
75-25-2	Bromoform	0.040	U	0.040	0.040
98-82-8	Cumene	0.040	U	0.040	0.040
79-34-5	1,1,2,2-Tetrachloroethane	0.040	U	0.040	0.040
103-65-1	n-Propylbenzene	0.040	U	0.040	0.040
622-96-8	4-Ethyltoluene	0.040	U	0.040	0.040
108-67-8	1,3,5-Trimethylbenzene	0.040	U	0.040	0.040
95-49-8	2-Chlorotoluene	0.040	U	0.040	0.040
98-06-6	tert-Butylbenzene	0.040	U	0.040	0.040
95-63-6	1,2,4-Trimethylbenzene	0.040	U	0.040	0.040
135-98-8	sec-Butylbenzene	0.040	U	0.040	0.040
99-87-6	4-Isopropyltoluene	0.040	U	0.040	0.040
541-73-1	1,3-Dichlorobenzene	0.040	U	0.040	0.040
106-46-7	1,4-Dichlorobenzene	0.040	U	0.040	0.040

FORM I
AIR - GC/MS VOA ORGANICS ANALYSIS DATA SHEET

Lab Name: TestAmerica Burlington Job No.: 200-47390-1

SDG No.:

Client Sample ID: 3348 Lab Sample ID: 200-47390-2

Matrix: Air Lab File ID: 34613-05.D

Analysis Method: TO-15 Date Collected: 02/13/2019 00:00

Sample wt/vol: 1000(mL) Date Analyzed: 02/16/2019 16:28

Soil Aliquot Vol: Dilution Factor: 0.2

Soil Extract Vol.: GC Column: RTX-624 ID: 0.32(mm)

% Moisture: Level: (low/med) Low

Analysis Batch No.: 140052 Units: ppb v/v

CAS NO.	COMPOUND NAME	RESULT	Q	RL	RL
100-44-7	Benzyl chloride	0.040	U	0.040	0.040
104-51-8	n-Butylbenzene	0.040	U	0.040	0.040
95-50-1	1,2-Dichlorobenzene	0.040	U	0.040	0.040
120-82-1	1,2,4-Trichlorobenzene	0.10	U	0.10	0.10
87-68-3	Hexachlorobutadiene	0.040	U	0.040	0.040
91-20-3	Naphthalene	0.10	U *	0.10	0.10

TestAmerica Burlington
Target Compound Quantitation Report

Data File: \\chromna\Burlington\ChromData\CHC.i\20190216-34613.b\34613-05.D
Lims ID: 200-47390-A-2
Client ID: 3348
Sample Type: Client
Inject. Date: 16-Feb-2019 16:28:30 ALS Bottle#: 5 Worklist Smp#: 5
Purge Vol: 200.000 mL Dil. Factor: 0.2000
Sample Info: 200-0034613-005
Misc. Info.: 47390-02
Operator ID: ggg Instrument ID: CHC.i

Method: \\chromna\Burlington\ChromData\CHC.i\20190216-34613.b\TO15_MasterMethod_(v1)_CHC.i.m
Limit Group: AI_TO15_ICAL
Last Update: 18-Feb-2019 08:35:32 Calib Date: 06-Feb-2019 00:53:30
Integrator: RTE ID Type: Deconvolution ID
Quant Method: Internal Standard Quant By: Initial Calibration
Last ICal File: \\chromna\Burlington\ChromData\CHC.i\20190205-34442.b\34442-11.D

Column 1 : RTX-624 (0.32 mm) Det: MS SCAN
Process Host: CTX1018

First Level Reviewer: desjardinsb Date: 18-Feb-2019 08:35:32

Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
1 Propene	41		2.967				ND	
2 Dichlorodifluoromethane	85		3.031				ND	
3 Chlorodifluoromethane	51		3.079				ND	
4 1,2-Dichloro-1,1,2,2-tetra	85		3.288				ND	
5 Chloromethane	50		3.416				ND	U
6 Butane	43		3.618				ND	
7 Vinyl chloride	62		3.656				ND	
8 Butadiene	54		3.730				ND	
10 Bromomethane	94		4.392				ND	
11 Chloroethane	64		4.622				ND	
13 Vinyl bromide	106		5.011				ND	
14 Trichlorofluoromethane	101		5.123				ND	
17 Ethanol	45	5.716	5.694	0.022	47	1519	0.2049	
20 1,1,2-Trichloro-1,2,2-trif	101		6.212				ND	
21 1,1-Dichloroethene	96		6.239				ND	
22 Acetone	43	6.463	6.452	0.011	99	12514	0.3726	
23 Carbon disulfide	76	6.602	6.612	-0.010	98	2943	0.0412	
24 Isopropyl alcohol	45		6.773				ND	
25 3-Chloro-1-propene	41		7.018				ND	
27 Methylene Chloride	49		7.312				ND	
28 2-Methyl-2-propanol	59		7.546				ND	
29 Methyl tert-butyl ether	73		7.733				ND	
31 trans-1,2-Dichloroethene	61		7.765				ND	
33 Hexane	57		8.176				ND	
34 1,1-Dichloroethane	63		8.630				ND	
35 Vinyl acetate	43		8.715				ND	
37 cis-1,2-Dichloroethene	96		9.740				ND	
38 2-Butanone (MEK)	72	9.799	9.777	0.022	99	672	0.0496	
39 Ethyl acetate	88		9.841				ND	
* 40 Chlorobromomethane	128	10.194	10.199	-0.005	84	489617	10.0	
S 30 1,2-Dichloroethene, Total	61		10.200				ND	

Compound	Sig	RT (min.)	Adj RT (min.)	Dlt RT (min.)	Q	Response	OnCol Amt ppb v/v	Flags
41 Tetrahydrofuran	42		10.204				ND	
42 Chloroform	83		10.348				ND	
43 Cyclohexane	84		10.599				ND	
44 1,1,1-Trichloroethane	97		10.615				ND	
45 Carbon tetrachloride	117		10.877				ND	
47 Benzene	78	11.320	11.325	-0.005	90	7741	0.0744	M
46 Isooctane	57		11.330				ND	
48 1,2-Dichloroethane	62		11.496				ND	
49 n-Heptane	43		11.731				ND	
* 50 1,4-Difluorobenzene	114	12.179	12.184	-0.005	91	2902619	10.0	
53 Trichloroethene	95		12.654				ND	
54 1,2-Dichloropropane	63		13.187				ND	
55 Methyl methacrylate	69		13.385				ND	
56 1,4-Dioxane	88		13.428				ND	
57 Dibromomethane	174		13.449				ND	
58 Dichlorobromomethane	83		13.764				ND	
60 cis-1,3-Dichloropropene	75		14.719				ND	
61 4-Methyl-2-pentanone (MIBK	43		15.002				ND	
65 Toluene	92	15.306	15.312	-0.006	91	1257	0.0132	
66 trans-1,3-Dichloropropene	75		15.915				ND	
67 1,1,2-Trichloroethane	83		16.283				ND	
68 Tetrachloroethene	166		16.411				ND	
69 2-Hexanone	43		16.731				ND	
71 Chlorodibromomethane	129		17.051				ND	
72 Ethylene Dibromide	107		17.308				ND	
* 74 Chlorobenzene-d5	117	18.215	18.215	0.000	85	3090372	10.0	
75 Chlorobenzene	112		18.274				ND	
76 Ethylbenzene	91		18.434				ND	
78 m-Xylene & p-Xylene	106		18.685				ND	
79 o-Xylene	106		19.522				ND	
80 Styrene	104		19.576				ND	
81 Bromoform	173		20.003				ND	
S 73 Xylenes, Total	106		20.100				ND	
82 Isopropylbenzene	105		20.238				ND	
84 1,1,2,2-Tetrachloroethane	83		20.905				ND	
85 N-Propylbenzene	91		20.985				ND	
88 4-Ethyltoluene	105		21.182				ND	
89 2-Chlorotoluene	91		21.182				ND	
90 1,3,5-Trimethylbenzene	105		21.289				ND	
92 tert-Butylbenzene	119		21.785				ND	
93 1,2,4-Trimethylbenzene	105		21.887				ND	
94 sec-Butylbenzene	105		22.121				ND	
95 4-Isopropyltoluene	119		22.330				ND	
96 1,3-Dichlorobenzene	146	22.356	22.351	0.005	92	2953	0.0206	
97 1,4-Dichlorobenzene	146	22.484	22.490	-0.006	90	3096	0.0212	
98 Benzyl chloride	91	22.687	22.677	0.011	94	2524	0.0151	
100 n-Butylbenzene	91		22.895				ND	
101 1,2-Dichlorobenzene	146	23.013	23.007	0.006	94	3527	0.0251	
103 1,2,4-Trichlorobenzene	180	25.409	25.409	0.000	93	10703	0.0938	
104 Hexachlorobutadiene	225	25.596	25.601	-0.005	94	4880	0.0454	
105 Naphthalene	128	25.863	25.857	0.006	99	35647	0.1612	

QC Flag Legend

Review Flags

M - Manually Integrated

U - Marked Undetected

Reagents:

ATTO15CISs_00010 Amount Added: 20.00 Units: mL Run Reagent

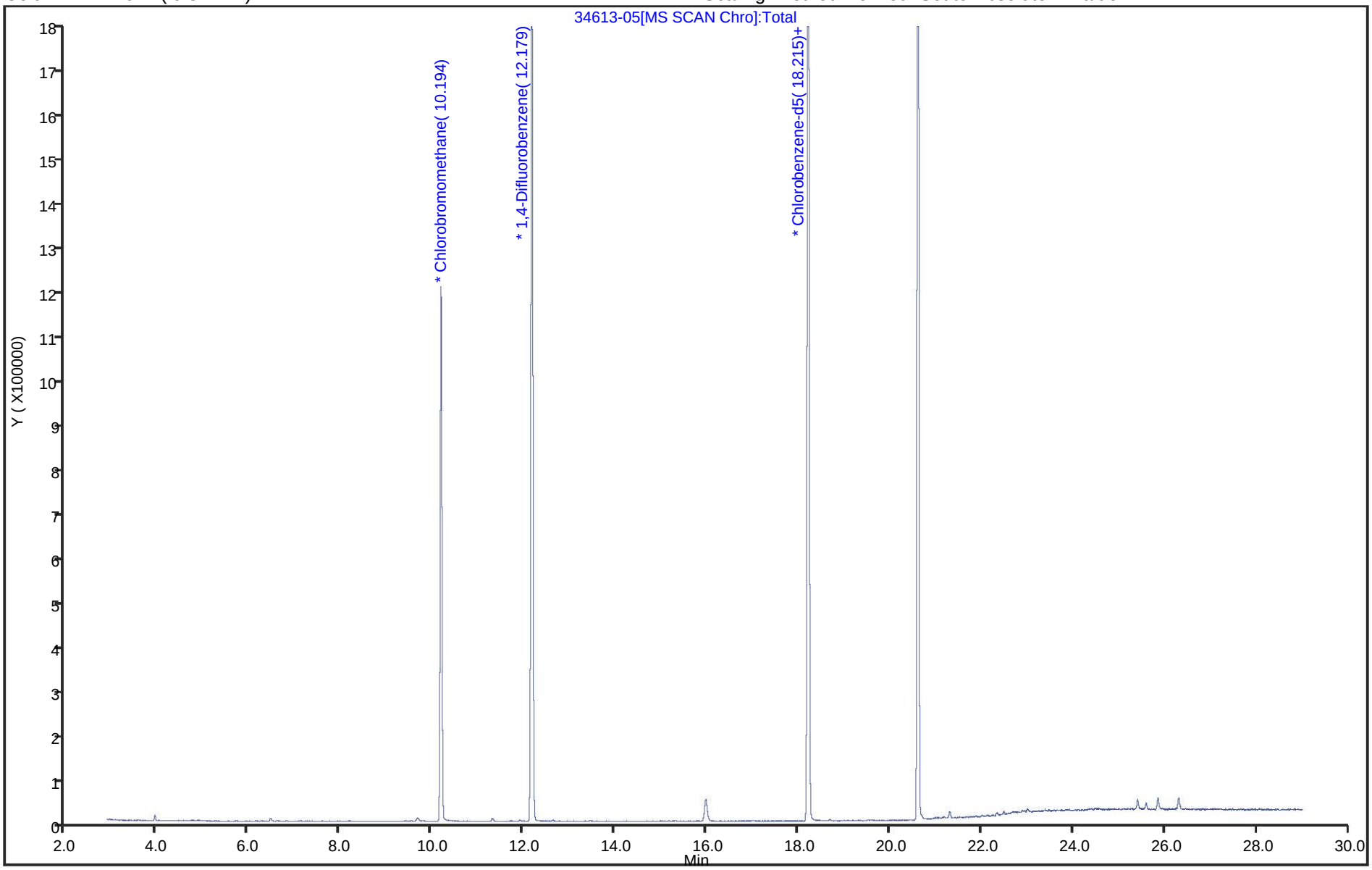
Report Date: 18-Feb-2019 08:35:33 Chrom Revision: 2.3 11-Feb-2019 16:31:10

TestAmerica Burlington

Data File: \\chromna\Burlington\ChromData\CHC.i\20190216-34613.b\34613-05.D

Injection Date:	16-Feb-2019 16:28:30	Instrument ID:	CHC.i	Operator ID:	ggg
Lims ID:	200-47390-A-2	Lab Sample ID:	200-47390-2	Worklist Smp#:	5
Client ID:	3348				
Purge Vol:	200.000 mL	Dil. Factor:	0.2000	ALS Bottle#:	5
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		

Column: RTX-624 (0.32 mm) Y Scaling: Method Defined: Set to Absolute Y Value



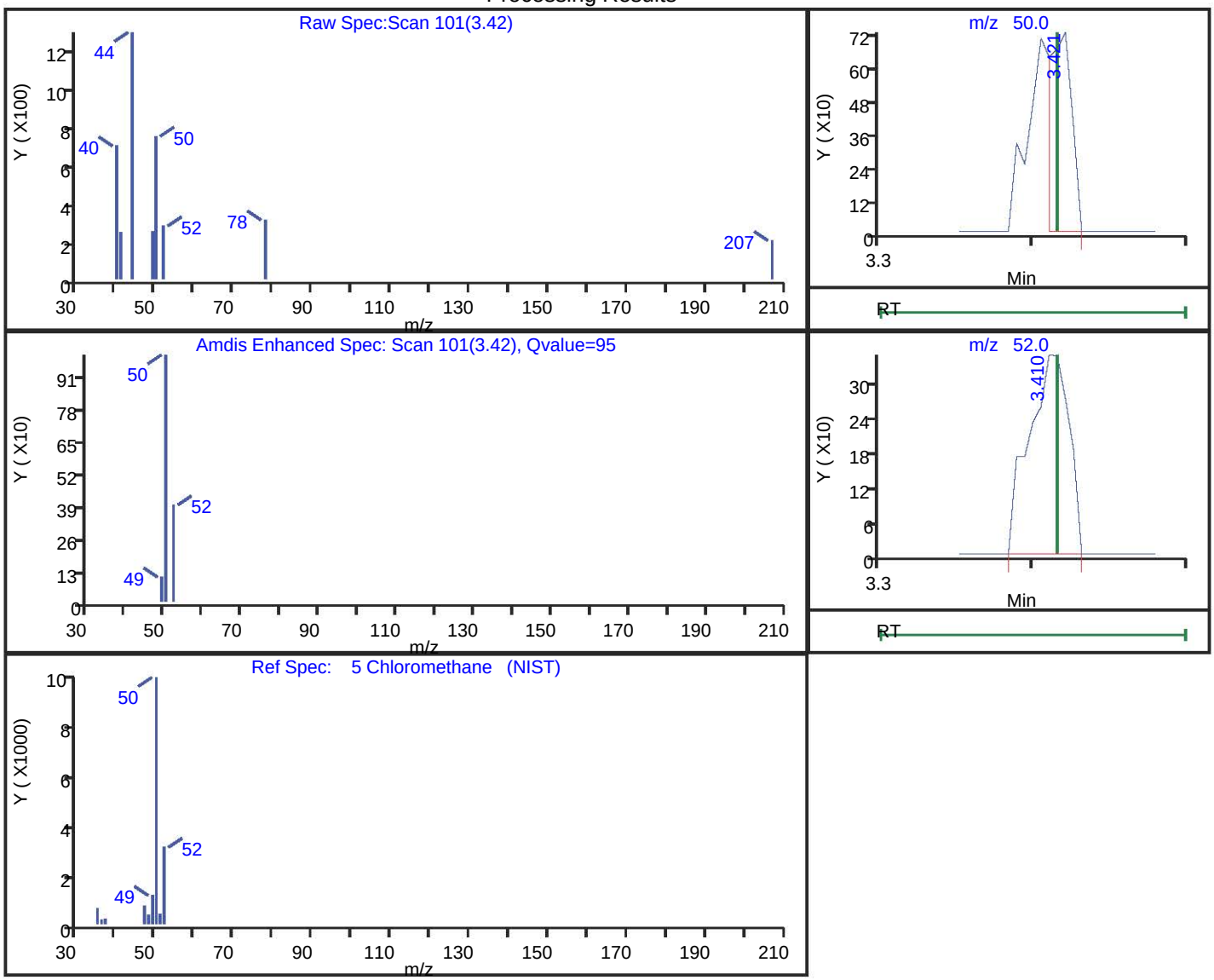
User Disabled Compound Report

TestAmerica Burlington

Data File:	\\chromna\Burlington\ChromData\CHC.i\20190216-34613.b\34613-05.D				
Injection Date:	16-Feb-2019 16:28:30	Instrument ID:	CHC.i		
Lims ID:	200-47390-A-2	Lab Sample ID:	200-47390-2		
Client ID:	3348				
Operator ID:	ggg	ALS Bottle#:	5	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

5 Chloromethane, CAS: 74-87-3

Processing Results



RT	Mass	Response	Amount
3.42	50.00	777	0.036473
3.41	52.00	630	

Reviewer: desjardinsb, 18-Feb-2019 08:34:31

Audit Action: Marked Compound Undetected Audit Reason: Invalid Compound ID

Manual Integration/User Assign Peak Report

TestAmerica Burlington

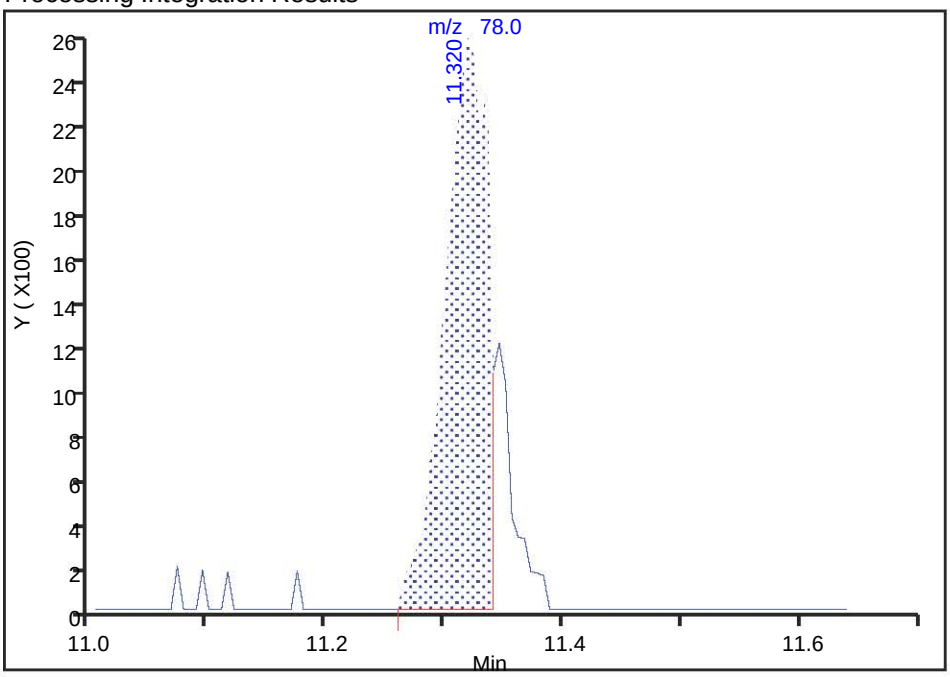
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190216-34613.b\34613-05.D				
Injection Date:	16-Feb-2019 16:28:30	Instrument ID:	CHC.i		
Lims ID:	200-47390-A-2	Lab Sample ID:	200-47390-2		
Client ID:	3348				
Operator ID:	ggg	ALS Bottle#:	5	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

47 Benzene, CAS: 71-43-2

Signal: 1

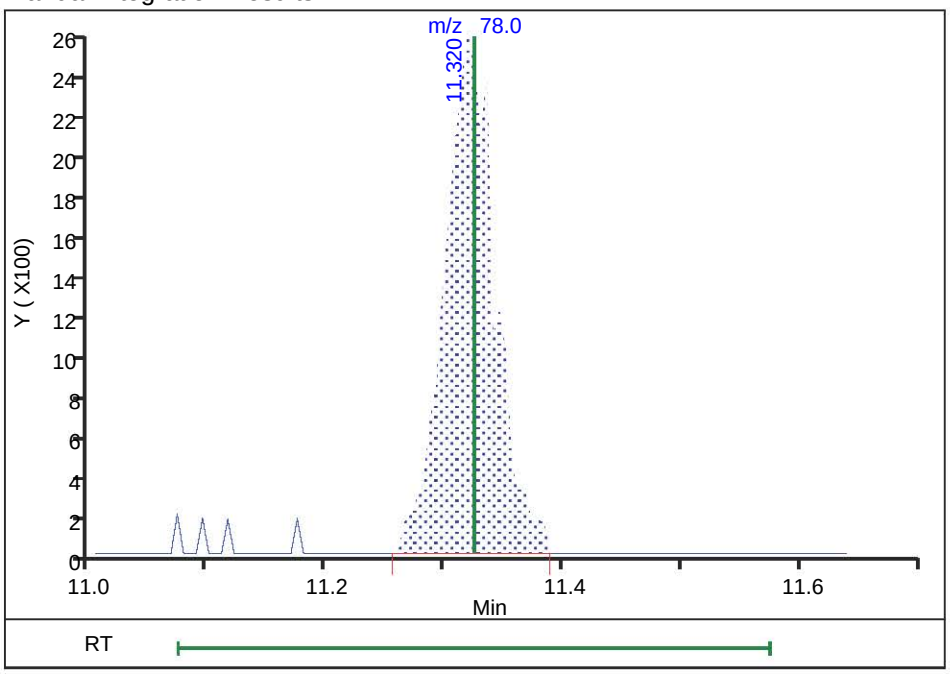
Processing Integration Results

RT: 11.32
Area: 6534
Amount: 0.062762
Amount Units: ppb v/v



Manual Integration Results

RT: 11.32
Area: 7741
Amount: 0.074356
Amount Units: ppb v/v



Reviewer: desjardinsb, 18-Feb-2019 08:35:01

Audit Action: Manually Integrated Audit Reason: Baseline

Manual Integration/User Assign Peak Report

TestAmerica Burlington

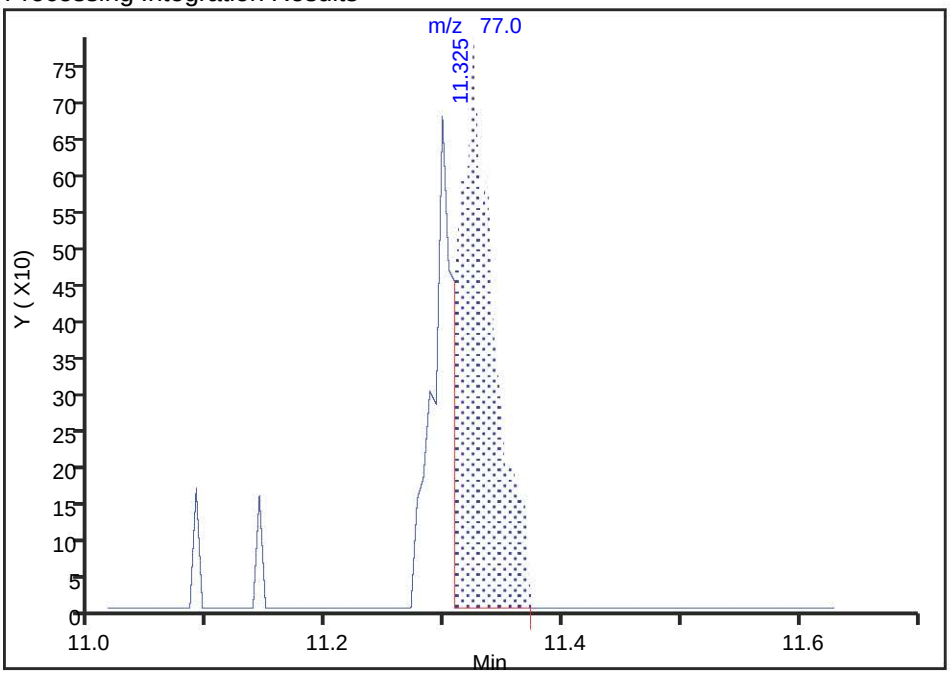
Data File:	\\chromna\Burlington\ChromData\CHC.i\20190216-34613.b\34613-05.D				
Injection Date:	16-Feb-2019 16:28:30	Instrument ID:	CHC.i		
Lims ID:	200-47390-A-2	Lab Sample ID:	200-47390-2		
Client ID:	3348				
Operator ID:	ggg	ALS Bottle#:	5	Worklist Smp#:	5
Purge Vol:	200.000 mL	Dil. Factor:	0.2000		
Method:	TO15_MasterMethod_(v1)_CHC.i	Limit Group:	AI_TO15_ICAL		
Column:	RTX-624 (0.32 mm)	Detector	MS SCAN		

47 Benzene, CAS: 71-43-2

Signal: 2

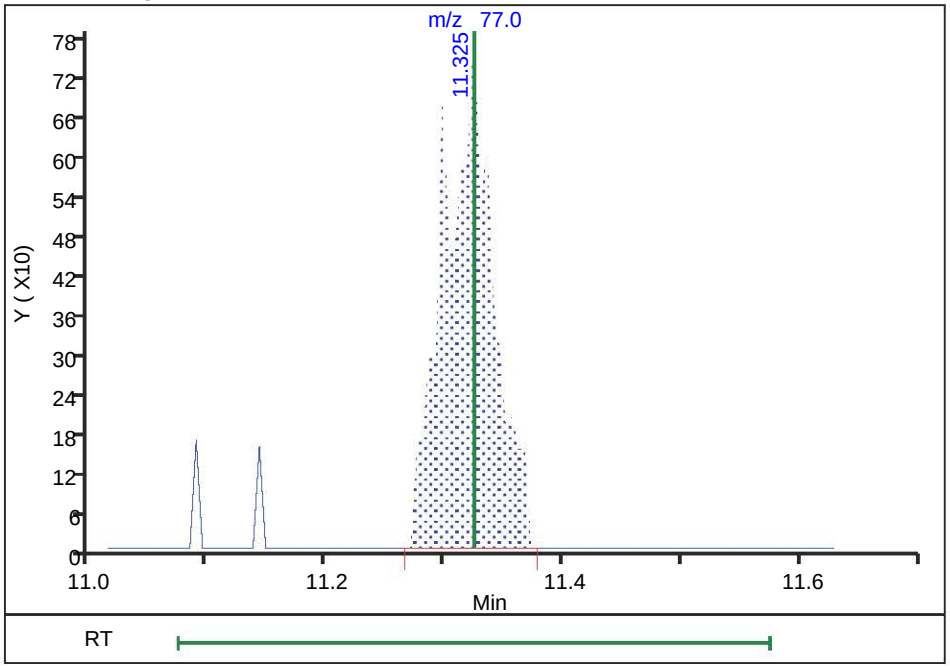
Processing Integration Results

RT: 11.32
Area: 1561
Amount: 0.062762
Amount Units: ppb v/v



Manual Integration Results

RT: 11.32
Area: 2217
Amount: 0.074356
Amount Units: ppb v/v



Reviewer: desjardinsb, 18-Feb-2019 08:35:04
Audit Action: Manually Integrated Audit Reason: Baseline

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ANALYTICAL REPORT

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Tel: (865)291-3000

Laboratory Job ID: 140-16324-1
Client Project/Site: Fox Shores Apt - 193706620

For:
Stantec Consulting Corp.
1165 Scheuring Road
De Pere, Wisconsin 54115

Attn: Mr. Jeff Brand

Authorized for release by:
8/22/2019 12:56:17 PM

Sandie Fredrick, Project Manager II
(920)261-1660
sandie.fredrick@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Cover Page 1
Table of Contents 2
Definitions/Glossary 3
Case Narrative 4
Detection Summary 5
Client Sample Results 6
Default Detection Limits 9
QC Sample Results 10
QC Association Summary 11
Lab Chronicle 12
Certification Summary 14
Method Summary 15
Sample Summary 16
Chain of Custody 17
Receipt Checklists 19

Definitions/Glossary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 140-16324-1

Laboratory: Eurofins TestAmerica, Knoxville

Narrative

Job Narrative
140-16324-1

Comments
No additional comments.

Receipt
The samples were received on 8/14/2019 10:00 AM; the samples arrived in good condition, properly preserved and, where required, on ice.

Receipt Exceptions
The container label for the following samples did not match the information listed on the Chain-of-Custody (COC): VP-4 (140-16324-1), VP-5 (140-16324-2) and VP-6 (140-16324-3). The container labels are blank; the samples were matched by the Canister IDs, and labeled per the Chain-Of-Custody.

Air - GC/MS VOA
Method(s) TO 15 LL, TO-14A, TO-15: EPA methods TO-14A and TO-15 specify the use of humidified "zero air" as the blank reagent for canister cleaning, instrument calibration and sample analysis. Ultra-high purity humidified nitrogen from a cryogenic reservoir is used in place of "zero air" by Eurofins TestAmerica Knoxville.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Client Sample ID: VP-4 — Lab Sample ID: 140-16324-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	1800		32	2.2	ppb v/v	3.53		TO-15	Total/NA

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	9100		160	11	ug/m3	3.53		TO-15	Total/NA

Client Sample ID: VP-5 — Lab Sample ID: 140-16324-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	2300		57	4.0	ppb v/v	8.53		TO-15	Total/NA

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	11000		280	20	ug/m3	8.53		TO-15	Total/NA

Client Sample ID: VP-6 — Lab Sample ID: 140-16324-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	1000		59	4.1	ppb v/v	8.86		TO-15	Total/NA

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Dichlorodifluoromethane	5100		290	20	ug/m3	8.86		TO-15	Total/NA

This Detection Summary does not include radiochemical test results.

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Client Sample ID: VP-4
Date Collected: 08/13/19 10:28
Date Received: 08/14/19 10:00
Sample Container: Summa Canister 6L

Lab Sample ID: 140-16324-1
Matrix: Air

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	1800		32	2.2	ppb v/v			08/16/19 18:14	3.53

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	9100		160	11	ug/m3			08/16/19 18:14	3.53

Client Sample Results

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Client Sample ID: VP-5

Lab Sample ID: 140-16324-2

Date Collected: 08/13/19 10:20
Matrix: Air
Date Received: 08/14/19 10:00
Sample Container: Summa Canister 6L

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	2300		57	4.0	ppb v/v			08/21/19 06:31	8.53

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	11000		280	20	ug/m3			08/21/19 06:31	8.53

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Client Sample ID: VP-6
Date Collected: 08/13/19 10:10
Date Received: 08/14/19 10:00
Sample Container: Summa Canister 6L

Lab Sample ID: 140-16324-3
Matrix: Air

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	1000		59	4.1	ppb v/v			08/21/19 07:27	8.86

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	5100		290	20	ug/m3			08/21/19 07:27	8.86

Default Detection Limits

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Analyte	RL	MDL	Units
Dichlorodifluoromethane	0.50	0.035	ppb v/v
Dichlorodifluoromethane	2.5	0.17	ug/m3

Method: TO-15 - Volatile Organic Compounds in Ambient Air

Lab Sample ID: MB 140-32703/9
Matrix: Air
Analysis Batch: 32703

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.035		0.50	0.035	ppb v/v			08/16/19 15:03	1

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.17		2.5	0.17	ug/m3			08/16/19 15:03	1

Lab Sample ID: LCS 140-32703/1002
Matrix: Air
Analysis Batch: 32703

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	2.00	2.58		ppb v/v		129	60 - 140

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	9.9	12.8		ug/m3		129	60 - 140

Lab Sample ID: MB 140-32778/5
Matrix: Air
Analysis Batch: 32778

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.035		0.50	0.035	ppb v/v			08/20/19 12:45	1

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dichlorodifluoromethane	<0.17		2.5	0.17	ug/m3			08/20/19 12:45	1

Lab Sample ID: LCS 140-32778/1002
Matrix: Air
Analysis Batch: 32778

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	1.00	0.977		ppb v/v		98	60 - 140

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dichlorodifluoromethane	4.9	4.83		ug/m3		98	60 - 140

QC Association Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Air - GC/MS VOA

Analysis Batch: 32703

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-16324-1	VP-4	Total/NA	Air	TO-15	
MB 140-32703/9	Method Blank	Total/NA	Air	TO-15	
LCS 140-32703/1002	Lab Control Sample	Total/NA	Air	TO-15	

Analysis Batch: 32778

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-16324-2	VP-5	Total/NA	Air	TO-15	
140-16324-3	VP-6	Total/NA	Air	TO-15	
MB 140-32778/5	Method Blank	Total/NA	Air	TO-15	
LCS 140-32778/1002	Lab Control Sample	Total/NA	Air	TO-15	

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Client Sample ID: VP-4
Lab Sample ID: 140-16324-1
Date Collected: 08/13/19 10:28
Matrix: Air
Date Received: 08/14/19 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		3.53	11 mL	500 mL	32703	08/16/19 18:14	S1K	TAL KNX
	Instrument ID: MG									

Client Sample ID: VP-5
Lab Sample ID: 140-16324-2
Date Collected: 08/13/19 10:20
Matrix: Air
Date Received: 08/14/19 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		8.53	15 mL	500 mL	32778	08/21/19 06:31	S1K	TAL KNX
	Instrument ID: MH									

Client Sample ID: VP-6
Lab Sample ID: 140-16324-3
Date Collected: 08/13/19 10:10
Matrix: Air
Date Received: 08/14/19 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		8.86	15 mL	500 mL	32778	08/21/19 07:27	S1K	TAL KNX
	Instrument ID: MH									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-32703/9
Date Collected: N/A
Matrix: Air
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	200 mL	500 mL	32703	08/16/19 15:03	S1K	TAL KNX
	Instrument ID: MG									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-32778/5
Date Collected: N/A
Matrix: Air
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	200 mL	500 mL	32778	08/20/19 12:45	S1K	TAL KNX
	Instrument ID: MH									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-32703/1002
Date Collected: N/A
Matrix: Air
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	500 mL	500 mL	32703	08/16/19 09:32	S1K	TAL KNX
	Instrument ID: MG									

Lab Chronicle

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Client Sample ID: Lab Control Sample

Date Collected: N/A
Date Received: N/A

Lab Sample ID: LCS 140-32778/1002

Matrix: Air

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	TO-15		1	500 mL	500 mL	32778	08/20/19 09:19	S1K	TAL KNX
	Instrument ID: MH									

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Accreditation/Certification Summary

Client: Stantec Consulting Corp. Job ID: 140-16324-1
Project/Site: Fox Shores Apt - 193706620

Laboratory: Eurofins TestAmerica, Knoxville

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State Program	998044300	08-31-20

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Wisconsin	State Program	999580010	08-31-19 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Method	Method Description	Protocol	Laboratory
TO-15	Volatile Organic Compounds in Ambient Air	EPA	TAL KNX

Protocol References:

EPA = US Environmental Protection Agency

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Sample Summary

Client: Stantec Consulting Corp.
Project/Site: Fox Shores Apt - 193706620

Job ID: 140-16324-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
140-16324-1	VP-4	Air	08/13/19 10:28	08/14/19 10:00	Air Canister (6-Liter) #11169
140-16324-2	VP-5	Air	08/13/19 10:20	08/14/19 10:00	Air Canister (6-Liter) #10217
140-16324-3	VP-6	Air	08/13/19 10:10	08/14/19 10:00	Air Canister (6-Liter) #11972

TestAmerica Burlington
30 Community Drive
Suite 11
South Burlington, VT 05403-6809
phone 802.660.1990 fax 802.660.1919

Canister Samples Chain of Custody Record

TestAmerica Laboratories, Inc. assumes no liability with respect to the collection and shipment of these samples.

140-16324 Chain of Custody

Client Contact Information	Client Project Manager: Jeff Brand	Samples Collected By: Jeff Brand	COC No:
Company Name: Stantec	Phone: 920-278-3208		1 of 1 COCs
Address: 1165 Schwring Rd	Email: Jeff.brand@stantec.com		
City/State/Zip DePere WI 54115			For Lab Use Only:
Phone: 920-592-8406	Site Contact:		Walk-in Client:
FAX: 920-592-8444	Tel/Fax		Lab Sampling:
Project Name: Fox Shores Apts.	Anaylsis Turnaround Time		
Site/Location: Kaukauna WI	Standard (Specific):		Job / SDG No.:
PO# Proj # 19370662O	Rush (Specifiy):		(See below for Add'l Items)

Sample Identification	Sample Date(s)	Time Start	Time Stop	Canister Vacuum in Field, 'Hg (Start)'	Canister Vacuum in Field, 'Hg (Stop)'	Flow Controller ID	Canister ID	TO-14/15 (Standard / Low Level)	TO-15 SIM	EPA 3C	EPA 25C	ASTM D-1946	EPA 15/16	Other (Please specify in notes sectio	Sample Type	Indoor Air/Ambient Air	Sub-Slab	Soil Gas	Soil Vapor Extraction (SVE)	Landfill Gas	Other (Please specify in notes section)	Sample Specific Notes:
VP-4	8-13-19	944	1028	>-30	-2	12073	11169	X														*
VP-5	1	939	1020	-29	0	09575	10217	X														*
VP-6	↓	935	1010	-29	0	10244	11972	X														*

Temperature (Fahrenheit)	Interior	Ambient
Start		
Stop		

Pressure (inches of Hg)	Interior	Ambient
Start		
Stop		

Received @ ambient, 1 box, FedEx 5o
Custody seal intact, #KW#8178 6445 5116
KW 8/14/19

Special Instructions/QC Requirements & Comments:

* Report only dichlorodifluoromethane for each sample

Samples Shipped by: Stantec	Date / Time: 8/13/19 13:00	Samples Received by:	
Samples Relinquished by: Jeff Brand	Date / Time:	Received by: KW 8/14/19 1000 CT	
Relinquished by:	Date / Time:	Received by:	3 Cans, 3 KR
Lab Use Only: Shipper Name:	Opened by:	Condition:	

Form No. CA-C-WI-003, Rev. 2.5, dated 9/22/2017

Loc: 140
16324

EUROFINS/TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST **Log In Number:**

Review Items	Yes	No	NA	If No, what was the problem?
1. Are the shipping containers intact?	✓			☐ **Containers, Broken**
2. Were ambient air containers received intact?			✓	☒ Checked in lab
3. The coolers/containers custody seal if present, is it intact?	✓			☐ Yes ☐ NA
4. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C, VOST: 10°C) Thermometer ID :_____ Correction factor: _____			✓	☐ **Cooler Out of Temp, Client Contacted, Proceed/Cancel** ☐ **Cooler Out of Temp, Same Day Receipt**
5. Were all of the sample containers received intact?	✓			☐ **Containers, Broken**
6. Were samples received in appropriate containers?	✓			☐ **Containers, Improper; Client Contacted; Proceed/Cancel**
7. Do sample container labels match COC? (IDs, Dates, Times)		✓		☒ **COC & Samples Do Not Match** ☐ **COC Incorrect/Incomplete** ☐ **COC Not Received**
8. Were all of the samples listed on the COC received?	✓			☐ **Sample Received, Not on COC** ☐ **Sample on COC, Not Received**
9. Is the date/time of sample collection noted?	✓			☐ **COC; No Date/Time; Client Contacted**
10. Was the sampler identified on the COC?	✓			☐ **Sampler Not Listed on COC**
11. Is the client and project name/# identified?	✓			☐ **COC Incorrect/Incomplete**
12. Are tests/parameters listed for each sample?	✓			☐ **COC No tests on COC**
13. Is the matrix of the samples noted?	✓			☐ **COC Incorrect/Incomplete**
14. Was COC relinquished? (Signed/Dated/Timed)	✓			☐ **COC Incorrect/Incomplete**
15. Were samples received within holding time?	✓			☐ **Holding Time - Receipt**
16. Were samples received with correct chemical preservative (excluding Encore)?			✓	☐ **pH Adjusted, pH Included (See box 16A)** ☐ **Incorrect Preservative**
17. Were VOA samples received without headspace?			✓	☐ **Headspace (VOA only)**
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			✓	☐ **Residual Chlorine**
19. For 1613B water samples is pH<9?			✓	☐ If no, notify lab to adjust
20. For rad samples was sample activity info. Provided?			✓	☐ Project missing info

Comments/Actions Taken

7. The container labels are blank; samples noted per Canister ID.

Labeling Verified by: **Date:**

pH test strip lot number:

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: 500096S9 PM Instructions: _____

Sample Receiving Associate: KL Date: 8/14/19

QA026R32.doc, 062719

TestAmerica Knoxville - Air Canister Initial Pressure Check

Gauge ID: G5
Date: 8/15/2019

Analyst	Sample ID	Asset #	Cleaning Job	Cert	Size (L)	Pressure @ Receipt (-in Hg or +psig)	Time	Comments
HMT	140-16324-a-1	11169	16179	B	6	-1.2	10:16	
HMT	140-16324-a-2	10217	16179	B	6	0.0	10:17	
HMT	140-16324-a-3	11972	16179	B	6	0.0	10:18	

Appendix G

Partner Engineering and Science, Inc. - Phase II Subsurface Investigation Report

PARTNER
Engineering and Science, Inc.®

PHASE II SUBSURFACE INVESTIGATION REPORT

Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130

November 20, 2018
Partner Project Number: 18-215232.3

Prepared for:

Berkadia Commercial Mortgage LLC
101 South Hanley Road, Suite 550
St Louis, Missouri 63105



Engineers who understand your business

PARTNER
Engineering and Science, Inc.

November 20, 2018

Mr. Darak LaCroix
Berkadia Commercial Mortgage LLC
101 South Hanley Road, Suite 550
St Louis, Missouri 63105

Subject: Phase II Subsurface Investigation Report
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project Number: 18-215232.3

Dear Mr. LaCroix:

Partner Engineering and Science, Inc. (Partner) is pleased to provide the results of the assessment performed on the above-referenced property. The following report describes the field activities, methods, and findings of the Phase II Subsurface Investigation conducted at the above-referenced property.

This assessment was performed utilizing methods and procedures consistent with good commercial or customary practices designed to conform to acceptable industry standards. The independent conclusions represent Partner's best professional judgment based upon existing conditions and the information and data available to us during the course of this assignment.

We appreciate the opportunity to provide these services. If you have any questions concerning this report, or if we can assist you in any other matter, please contact Scott Chiu at (214) 234-9561.

Sincerely,

Partner Engineering and Science, Inc.

Jonathan Lokko
Project Scientist

Andres Simonson
Regional Manager – Subsurface Investigation

Scott Chiu
National Client Manager

TABLE OF CONTENTS

1.0 Introduction 1
1.1 Purpose 1
1.2 Limitations 1
1.3 User Reliance 1
2.0 Site Background 2
2.1 Site Description 2
2.2 Site History 2
2.3 Geology and Hydrogeology 3
3.0 Field Activities 5
3.1 Preparatory Activities 5
3.1.1 Utility Clearance 5
3.1.2 Health and Safety Plan 5
3.2 Drilling Equipment 5
3.3 Boring Locations 5
3.4 Soil Sampling 6
3.5 Groundwater Sampling 6
3.6 Sub-Slab Soil Gas Sampling 7
3.7 Post-Sampling Activities 8
4.0 Laboratory Analysis 9
4.1 Laboratory Analysis 9
4.2 Laboratory Analytical Results 9
4.2.1 Soil Sample Analytical Results 9
4.2.2 Groundwater Sample Analytical Results 9
4.2.3 Sub-Slab Soil Gas Sample Analytical Results 9
5.0 Discussion and Conclusions 11
5.1 Regulatory Agency Guidance 11
5.2 Discussion 11
5.3 Summary and Conclusions 12

ATTACHMENTS

Tables
1. Summary of Investigation Scope
2. Soil Sample Laboratory Results Summary
3. Groundwater Sample Laboratory Results Summary
4. Sub-Slab Soil Gas Sample Laboratory Results Summary

Figures
1. Site Vicinity Map
2. Topographic Map
3. Sample Location Map

Appendices
A. Boring Logs
B. Laboratory Analytical Reports

1.0 INTRODUCTION

1.1 Purpose

The purpose of the investigation was to evaluate the potential impact of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and/or metals to soil gas, soil, and/or groundwater as a consequence of a release or releases from the general historical former industrial use of the subject property and/or CREC sites. Berkadia Commercial Mortgage LLC provided project authorization of Partner Proposal Number P18-215232.3.

1.2 Limitations

This report presents a summary of work conducted by Partner. The work includes observations of site conditions encountered and the analytical results provided by an independent third party laboratory of samples collected during the course of the project. The number and location of samples were selected to provide the required information. However, it cannot be assumed that the limited available data are representative of subsurface conditions in areas not sampled.

Conclusions and/or recommendations are based on the observations, laboratory analyses, and the governing regulations. Conclusions and/or recommendations beyond those stated and reported herein should not be inferred from this document.

Partner warrants that the environmental consulting services contained herein were accomplished in accordance with generally-accepted practices in the environmental engineering, geology, and hydrogeology fields that existed at the time and location of work. No other warranties are implied or expressed.

1.3 User Reliance

Partner was engaged by Berkadia Commercial Mortgage LLC (the Addressee), or their authorized representative, to perform this investigation. The engagement agreement specifically states the scope and purpose of the investigation, as well as the contractual obligations and limitations of both parties. This report and the information therein, are for the exclusive use of the Addressee. This report has no other purpose and may not be relied upon, or used, by any other person or entity without the written consent of Partner. Third parties that obtain this report, or the information therein, shall have no rights of recourse or recovery against Partner, its officers, employees, vendors, successors or assigns. Any such unauthorized user shall be responsible to protect, indemnify and hold Partner, the Addressee and their respective officers, employees, vendors, successors and assigns harmless from any and all claims, damages, losses, liabilities, expenses (including reasonable attorneys' fees) and costs attributable to such use. Unauthorized use of this report shall constitute acceptance of, and commitment to, these responsibilities, which shall be irrevocable and shall apply regardless of the cause of action or legal theory pled or asserted.

This report has been completed under specific Terms and Conditions relating to scope, relying parties, limitations of liability, indemnification, dispute resolution, and other factors relevant to any reliance on this report. Any parties relying on this report do so having accepted Partner's standard Terms and Conditions, a copy of which can be found at http: / www.partneresi.com/terms-and-conditions.php

2.0 SITE BACKGROUND

2.1 Site Description

The subject property consists of three parcels of land comprising 2.185 acres located to the north and west of Fox Shores Drive within a mixed commercial and residential area of Kaukauna, Wisconsin. The subject property is currently occupied by the Fox Shores Apartments for residential use. Onsite operations consist of general residential operations and maintenance activities. In addition to the current structures, the subject property is also improved with paved-parking areas and limited landscaping

The subject property is bound by Fox River to the north, Fox Shores Drive beyond which is Ghost Town Fitness Center (180 Fox Shores Drive) to the east, Bicentennial Court beyond which is City of Kaukauna Street and Parks Department operations facility (206 West Third Street and 201 Reaume Avenue) to the south, and River Park Place Apartments (420 Bicentennial Court to the west. Refer to Figure 1 for a site plan showing site features and surrounding properties.

2.2 Site History

Partner completed a *Phase I Environmental Site Assessment Report* (Phase I), dated July 6, 2018, prepared on behalf of Berkadia Commercial Mortgage LLC. According to the reviewed historical sources, the subject property was formerly developed as early as circa 1890. Development activities, as depicted on Sanborn fire insurance maps, indicate the subject property and vicinity were developed as part of the Chicago and Northwest Rail Road Shops. Numerous structures were developed on the subject property between approximately 1890 until at least 1971 per historical aerial imagery. Aerial imagery depicts the site as undeveloped in 1982. Tax assessor documents indicate development of the subject property began in 1983 with the development of the existing multi-family residential structures along Bicentennial Court. A second phase of residential structures were developed in 1992 along Fox Shores Drive.

The 1925 Sanborn map depicts a carpentry shop, machine shop, repair shop, engine room, coal room, blacksmith shop, supply warehouses, tin shop, and pipe shed. It is assumed that these occupants and structures existed at the subject property throughout the period (c. 1890-1971) the subject property was developed for railroad services.

The Phase I identified the following recognized environmental condition (REC) associated with the subject property:

> The west adjacent property, identified as the USACE (United States Army Corps of Engineers) – Parcel J (Kaukauna Power Canal) is an open Environmental Repair Program (ERP) case on the online Wisconsin Bureau for Redevelopment and Remediation Tracking (WI BRRTS) database. The site's address is identified as the "end of 420 Bicentennial Court". The responsible party for this site is listed at the USACE. According to Wisconsin Department of Natural Resources (WDNR) records, the constituent of concern for this site is identified as lead and impacts are known to be present in the soil media. The case was opened and responsible party notified on March 1, 2003. To date, no remedial activities have occurred. Per correspondence with the WDNR case manager assigned to site, the USACE has not made efforts to pursue remediation of the site. Parcel J, as depicted on a sampling map obtained from the WDNR, encompasses the shoreline of the Fox

River beginning to the west of the subject property and extends eastward toward the subject property, ultimately concluding at the northeast corner of the subject property. In total, this site represents the north and northwest adjacent property. Soil sampling results from 2004 and 2005 subsurface investigation indicate elevated levels of lead immediately north and northwest of the subject property boundary along the Fox River shoreline.

Limited information is available for the USACE – Parcel J site given the USACE's denial of responsibility for the contamination to date. Correspondence with WDNR also indicated the site's priority level with the WDNR does not qualify it for State funded remediation. As of the August 9, 2016 semi-annual status report, no action has been taken at the site. The WDNR will continue to issue semi-annual status updates per WDNR policy; however, at this time, no action is anticipated. Based on the known soil contamination abutting the northern and northwestern boundary of the subject property, this site represents a REC.

Two controlled RECs (CRECs) were identified:

1. The property, identified as Ghost Town Fitness Center at 180 Fox Shores Drive, is located adjacent to the east of the subject property and is associated with arsenic and selenium groundwater impact.
2. The property, identified as the Kaukauna Waste Oil Collection Site at 201 West 2nd Street, 222 3rd Street, and 3rd Street 200 Block, and is located adjacent to the south of the subject property beyond Bicentennial Court and is associated with petroleum soil and groundwater impact.

According to a Phase II Subsurface Investigation conducted at the south adjacent property and correspondence with the WDNR, the depth and direction of groundwater in the vicinity of the subject property is inferred to be approximately five feet below ground surface (bgs) and flow toward the southeast

2.3 Geology and Hydrogeology

Based on a review of the United States Geological Survey (USGS) *Kaukauna Wisconsin* Quadrangle topographic map, the subject property is situated at an elevation approximately 657 feet above mean sea level, and the local topography is sloping gently to the southeast. Refer to Figure 2 for a topographic map of the site vicinity.

The subject property is situated within the Eastern Ridges and Lowlands physiographic province of the State of Wisconsin. The topography of the eastern ridges and lowlands is controlled by cuestas. The westernmost ridge is the rather low, narrow cuesta formed by the resistant Lower Magnesian limestone. It is alluded to hereafter as the Magnesian cuesta. The eastern upland is the higher and broader cuesta of Niagara limestone. The intermediate Green Bay- Lake Winnebago- Rock River lowland lies upon the belt of Black River and Galena limestone, with the gentle back slope of the Magnesian cuesta for one wall and the steep escarpment of the Niagara cuesta for the other.

Based on information obtained from the United States Department of Agriculture (USDA) Natural Resources Conservation Service Web Soil Survey online database, the subject property is mapped as Udorthents. Udorthents consists of well drained to excessively drained soils along mainly the southern

edge of Block Island adjacent to Block Island Sound in the Mohegan Bluff area. Wind, waves, and rain have eroded these soils and undercut areas on bluffs. Areas are long and narrow and mostly range from 10 to 200 acres mainly loamy sand, sandy loam and silty clay loam that are well drained with 0 to 5 percent slopes.

Based on borings advanced during this investigation, the underlying subsurface consists predominantly of black clay with some sand and gravel from the ground surface to approximately 6 feet below ground surface (bgs). From 6 feet to 10 feet bgs, the subsurface consists predominantly of brown to gray clay with some sand and gravel. Groundwater was encountered during this investigation between 4.5 and 7 feet bgs.

3.0 FIELD ACTIVITIES

The scope of the Phase II Subsurface Investigation included a limited geophysical survey (boring clearance only), the advancement of five borings (B1 through B5) for the collection of representative soil and groundwater samples, and the installation of three temporary sub-slab soil gas sampling points for the collection of representative soil gas samples. Refer to Table 1 for a summary of the borings, sampling schedule and laboratory analyses for this investigation.

3.1 Preparatory Activities

Prior to the initiation of fieldwork, Partner completed the following activities.

3.1.1 Utility Clearance

Partner subcontracted with the driller Johnson Probing, Inc. (Johnson) who notified Wisconsin Diggers Hotline to clear public utility lines as required by law at least 72 hours prior to drilling activities. Wisconsin Diggers Hotline issued ticket numbers 20183912709 for the project.

In addition, Partner subcontracted with Ground Penetrating Radar Systems, Inc. (GPRS) of Wisconsin on October 3, 2018 to clear boring locations of utilities. GPRS systematically free-traversed each proposed boring location with a Radio-detection model RD7000 electromagnetic induction (EM) equipment unit with line-tracing capabilities, and a GSSI model SIR-3000 ground penetrating radar (GPR) unit. The equipment data were interpreted in real time for evidence of utility lines and/or other subsurface features of potential concern. Borings were positioned based on the geophysical survey results to avoid damaging underground features. No significant boring location limitations were encountered.

3.1.2 Health and Safety Plan

Partner prepared a site-specific Health and Safety Plan, which was reviewed with on-site personnel involved in the project prior to the commencement of drilling activities.

3.2 Drilling Equipment

On October 3, 2018, Partner subcontracted with Johnson to provide and operate drilling equipment. Johnson, under the direction of Partner, advanced five exterior soil borings (B1 through B5) with a Geoprobe model 6610DT. The temporary sub-slab soil gas pins were installed with a hand drill. Drilling rods and sampling equipment were decontaminated between samples and borings to prevent cross-contamination

3.3 Boring Locations

Borings B1 and B2 were advanced respectively at the exterior southeastern and southwestern portions of the subject property in the area of historic industrial operations. Boring B3 was advanced at the exterior west central portion of the subject property in the area of historic industrial operations. Boring B4 was advanced at the exterior northwestern portion of the subject property in the area of historic industrial operations. Boring B5 was advanced at the exterior north central portion of the subject property in the area of historic industrial operations. Given the former general industrial use, the borings were placed to generally cover the extent of the property. Refer to Figure 3 for a map indicating boring locations.

3.4 Soil Sampling

Borings B1 through B4 were each advanced by the direct-push drill rig to a terminal depth of 10 feet bgs. Boring B5 was advanced by the direct-push drill rig to a terminal depth of 7 feet bgs due to probe refusal.

Soil samples were collected using a 5-foot long by 2.25-inch diameter MacroCore sampler with a 5-foot long acetate liner, which was advanced by the direct-push drill rig using 5-foot long by 1.5-inch diameter drill rods. The samplers were driven into the subsurface to allow undisturbed soil to enter the open MacroCore barrel and retrieved to recover the soil-filled liners. A lengthwise section of each acetate liner was removed with a splitting tool to expose the soil and the samples were collected using a stainless spoon. The soil column at each boring was visually inspected for discoloration, monitored for odors, and classified in accordance with the Unified Soil Classification System (USCS). Additionally, the soil column was field-screened with a photoionization detector (PID) calibrated to 100 parts per million (ppm) isobutylene.

Based on borings advanced during this investigation, the underlying subsurface consists predominantly of black clay with some sand and gravel from the ground surface to approximately 6 feet bgs. From 6 feet to 10 feet bgs, the subsurface consists predominantly of brown to gray clay with some sand and gravel. Groundwater was encountered during this investigation between 4.5 and 7 feet bgs.

No visual and olfactory evidence of impacted conditions was detected in any of the borings. PID readings on the soil profile screened from borings B1 through B5 ranged from 0.0 ppm to 0.1 ppm.

Refer to Appendix A for a copy of the soil boring logs.

Soil depths selected for laboratory analysis were sampled directly from the liners using a disposable plastic syringe and retained in two sodium bisulfate-preserved and one methanol volatile organics analysis (VOA) vials in accordance with United States Environmental Protection Agency (EPA) Method 5035 sampling protocol. A soil sample was also collected by transferring soil into a laboratory-supplied, 4-ounce, wide-mouth, unpreserved glass jar, which was sealed with a threaded, Teflon-lined lid for PAHs and Resource Conservation and Recovery Act (RCRA) 8 metals analysis. The jars were filled with soil to capacity to minimize headspace and reduce the potential for volatilization. The jars and VOA vials were labeled for identification and stored in an iced-cooler.

As no staining or elevated PID readings were encountered, soil samples from each boring B1 through B5 were collected from intervals above the groundwater interface from depths between 3 and 8 feet bgs. A surficial soil sample was collected from each boring B1 through B5 at intervals 0.5-1.0 feet bgs (to address the reported metals surficial impacts on the adjacent property).

3.5 Groundwater Sampling

After soil sampling to the terminal depth, groundwater samples were collected by withdrawing the drill rods from the subsurface and installing ¾-inch diameter temporary monitoring wells within the open boreholes of borings B1 through B5. Each monitoring well consisted of a five-foot long, 0.010-inch factory-slotted polyvinyl chloride (PVC) screen at the terminal end and blank PVC risers from the top of the screen interval to the ground surface. New screens, risers, and tubing were used for each temporary monitoring well. Groundwater samples were collected from temporary well points at borings B1 through

B4 screened from 5 feet bgs to 10 feet bgs. Groundwater sample was collected from temporary well point at borings B5 screened from 2 feet bgs to 7 feet bgs

Groundwater samples were retrieved from each monitoring well using a new section of 3/8-inch diameter Teflon tubing fed through a peristaltic pump and conveyed into three hydrochloric acid-preserved and two unpreserved VOA vials and two 250 mL amber jars. Each vial was filled with no observable headspace or air bubbles to minimize the potential for volatilization, labeled for identification, and stored in an iced cooler.

3.6 Sub-Slab Soil Gas Sampling

To facilitate the collection of a soil gas sample from beneath the subject property, temporary sub-slab soil gas sample point VP-1 through VP-3 were advanced using a power hand drill to a depth of 1.0 feet bgs through the floor slab. The sub-slab soil-gas sampling point, consisting of a pre-fabricated stainless steel Vapor Pin™ equipped with a silicone sleeve, was manually inserted into a $^{5}/_{8}$-inch diameter hole drilled through the concrete slab of the subject property building using a rotary hammer drill. After installing the Vapor Pin™ a protective cap was placed over the barbed sampling end of the Vapor Pin™ and a water dam was installed around the Vapor Pin™ to further ensure that an air tight seal was present around the sampling point. Once the air tight seal was confirmed, the water dam was removed and the sample tubing and the Vapor Pin™ were purged of ambient air using a PID. The sampling end of the tubing was initially connected to a PID to field screen the soil-gas conditions relating to VOCs and to purge the sample point. The soil-gas sample point was purged for approximately two minutes. The PID readings were 0.0 ppm. Prior to purging, ambient air quality was monitored at the subject property and PID background reading was 0.0 ppm. After the ambient air was purged from the sample tubing and Vapor Pin™, a connection was made with new Teflon tubing and a laboratory-supplied certified clean 1-liter Summa® canisters equipped with 5.0-minute flow controllers.

Soil gas samples were collected in general accordance with the Wisconsin Department of Natural Resources (WDNR) Indoor Air Vapor Levels and Vapor Risk Screening Levels based on the May 2016 EPA Regional Screening Level Tables

Soil gas samples were collected using 1-liter, stainless-steel, cylindrical Summa® canisters. The sampling containers were provided by Pace Analytical (Pace), which subjected each canister to a rigorous cleaning process using a combination of dilution, heat, and high vacuum. After cleaning, the canisters were batch certified to be free of target contaminants to a specified reporting limit via gas chromatography/mass spectroscopy prior to delivery. Partner received the Summa® canisters evacuated to approximately 30 inches of mercury. The Summa® canisters were fitted with stainless-steel flow controllers, which ESC calibrated to maintain constant flow (approximately 200 milliliters per minute) for approximately five minutes of sampling time.

Each probe was allowed to equilibrate after installation prior to sampling. After equilibration, the sample tubing and sampler screen were purged of ambient air using a syringe and a PID reading was collected. Once the tubing was evacuated of ambient air, the sampling end of the tubing was fitted to the sampling canister and the port valve was opened, causing air to enter the sample container due to the pressure differential. Partner closed the valves after the canister was evacuated to approximately two inches of

mercury, with pertinent data (e.g., time, canister vacuum) recorded at the start and end of sampling. The Summa® canisters were labeled for identification and stored away from direct sunlight prior to analysis.

Refer to Figure 3 for a map indicating sub-slab sample location.

3.7 Post-Sampling Activities

Probes/temporary well points were removed from the subsurface and the boreholes were backfilled with hydrated bentonite chips following sampling activities. Following the removal of the Vapor Pin, the concrete slab and the hole created by the drill was backfilled with hydraulic concrete patch.

No significant amounts of derived wastes were generated during this investigation.

4.0 LABORATORY ANALYSIS

4.1 Laboratory Analysis

Partner collected ten soil samples, five groundwater samples, and three soil gas samples on October 3, 2018, which were transported in an iced cooler and/or shipping container (sub-slab) under proper chain-of-custody protocol Environmental Science Corporation Lab Sciences, Inc. (ESC), a state-certified laboratory [Wisconsin state accreditation certificate number 9980939910] in the City of Mount Juliet, Tennessee, for analysis on October 4, 2018.

Based on field-screening results, visual observations, and/or olfactory observations, two soil samples and one groundwater were collected from each boring. The deeper soil samples were analyzed for VOCs in accordance with EPA Method 8260 and PAHs single ion monitoring (SIM) in accordance with EPA Method 8270. The shallow soil samples were analyzed for Resource Conservation and Recovery Act (RCRA) 8 metals via EPA Methods 6010 and 7471. The groundwater samples were analyzed for VOCs in accordance with EPA Method 8260 and PAHs-SIM in accordance with EPA Method 8270.

The sub-slab soil gas samples were analyzed for VOCs in accordance with EPA Method TO-15.

4.2 Laboratory Analytical Results

Laboratory analytical results are included in Appendix B and discussed below.

4.2.1 Soil Sample Analytical Results

Several VOCs (including acetone, benzene, ethylbenzene, 2- butanone, naphthalene, toluene, 1,2,4-trimethylbenzene and 1,2,3-trimethylbenzene were detected at concentrations above the laboratory reported detection limit (RDLs) in one or more of the analyzed soil samples. No other VOCs were detected in the soil samples analyzed.

Between two and seventeen PAHs were detected at concentrations above the laboratory RDLs in soil samples B1(0.5-1), B3(3.-4) and B4 (6-7). PAHs were not present at detectable concentrations in the remaining soil samples analyzed. RCRA 8 metals including arsenic, barium, cadmium, chromium, lead, selenium and mercury were detected in the all soil samples analyzed for metals. Refer to Table 2 for a summary of the soil sample laboratory analysis results.

4.2.2 Groundwater Sample Analytical Results

One VOC constituent, p-isopropyltoluene, was detected at a concentration above the laboratory RDLs in the groundwater sample B1-GW. No other VOCs were detected in the remaining groundwater samples analyzed. Several PAHs were detected at concentrations above the laboratory RDLs in the groundwater samples B1-GW through B5-GW collected from borings B1 through B5 respectively.

Refer to Table 3 for a summary of the groundwater sample laboratory analysis results.

4.2.3 Sub-Slab Soil Gas Sample Analytical Results

Several VOCs including acetone, benzene, cyclohexane, ethanol, ethylbenzene, trichlorofluoromethane, dichlorodifluoromethane, heptane, n-hexane, methylene chloride, 2-butanone (MEK), 2-propanol,

propene, tetrachloroethene (PCE), toluene, trichloroethene (TCE), 1,2,4–trimethylbenzene, 1,3,5-trimethylbenzene, m & p xylene and o-xylene were detected above the laboratory sample detection limit in at least one or more of the sub-slab soil gas samples analyzed. No other VOCs were identified above the laboratory detection limts in the analyzed soil gas samples.

Refer to Table 4 for a summary of the sub-slab soil gas sample VOCs laboratory analysis results.

5.0 DISCUSSION AND CONCLUSIONS

5.1 Regulatory Agency Guidance

Soil Guidance

The analytical results of soil samples collected during this subsurface investigation were compared to calculate Site-Specific Residual Contaminant Levels (SSRCLs) using the EPA Regional Soil Screening Level Web Calculator and the WDNR Remediation & Redevelopment (RR) Program's guidance document entitled *Soil Residual Contaminant Level Determinations Using the U.S. EPA Regional Screening Level Web Calculator*, PUB-RR-890 issued January 23, 2014. Partner utilized the most recently updated WDNR RR program spreadsheet (June 2016) to obtain the Residual Contaminant Levels (RCLs) based on either the direct contact pathway (for sample results collected from zero to four feet bgs) and the soil to groundwater pathway (for sample results collected deeper than four feet bgs) for non-industrial property use as set forth in the *Department of Natural Resources Chapter NR 720 (NR 720) of the Wisconsin Administrative Code* (Wis. Adm. Code).

Groundwater Guidance

The groundwater sample analytical results were compared to groundwater contaminant concentrations as set forth in Department of Natural Resources Chapter NR 140, Wis. Admin. Code (NR 140). For each regulated compound, two standards have been established: the Enforcement Standard (ES) and the Preventive Action Limit (PAL). In general, if the regulated contaminant concentration exceeds the PAL value, but is below the ES value, the WDNR may require additional investigation/continued monitoring. If the regulated contaminant concentration exceeds the ES value, the WDNR may require additional investigation, continued monitoring, and/or remediation.

Sub-Slab Soil Gas Guidance

The sub-slab soil gas sample analytical results were compared to WDNR Vapor Risk Screening Levels (VRSLs) which are based on EPA regional screening level tables, applying a $1x10^{-5}$ excess lifetime cancer risk, or hazard index (HI) of 1. Current land use at the subject property is residential; therefore, residential standards were used.

5.2 Discussion

Soil

Exceedances of targeted RCRA metals were detected in the surficial soil samples collected from borings B1 through B5. Specifically, arsenic was detected at concentrations 17.7 milligrams per kg (mg/kg), 0732 mg/kg, 3.07 mg/kg, 116 mg/kg and 7.56 mg/kg in l the surficial soil samples B1(0.5-1) through B5(0.5-1) respectively exceeding the direct contact pathway non- industrial RCLs and the groundwater pathway RCLs. Lead was detected at concentrations of 940 mg/kg, 209 mg/kg, 272 mg/kg and 205 mg/kg in soil sample B1(0.5-1), B3(0.5-1), B4(0.5-1) and B5(0.5-1) respectively exceeding the groundwater pathway RCL and/or the direct contact pathway non- industrial RCLs. Cadmium, selenium and mercury exceedances were also detected in the surficial soil samples B1(0.5-1), B4(0.5-1) and B5(0.5-1). The detected VOCs and

PAHs in the soil samples were all below their applicable RCLs. Soil results indicate surficial soil at the property has been impacted with metals.

Groundwater

The PAH constituents benzo(a)pyrene and chrysene were detected at concentrations of 0.225 micrograms per liter (µg/l) and 0.454 µg/l in in groundwater sample B3-GW, exceeding their corresponding WDNR ES and PALs. Benzo(b)fluoranthene and fluoranthene were detected at concentrations of 0.156 µg/l and 0.243 µg/l in groundwater sample B3-GW at concentrations exceeding their respective PALs. Benzo(a)pyrene benzo(b)fluoranthene, chrysene and fluoranthene were also detected at concentrations of 0.0766 µg/l, 0.116 µg/l, 0.118 µg/l and 0.203 µg/l in groundwater sample B5-GW at concentrations exceeding their respective PALs. The remaining detectable concentrations of VOCs and PAHs in the analyzed groundwater samples did not exceed their respective RCLs.

The detected PAH exceedances in the groundwater samples warrants additional investigation/continued monitoring. Specifically, the elevated concentration may be attributable to the turbidity of the samples.

Soil Gas

Of the detected concentrations of VOCs in the analyzed soil gas samples, dichlorodifluoromethane was detected at concentrations of 7,060 micrograms per cubic meter (µg/m^3), 12,6000 µg/m^3 and 7,9000 µg/m^3 in VP-1, VP-2 and VP-3 respectively exceeding the applicable WDNR soil gas VRSL. The compound is a known Freon gas and may be associated with leaks from the on-site air conditioning system. Given the lack of significant concentrations of other VOCs, the dichlorodifluoromethane detections and exceedances do not appear related to the REC. However, further investigation would be required to verify the source.

5.3 Summary and Conclusions

Partner conducted a Phase II Subsurface Investigation at the subject property to evaluate the potential impact of VOCs, PAHs, and/or metals to soil, groundwater and or/soil gas as a consequence of a release or releases from the general historical former industrial use of the subject property and/or adjacent CREC sites.

The scope of the Phase II Subsurface Investigation included a geophysical survey to clear boring locations and the advancement of five borings (B1 through B5) within the subject property for the collection of investigative soil and groundwater samples. Additionally, three temporary sub-slab soil gas points (VP-1 through VP-5) was installed within the subject property.

Based on borings advanced during this investigation, no visual or olfactory evidence of impacted conditions were detected from the soil profile screened in any of the borings. No elevated PID readings were recorded on the soil profile screened from borings B1 through B5.

Based on field-screening results, visual observations, and/or olfactory observations, ten soil samples and five groundwater samples were collected from borings B1 through B5. Two soil samples (surficial and deeper) and one groundwater sample were collected from each boring. Three sub-slab soil gas samples VP-1 through VP-3 were also collected from the property

The soil samples were analyzed for VOCs in accordance with EPA Method 8260, PAHs single ion monitoring (SIM) in accordance with EPA Method 8270, and/or Resource Conservation and Recovery Act (RCRA) 8 metals via EPA Methods 6010 and 7471. The groundwater samples were analyzed for VOCs in accordance with EPA Method 8260 and PAHs-SIM in accordance with EPA Method 8270.

The sub-slab soil gas samples were analyzed for VOCs in accordance with EPA Method TO-15.

The analytical results of soil samples collected indicated exceedances of targeted RCRA metals including arsenic, cadmium, lead selenium and mercury in the surficial soil samples collected from borings B1 through B5. No VOCs and PAHs exceedances were detected in all the soil samples analyzed. Soil results indicate surficial soil at the property has been impacted with metals.

The analytical results of groundwater samples indicated that PAH constituents including benzo(b)fluoranthene, fluoranthene, benzo(a)pyrene and chrysene were detected in groundwater samples B3-GW and B5-GW at concentrations that exceed their corresponding WDNR ES and/or PALs. The detected PAH exceedances in the groundwater samples warrants additional investigation/continued monitoring. The elevated concentration may be attributable to the turbidity of the samples.

The analytical results of sub-slab soil gas sample indicate that of the detected concentrations of VOCs in the analyzed soil gas samples, only dichlorodifluoromethane exceeded the applicable WDNR soil gas VRSL. Given the lack of significant concentrations of other VOCs, the dichlorodifluoromethane detections and exceedances do not appear related to the REC. However, further investigation would be required to verify the source.

Based on the Phase II Subsurface Investigation, there is evidence of surficial soil metals impacts, possibly relating to the known USACE site. Partner recommends further investigation at the subject property.

TABLES

Table 1 : Summary of Investigation Scope
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project Number 18-215232.3
October 3, 2018

Borehole Identification	Location	Terminal Depth (feet bgs)	Sample Identification	Matrix Sampled	Sampling Depths (feet bgs)	Target Contaminants
B1	Exterior southeastern portion of subject property in the area of historic industrial operations	10.0	B1(0.5-1)	Soil	0.5 - 1.0	VOCs (8260), PAHs-SIM (8270), RCRA 8 metals (6010 & 7471)
			B1(6.0-7.0)		6.0 - 7.0	
			B1-GW	Groundwater	7.0 - 10.0	VOCs (8260), PAHs-SIM(8270)
B2	Exterior southwestern portion of subject property in the area of historic industrial operations	10.0	B2(0.5-1.0)	Soil	0.5 - 1.0	VOCs (8260), PAHs-SIM (8270), RCRA 8 metals (6010 & 7471)
			B2(7.0-8.0)		7.0 - 8.0	
			B2-GW	Groundwater	8.0 - 10.0	VOCs (8260), PAHs-SIM(8270)
B3	Exterior west central portion of subject property in the area of historic industrial operations	10.0	B3(0.5-1.0)	Soil	0.5 - 1.0	VOCs (8260), PAHs-SIM (8270), RCRA 8 metals (6010 & 7471)
			B3(3.0-4.0)		3.0 - 4.0	
			B3-GW	Groundwater	5.0 - 10.0	VOCs (8260), PAHs-SIM(8270)
B4	Exterior northwestern portion of subject property in the area of historic industrial operations	10.0	B4(0.5-1.0)	Soil	0.5 - 1.0	VOCs (8260), PAHs-SIM (8270), RCRA 8 metals (6010 & 7471)
			B4(6.0-7.0)		6.0 - 7.0	
			B4-GW	Groundwater	5.0 - 10.0	VOCs (8260), PAHs-SIM(8270)
B5	Exterior north central portion of subject property in the area of historic industrial operations	7.0	B5(0.5-1.0)	Soil	0.5 - 1.0	VOCs (8260), PAHs-SIM (8270), RCRA 8 metals (6010 & 7471)
			B5(3.5-4.5)		3.5 - 4.5	
			B5-GW	Groundwater	4.5 - 7.0	VOCs (8260), PAHs-SIM(8270)
VP-1	Interior northwestern portion of property in the area of historic industrial operations	1.0	VP-1	Soil gas	0.5 - 1.0	VOCs (TO-15)
VP-2	Interior southwestern portion of property in the area of historic industrial operations	1.0	VP-2	Soil gas	0.5 - 1.0	VOCs (TO-15)
VP-3	Interior southeastern portion of property in the area of historic industrial operations	1.0	VP-3	Soil gas	0.5 - 1.0	VOCs (TO-15)

Notes:
VOCs (8260)= Volatile organic compounds in accordance with United States Environmental Protection Agency (EPA) method 8260
PAHs (8270)= Polycyclic aromatic hydrocarbons in accordance with United States Environmental Protection Agency (EPA) method 8270
VOCs (TO-15)= Volatile organic compounds in accordance with United States Environmental Protection Agency (EPA) method TO-15
RCRA = Resource Conservation and Recovery Act in accordance with EPA methods 6010 and 7471
SIM = Single ion monitoring
bgs = Below ground surface

Table 2 : Soil Sample Laboratory Results Summary
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project Number 18-215232.3
October 3, 2018

Analyte	WDNR RCL Direct Contact - Non Industrial	WDNR Groundwater Pathway RCL	B1 (0.5-1)	B1 (6-7)	B2 (0.5-1)	B2 (7-8)	B3 (0.5-1)	B3 (3-4)	B4 (0.5-1)	B4 (6-7)	B5 (0.5-1)	B5 (3.5-4.5)
Volatile Organic Compounds (VOCs) via 8260B (mg/kg)												
ACETONE	63400	3.68	NA	<0.0287	NA	<0.0278	NA	<0.0293	NA	0.0363	NA	0.0394
BENZENE	1.6	0.0051	NA	<0.00115	NA	<0.00111	NA	<0.00117	NA	0.000791J	NA	<0.00123
ETHYLBENZENE	8.02	1.57	NA	<0.00287	NA	<0.00278	NA	<0.00293	NA	0.000998J	NA	<0.00308
2-BUTANONE (MEK)	28400	1.67	NA	0.0193J	NA	0.028	NA	0.0297	NA	0.0274J	NA	0.0349
NAPHTHALENE	5.52	0.658	NA	<0.0144	NA	<0.0139	NA	<0.0146	NA	0.00448J	NA	<0.0154
TOLUENE	8.18	1.11	NA	<0.00574	NA	0.00149J	NA	0.00154J	NA	0.00569J	NA	<0.00616
1,2,4-TRIMETHYLBENZENE	219	1.38	NA	<0.00574	NA	<0.00557	NA	<0.00585	NA	0.00242J	NA	<0.00616
1,2,3-TRIMETHYLBENZENE	NE	NE	NA	<0.00574	NA	<0.00557	NA	<0.00585	NA	0.00162J	NA	<0.00616
Polycyclic Aromatic Hydrocarbons (PAHs) via 8270C-SIM (mg/kg)												
ANTHRACENE	17900	197	NA	<0.00689	NA	<0.00668	NA	0.00425J	NA	<0.00706	NA	<0.00739
ACENAPHTHENE	3590	NE	NA	<0.00689	NA	<0.00668	NA	0.00231J	NA	<0.00706	NA	<0.00739
BENZO(A)ANTHRACENE	NE	NE	NA	<0.00689	NA	<0.00668	NA	0.018	NA	<0.00706	NA	<0.00739
BENZO(A)PYRENE	0.115	0.47	NA	<0.00689	NA	<0.00668	NA	0.02	NA	<0.00706	NA	<0.00739
BENZO(B)FLUORANTHENE	1.15	0.478	NA	<0.00689	NA	<0.00668	NA	0.0265	NA	<0.00706	NA	<0.00739
BENZO(G,H,I)PERYLENE	NE	NE	NA	<0.00689	NA	<0.00668	NA	0.0158	NA	<0.00706	NA	<0.00739
BENZO(K)FLUORANTHENE	11.5	NE	NA	<0.00689	NA	<0.00668	NA	0.0102	NA	<0.00706	NA	<0.00739
CHRYSENE	11.5	0.144	NA	<0.00689	NA	<0.00668	NA	0.0268	NA	<0.00706	NA	<0.00739
DIBENZ(A,H)ANTHRACENE	0.115	NE	NA	<0.00689	NA	<0.00668	NA	0.0031J	NA	<0.00706	NA	<0.00739
FLUORANTHENE	2390	88.9	NA	0.000821J	NA	<0.00668	NA	0.0521	NA	0.000857J	NA	<0.00739
FLUORENE	2390	14.8	NA	<0.00689	NA	<0.00668	NA	0.00253J	NA	<0.00706	NA	<0.00739
INDENO(1,2,3-CD)PYRENE	1.15	NE	NA	<0.00689	NA	<0.00668	NA	0.0125	NA	<0.00706	NA	<0.00739
NAPHTHALENE	5.52	0.658	NA	<0.0230	NA	<0.0223	NA	0.00723J	NA	<0.0235	NA	<0.0246
PHENANTHRENE	NE	NE	NA	0.000704J	NA	<0.00668	NA	0.0351	NA	<0.00706	NA	<0.00739
PYRENE	1790	54.5	NA	<0.00689	NA	<0.00668	NA	0.0349	NA	<0.00706	NA	<0.00739
1-METHYLNAPHTHALENE	17.6	NE	NA	<0.0230	NA	<0.0223	NA	0.00581J	NA	<0.0235	NA	<0.0246
2-METHYLNAPHTHALENE	239	NE	NA	<0.0230	NA	<0.0223	NA	0.00786J	NA	<0.0235	NA	<0.0246
Resource Conservation & Recovery Act (RCRA) 8 metals via 6010 and 7471 (mg/kg)												
ARSENIC	0.677	0.584	17.7	NA	0.732J	NA	3.07	NA	116	NA	7.55	NA
BARIUM	15300	165	81.8	NA	42.4	NA	76.1	NA	58.9	NA	49.3	NA
CADMIUM	71.1	0.752	2.8	NA	<0.230	NA	0.335	NA	2.01	NA	0.753	NA
CHROMIUM	100000	360000	22.6	NA	15.7	NA	17.9	NA	14	NA	11.5	NA
LEAD	400	27	940	NA	5.1	NA	209	NA	272	NA	205	NA
SELENIUM	391	0.52	2.58	NA	<2.30	NA	<2.28	NA	0.932J	NA	0.873J	NA
MERCURY	3.13	0.208	0.492	NA	0.0466	NA	0.0259	NA	0.0467	NA	0.11	NA

Notes:
WDNR = Wisconsin Department of Natural Resources
RCL = Residual Contaminant Level
bgs = below ground surface
SIM = selective ion monitoring
mg/kg = milligrams per kilogram
J = The identification of the analyte is acceptable; the reported value is an estimate
RDL = laboratory Reported Detection Limit
< = not detected above indicated RDL
NE = not established
NA = not analyzed
Values indicate a criteria exceedance

Table 3 : Groundwater Sample Laboratory Results Summary
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project Number 18-215232.3
October 3, 2018

Analyte	WDNR Enforcement Standards (ES)	WDNR Preventative Action Limits (PAL)	B1-GW	B2-GW	B3-GW	B4-GW	B5-GW
Volatile Organic Compounds (VOCs) via 8260B (µg/l)							
P-ISOPROPYLTOLUENE	NL	NL	1.56	<5.00	<1.00	<1.00	<1.00
NAPHTHALENE	100	10	<5.00	<25.0	<5.00	<5.00	<5.00
Polycyclic Aromatic Hydrocarbons (PAHs) via 8270C-SIM (µg/l)							
ANTHRACENE	3000	600	0.16	<0.0715	0.672	<0.0525	0.0292J
ACENAPHTHENE	NL	NL	<0.0590	<0.0715	0.107J	<0.0525	0.0155J
BENZO(A)ANTHRACENE	NL	NL	0.0151J	0.00712J	0.341J	0.00583J	0.0698
BENZO(A)PYRENE	0.2	0.02	<0.0590	<0.0715	**0.225J**	<0.0525	0.0766
BENZO(B)FLUORANTHENE	0.2	0.02	0.0099J	<0.0715	0.156J	<0.0525	0.116J
BENZO(G,H,I)PERYLENE	NL	NL	0.00654J	<0.0715	0.326J	<0.0525	0.0991
BENZO(K)FLUORANTHENE	NL	NL	<0.0590	<0.0715	<0.500	<0.0525	0.0328J
CHRYSENE	0.2	0.02	<0.0590	<0.0715	**0.454J**	<0.0525	0.118J
DIBENZ(A,H)ANTHRACENE	NL	NL	<0.0590	<0.0715	<0.500	<0.0525	0.0143J
FLUORANTHENE	0.4	0.08	0.0353J	<0.0715	0.243J	<0.0525	0.203
INDENO(1,2,3-CD)PYRENE	NL	NL	<0.0590	<0.0715	<0.500	<0.0525	0.061J
NAPHTHALENE	100	10	0.0557J	0.0566J	0.243J	0.0338J	0.0452J
PHENANTHRENE	NL	NL	0.0293J	<0.0715	0.334	<0.0525	0.205
PYRENE	250	50	0.0175J	<0.0715	2.22	<0.0525	0.152
1-METHYLNAPHTHALENE	NL	NL	0.0257J	0.018J	<2.50	0.0152J	0.0335J
2-METHYLNAPHTHALENE	NL	NL	0.02J5	0.0185J	<2.50	0.0156J	0.0418J

Notes:
WDNR = Wisconsin Department of Natural Resources
SIM = selective ion monitoring
µg/l = microgram per liter
J = The identification of the analyte is acceptable; the reported value is an estimate
RDL = laboratory Reported Detection Limit
< = not detected above indicated RDL
NL = not listed
Bold values indicate exceedance of most stringent criteria

Table 4 : Sub-Slab Soil Gas Sample Laboratory Results Summary
Fox Shores Apartments
400 Fox Shores Drive
Kaukauna, Wisconsin 54130
Partner Project Number 18-215232.3
October 3, 2018

ANALYTE	Residential SubSlab VRSL	VP-1	VP-2	VP-3
VOCs via EPA Method TO-15 (µg/m3)				
ACETONE	NE	2680	12.1	41.5
BENZENE	120	8.59	<1.28	<1.28
CYCLOHEXANE	NE	9.63	1.82	<1.38
ETHANOL	NE	6200	30.3	55.7
ETHYLBENZENE	370	22.4	2	2.39
TRICHLOROFLUOROMETHANE	NE	18.4	25	67.4
DICHLORODIFLUOROMETHANE	3300	**7060**	**126000**	**79000**
HEPTANE	NE	28.2	10.9	<1.64
N-HEXANE	NE	28.3	7.65	<1.41
METHYLENE CHLORIDE	21000	17.6	<1.39	<1.39
2-BUTANONE (MEK)	NE	26.1	<7.37	<7.37
2-PROPANOL	NE	15.8	<6.15	430
PROPENE	NE	<1.38	4.03	<1.38
TETRACHLOROETHENE	1400	<2.72	<2.72	7.27
TOLUENE	170000	44	2.61	2.66
TRICHLOROETHENE	70	6.39	<2.14	<2.14
1,2,4-TRIMETHYLBENZENE	2100	10.7	<1.96	<1.96
1,3,5-TRIMETHYLBENZENE	2100	2.46	<1.96	<1.96
M&P-XYLENE	3300	23.8	<3.47	6.94
O-XYLENE	3300	9.73	<1.73	3.21

Notes:
VOCs = Volatile organic compounds
VISL = vapor intrusion screening level
VRSL = vapor risk screening level
µg/m^3 = micrograms per cubic meter
EPA = United States Environmental Protection Agency
< = not detected above indicated laboratory Reporting Limit (RL)
NE = Not established
Values in bold exceeds standard
* = Target Soil-Gas Concentrations for Carcinogens in the Residential Exposure Scenario

FIGURES

PARTNER



PARTNER
Engineering and Science, Inc.
805 N. Milwaukee Ave, Suite 401
Chicago, Illinois 60642

Project Number: 18-215232.3

N

Legend

Subject Site

Site Vicinity Map

Figure	Prepared By	Date
1	J. Lokko	October 2018

400 Fox Shores Drive
Kaukauna, Wisconsin 54130



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805 N. Milwaukee Ave, Suite 401
Chicago, Illinois 60642

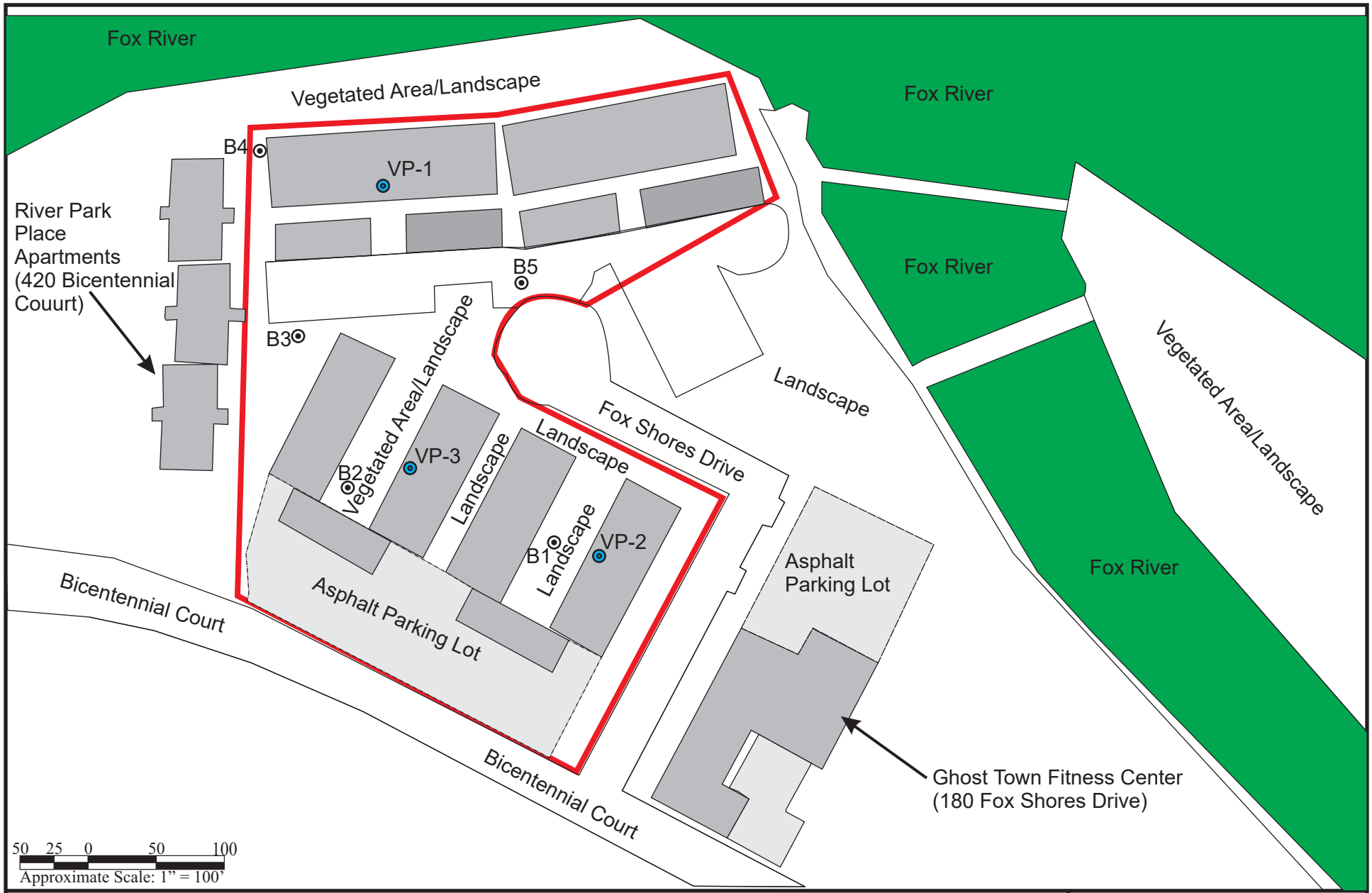
Project Number: 18-215232.3

USGS *Kaukauna, WI* Quadrangle
Version: 2016

Topographic Map

Figure	Prepared By	Date
2	J. Lokko	October 2018

400 Fox Shores Drive
Kaukauna, Wisconsin 54130



PARTNER
Engineering and Science, Inc.
805 N. Milwaukee Ave, Suite 401
Chicago, Illinois 60642

Project Number: 18-215232.3

Legend

N

Subject Site

Soil Boring & Sample Location

Soil Gas Sample Location

Sample Location Map

Figure	Prepared By	Date
3	J. Lokko	October 2018

400 Fox Shores Drive
Kaukauna, Wisconsin 54130

APPENDIX A: BORING LOGS

PARTNER

Boring Number:	B1				Page 1 of 5
Location:	Southeastern portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	7' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B1 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.0		Black clay with some sand and gravel, medium-soft, moist	
3					
4		0.0			
5					
6		0.0	CL		5/5 recovery
7	B1 (6-7)			Brown clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
8		0.0			
9				Brown clay with some sand and gravel, medium-soft, moist	
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B1-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B2				Page 2 of 5
Location:	Southwestern portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	8' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B2 (0.5-1)		--	Organic topsoil	4/5 recovery (sample volume collected for metals analysis)
2		0.1		Black clay with some sand and gravel, medium-soft, moist	
3				Brown clay with some sand and gravel, medium-soft, moist	
4		0.0			
5					
6		0.1	CL		4/5 recovery
7					
8	B2 (7-8)	0.1		Brown clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
9				Gray clay with some sand and gravel, medium-soft, moist	
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B2-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B3				Page 3 of 5
Location:	West central portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	4.5' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B3 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.1		Tan clay with some sand and gravel, medium-soft, moist	
3				Brown clay with some sand and gravel, medium-soft, moist	
4	B3 (3-4)	0.0			(sample volume collected for VOCs and PAHs analysis)
5				Brown clay with some sand and gravel, medium-soft, wet	
6		0.0	CL		2/5 recovery
7					
8		0.1			
9					
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B3-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Boring Number:	B4				Page 4 of 5
Location:	Northwestern portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	7' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B4 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.0		Brown clay with some sand and gravel, medium-soft, moist	
3					
4		0.1			
5					
6		0.1	CL		5/5 recovery
7	B4 (6-7)			Brown clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
8		0.1		Brown clay with some sand and gravel, medium-soft, moist	
9					
10		0.0			
11				Borehole termintated at 10 feet bgs. Temporary 3/4 inch groundwater monitoring well installed to 10 feet, screend 5 to 10 feet. Groundwater sample B4-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
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25					

Boring Number:	B5				Page 5 of 5
Location:	North central portion of the subject property			Date Started:	10/3/2018
Site Address:	400 Fox Shores Drive			Date Completed:	10/3/2018
	Kaukauna, Wisconsin 54130			Depth to Groundwater:	4.5' bgs
Project Number:	18-215232.3			Field Technician:	L. Martin
Drill Rig Type:	Track-mounted GeoProbe 6610DT			**Partner Engineering and Science**	
Sampling Equipment:	five foot Macrocore			805 N. Milwaukee Ave., Ste. 401	
Borehole Diameter:	2.25 inch			Chicago, Illinois 60642	

Depth	Sample	PID	USCS	Description	Notes
1	B5 (0.5-1)		--	Organic topsoil	3/5 recovery (sample volume collected for metals analysis)
2		0.0		Black clay with some sand and gravel, medium-soft, moist	
3					
4		0.0	CL		
5	B5 (3.5-4.5)			Black/tan clay with some sand and gravel, medium-soft, wet	(sample volume collected for VOCs and PAHs analysis)
6		0.0			2/5 recovery
7					
8				Borehole termintated at 7 feet bgs due to refusal. Temporary 3/4 inch groundwater monitoring well installed to 7 feet, screend 2 to 7 feet. Groundwater sample B5-GW collected and borehole abandoned with chipped bentonite and patched to mach existing groundcover on 10/3/18.	
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APPENDIX B: LABORATORY ANALYTICAL REPORT

PARTNER

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

October 11, 2018

Partner Engineering & Science - IL

Sample Delivery Group:	L1031756
Samples Received:	10/04/2018
Project Number:	18-215232.3
Description:	Fox Shores Apartments
Site:	400 FOX SHORES DR. KAUKAUNA,WS
Report To:	Lucas Martin 805 North Milwaukee Avenue Suite 401 C Chicago, IL 60642

Entire Report Reviewed By:

John Hawkins
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace National is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.



Cp: Cover Page 1
Tc: Table of Contents 2
Ss: Sample Summary 3
Cn: Case Narrative 5
Sr: Sample Results 6
B1 (0.5-1) L1031756-01 6
B1 (6-7) L1031756-02 7
B2 (0.5-1) L1031756-03 9
B2 (7-8) L1031756-04 10
B3 (0.5-1) L1031756-05 12
B3 (3-4) L1031756-06 13
B4 (0.5-1) L1031756-07 15
B4 (6-7) L1031756-08 16
B5 (0.5-1) L1031756-09 18
B5 (3.5-4.5) L1031756-10 19
Qc: Quality Control Summary 21
Total Solids by Method 2540 G-2011 21
Mercury by Method 7471A 23
Metals (ICP) by Method 6010B 24
Volatile Organic Compounds (GC/MS) by Method 8260B 25
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM 35
Gl: Glossary of Terms 37
Al: Accreditations & Locations 38
Sc: Sample Chain of Custody 39

B1 (0.5-1) L1031756-01 Solid

Collected by: L. Martin | Collected date/time: 10/03/18 10:40 | Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178080	1	10/09/18 13:45	10/09/18 13:59	JD
Mercury by Method 7471A	WG1176321	1	10/05/18 08:05	10/08/18 19:56	TCT
Metals (ICP) by Method 6010B	WG1178006	1	10/09/18 10:58	10/09/18 19:23	ST

B1 (6-7) L1031756-02 Solid

Collected by: L. Martin | Collected date/time: 10/03/18 10:45 | Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178080	1	10/09/18 13:45	10/09/18 13:59	JD
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1178568	1	10/03/18 10:45	10/10/18 09:28	JHH
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178306	1	10/10/18 11:24	10/10/18 21:08	CJR

B2 (0.5-1) L1031756-03 Solid

Collected by: L. Martin | Collected date/time: 10/03/18 11:20 | Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178080	1	10/09/18 13:45	10/09/18 13:59	JD
Mercury by Method 7471A	WG1176321	1	10/05/18 08:05	10/08/18 19:58	TCT
Metals (ICP) by Method 6010B	WG1178006	1	10/09/18 10:58	10/09/18 19:26	ST

B2 (7-8) L1031756-04 Solid

Collected by: L. Martin | Collected date/time: 10/03/18 11:25 | Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178080	1	10/09/18 13:45	10/09/18 13:59	JD
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1178568	1	10/03/18 11:25	10/10/18 09:48	JHH
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178306	1	10/10/18 11:24	10/10/18 21:29	CJR

B3 (0.5-1) L1031756-05 Solid

Collected by: L. Martin | Collected date/time: 10/03/18 11:45 | Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178080	1	10/09/18 13:45	10/09/18 13:59	JD
Mercury by Method 7471A	WG1176321	1	10/05/18 08:05	10/08/18 20:01	TCT
Metals (ICP) by Method 6010B	WG1178006	1	10/09/18 10:58	10/09/18 19:28	ST

B3 (3-4) L1031756-06 Solid

Collected by: L. Martin | Collected date/time: 10/03/18 11:50 | Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178080	1	10/09/18 13:45	10/09/18 13:59	JD
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1178568	1	10/03/18 11:50	10/10/18 10:08	JHH
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178306	1	10/10/18 11:24	10/10/18 21:50	CJR

B4 (0.5-1) L1031756-07 Solid

Collected by: L. Martin
Collected date/time: 10/03/18 12:05
Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178081	1	10/09/18 13:36	10/09/18 13:43	JD
Mercury by Method 7471A	WG1176321	1	10/05/18 08:05	10/08/18 20:11	TCT
Metals (ICP) by Method 6010B	WG1178006	1	10/09/18 10:58	10/09/18 19:31	ST

B4 (6-7) L1031756-08 Solid

Collected by: L. Martin
Collected date/time: 10/03/18 12:10
Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178081	1	10/09/18 13:36	10/09/18 13:43	JD
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1177860	1	10/03/18 12:10	10/09/18 02:27	ACG
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178306	1	10/10/18 11:24	10/10/18 22:11	CJR

B5 (0.5-1) L1031756-09 Solid

Collected by: L. Martin
Collected date/time: 10/03/18 11:00
Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178081	1	10/09/18 13:36	10/09/18 13:43	JD
Mercury by Method 7471A	WG1176321	1	10/05/18 08:05	10/08/18 20:14	TCT
Metals (ICP) by Method 6010B	WG1178006	1	10/09/18 10:58	10/09/18 19:33	ST

B5 (3.5-4.5) L1031756-10 Solid

Collected by: L. Martin
Collected date/time: 10/03/18 11:05
Received date/time: 10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1178081	1	10/09/18 13:36	10/09/18 13:43	JD
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1177860	1	10/03/18 11:05	10/09/18 02:48	ACG
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178306	1	10/10/18 11:24	10/10/18 22:32	CJR

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

John Hawkins
Project Manager

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	81.1		1	10/09/2018 13:59	WG1178080

Mercury by Method 7471A

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Mercury	0.492		0.00345	0.0247	1	10/08/2018 19:56	WG1176321

Metals (ICP) by Method 6010B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Arsenic	17.7		0.567	1.23	1	10/09/2018 19:23	WG1178006
Barium	81.8		0.210	0.616	1	10/09/2018 19:23	WG1178006
Cadmium	2.80		0.0863	0.247	1	10/09/2018 19:23	WG1178006
Chromium	22.6		0.173	1.23	1	10/09/2018 19:23	WG1178006
Lead	940		0.234	0.616	1	10/09/2018 19:23	WG1178006
Selenium	2.58		0.764	2.47	1	10/09/2018 19:23	WG1178006
Silver	U		0.148	0.616	1	10/09/2018 19:23	WG1178006

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	87.1		1	10/09/2018 13:59	WG1178080

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Acetone	U		0.0157	0.0287	1	10/10/2018 09:28	WG1178568
Acrylonitrile	U		0.00218	0.0144	1	10/10/2018 09:28	WG1178568
Benzene	U		0.000459	0.00115	1	10/10/2018 09:28	WG1178568
Bromobenzene	U		0.00121	0.0144	1	10/10/2018 09:28	WG1178568
Bromodichloromethane	U		0.000905	0.00287	1	10/10/2018 09:28	WG1178568
Bromoform	U		0.00687	0.0287	1	10/10/2018 09:28	WG1178568
Bromomethane	U		0.00425	0.0144	1	10/10/2018 09:28	WG1178568
n-Butylbenzene	U		0.00441	0.0144	1	10/10/2018 09:28	WG1178568
sec-Butylbenzene	U		0.00290	0.0144	1	10/10/2018 09:28	WG1178568
tert-Butylbenzene	U		0.00178	0.00574	1	10/10/2018 09:28	WG1178568
Carbon tetrachloride	U		0.00124	0.00574	1	10/10/2018 09:28	WG1178568
Chlorobenzene	U		0.000658	0.00287	1	10/10/2018 09:28	WG1178568
Chlorodibromomethane	U		0.000517	0.00287	1	10/10/2018 09:28	WG1178568
Chloroethane	U		0.00124	0.00574	1	10/10/2018 09:28	WG1178568
Chloroform	U		0.000476	0.00287	1	10/10/2018 09:28	WG1178568
Chloromethane	U		0.00160	0.0144	1	10/10/2018 09:28	WG1178568
2-Chlorotoluene	U		0.00106	0.00287	1	10/10/2018 09:28	WG1178568
4-Chlorotoluene	U		0.00130	0.00574	1	10/10/2018 09:28	WG1178568
1,2-Dibromo-3-Chloropropane	U		0.00586	0.0287	1	10/10/2018 09:28	WG1178568
1,2-Dibromoethane	U		0.000603	0.00287	1	10/10/2018 09:28	WG1178568
Dibromomethane	U		0.00115	0.00574	1	10/10/2018 09:28	WG1178568
1,2-Dichlorobenzene	U		0.00166	0.00574	1	10/10/2018 09:28	WG1178568
1,3-Dichlorobenzene	U		0.00195	0.00574	1	10/10/2018 09:28	WG1178568
1,4-Dichlorobenzene	U		0.00226	0.00574	1	10/10/2018 09:28	WG1178568
Dichlorodifluoromethane	U		0.000939	0.00287	1	10/10/2018 09:28	WG1178568
1,1-Dichloroethane	U		0.000660	0.00287	1	10/10/2018 09:28	WG1178568
1,2-Dichloroethane	U		0.000545	0.00287	1	10/10/2018 09:28	WG1178568
1,1-Dichloroethene	U		0.000574	0.00287	1	10/10/2018 09:28	WG1178568
cis-1,2-Dichloroethene	U		0.000792	0.00287	1	10/10/2018 09:28	WG1178568
trans-1,2-Dichloroethene	U		0.00164	0.00574	1	10/10/2018 09:28	WG1178568
1,2-Dichloropropane	U		0.00146	0.00574	1	10/10/2018 09:28	WG1178568
1,1-Dichloropropene	U		0.000804	0.00287	1	10/10/2018 09:28	WG1178568
1,3-Dichloropropane	U		0.00201	0.00574	1	10/10/2018 09:28	WG1178568
cis-1,3-Dichloropropene	U		0.000778	0.00287	1	10/10/2018 09:28	WG1178568
trans-1,3-Dichloropropene	U		0.00176	0.00574	1	10/10/2018 09:28	WG1178568
2,2-Dichloropropane	U		0.000910	0.00287	1	10/10/2018 09:28	WG1178568
Di-isopropyl ether	U		0.000402	0.00115	1	10/10/2018 09:28	WG1178568
Ethylbenzene	U		0.000608	0.00287	1	10/10/2018 09:28	WG1178568
Hexachloro-1,3-butadiene	U		0.0146	0.0287	1	10/10/2018 09:28	WG1178568
Isopropylbenzene	U		0.000991	0.00287	1	10/10/2018 09:28	WG1178568
p-Isopropyltoluene	U		0.00268	0.00574	1	10/10/2018 09:28	WG1178568
2-Butanone (MEK)	0.0193	J	0.0144	0.0287	1	10/10/2018 09:28	WG1178568
Methylene Chloride	U		0.00762	0.0287	1	10/10/2018 09:28	WG1178568
4-Methyl-2-pentanone (MIBK)	U		0.0115	0.0287	1	10/10/2018 09:28	WG1178568
Methyl tert-butyl ether	U		0.000339	0.00115	1	10/10/2018 09:28	WG1178568
Naphthalene	U		0.00358	0.0144	1	10/10/2018 09:28	WG1178568
n-Propylbenzene	U		0.00135	0.00574	1	10/10/2018 09:28	WG1178568
Styrene	U		0.00313	0.0144	1	10/10/2018 09:28	WG1178568
1,1,1,2-Tetrachloroethane	U		0.000574	0.00287	1	10/10/2018 09:28	WG1178568
1,1,2,2-Tetrachloroethane	U		0.000448	0.00287	1	10/10/2018 09:28	WG1178568

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
1,1,2-Trichlorotrifluoroethane	U		0.000775	0.00287	1	10/10/2018 09:28	WG1178568
Tetrachloroethene	U		0.000804	0.00287	1	10/10/2018 09:28	WG1178568
Toluene	U		0.00144	0.00574	1	10/10/2018 09:28	WG1178568
1,2,3-Trichlorobenzene	U		0.000718	0.00287	1	10/10/2018 09:28	WG1178568
1,2,4-Trichlorobenzene	U		0.00553	0.0144	1	10/10/2018 09:28	WG1178568
1,1,1-Trichloroethane	U		0.000316	0.00287	1	10/10/2018 09:28	WG1178568
1,1,2-Trichloroethane	U		0.00101	0.00287	1	10/10/2018 09:28	WG1178568
Trichloroethene	U		0.000459	0.00115	1	10/10/2018 09:28	WG1178568
Trichlorofluoromethane	U		0.000574	0.00287	1	10/10/2018 09:28	WG1178568
1,2,3-Trichloropropane	U		0.00586	0.0144	1	10/10/2018 09:28	WG1178568
1,2,4-Trimethylbenzene	U		0.00133	0.00574	1	10/10/2018 09:28	WG1178568
1,2,3-Trimethylbenzene	U		0.00132	0.00574	1	10/10/2018 09:28	WG1178568
1,3,5-Trimethylbenzene	U		0.00124	0.00574	1	10/10/2018 09:28	WG1178568
Vinyl chloride	U		0.000784	0.00287	1	10/10/2018 09:28	WG1178568
Xylenes, Total	U		0.00549	0.00746	1	10/10/2018 09:28	WG1178568
(S) Toluene-d8	*119*			*75.0-131*		*10/10/2018 09:28*	WG1178568
(S) Dibromofluoromethane	*95.5*			*65.0-129*		*10/10/2018 09:28*	WG1178568
(S) 4-Bromofluorobenzene	*101*			*67.0-138*		*10/10/2018 09:28*	WG1178568

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
Anthracene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Acenaphthene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Acenaphthylene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Benzo(a)anthracene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Benzo(a)pyrene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Benzo(b)fluoranthene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Benzo(g,h,i)perylene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Benzo(k)fluoranthene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Chrysene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Dibenz(a,h)anthracene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Fluoranthene	0.000821	J	0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Fluorene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Indeno(1,2,3-cd)pyrene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Naphthalene	U		0.00230	0.0230	1	10/10/2018 21:08	WG1178306
Phenanthrene	0.000704	J	0.000689	0.00689	1	10/10/2018 21:08	WG1178306
Pyrene	U		0.000689	0.00689	1	10/10/2018 21:08	WG1178306
1-Methylnaphthalene	U		0.00230	0.0230	1	10/10/2018 21:08	WG1178306
2-Methylnaphthalene	U		0.00230	0.0230	1	10/10/2018 21:08	WG1178306
(S) Nitrobenzene-d5	*107*			*14.0-149*		*10/10/2018 21:08*	WG1178306
(S) 2-Fluorobiphenyl	*99.6*			*34.0-125*		*10/10/2018 21:08*	WG1178306
(S) p-Terphenyl-d14	*95.8*			*23.0-120*		*10/10/2018 21:08*	WG1178306

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	86.9		1	10/09/2018 13:59	WG1178080

Mercury by Method 7471A

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Mercury	0.0466		0.00322	0.0230	1	10/08/2018 19:58	WG1176321

Metals (ICP) by Method 6010B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Arsenic	0.732	J	0.529	1.15	1	10/09/2018 19:26	WG1178006
Barium	42.4		0.196	0.575	1	10/09/2018 19:26	WG1178006
Cadmium	U		0.0805	0.230	1	10/09/2018 19:26	WG1178006
Chromium	15.7		0.161	1.15	1	10/09/2018 19:26	WG1178006
Lead	5.10		0.219	0.575	1	10/09/2018 19:26	WG1178006
Selenium	U		0.713	2.30	1	10/09/2018 19:26	WG1178006
Silver	U		0.138	0.575	1	10/09/2018 19:26	WG1178006

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	89.8		1	10/09/2018 13:59	WG1178080

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Acetone	U		0.0153	0.0278	1	10/10/2018 09:48	WG1178568
Acrylonitrile	U		0.00212	0.0139	1	10/10/2018 09:48	WG1178568
Benzene	U		0.000445	0.00111	1	10/10/2018 09:48	WG1178568
Bromobenzene	U		0.00117	0.0139	1	10/10/2018 09:48	WG1178568
Bromodichloromethane	U		0.000878	0.00278	1	10/10/2018 09:48	WG1178568
Bromoform	U		0.00666	0.0278	1	10/10/2018 09:48	WG1178568
Bromomethane	U		0.00412	0.0139	1	10/10/2018 09:48	WG1178568
n-Butylbenzene	U		0.00428	0.0139	1	10/10/2018 09:48	WG1178568
sec-Butylbenzene	U		0.00282	0.0139	1	10/10/2018 09:48	WG1178568
tert-Butylbenzene	U		0.00173	0.00557	1	10/10/2018 09:48	WG1178568
Carbon tetrachloride	U		0.00120	0.00557	1	10/10/2018 09:48	WG1178568
Chlorobenzene	U		0.000638	0.00278	1	10/10/2018 09:48	WG1178568
Chlorodibromomethane	U		0.000501	0.00278	1	10/10/2018 09:48	WG1178568
Chloroethane	U		0.00120	0.00557	1	10/10/2018 09:48	WG1178568
Chloroform	U		0.000462	0.00278	1	10/10/2018 09:48	WG1178568
Chloromethane	U		0.00155	0.0139	1	10/10/2018 09:48	WG1178568
2-Chlorotoluene	U		0.00102	0.00278	1	10/10/2018 09:48	WG1178568
4-Chlorotoluene	U		0.00126	0.00557	1	10/10/2018 09:48	WG1178568
1,2-Dibromo-3-Chloropropane	U		0.00568	0.0278	1	10/10/2018 09:48	WG1178568
1,2-Dibromoethane	U		0.000585	0.00278	1	10/10/2018 09:48	WG1178568
Dibromomethane	U		0.00111	0.00557	1	10/10/2018 09:48	WG1178568
1,2-Dichlorobenzene	U		0.00161	0.00557	1	10/10/2018 09:48	WG1178568
1,3-Dichlorobenzene	U		0.00189	0.00557	1	10/10/2018 09:48	WG1178568
1,4-Dichlorobenzene	U		0.00219	0.00557	1	10/10/2018 09:48	WG1178568
Dichlorodifluoromethane	U		0.000911	0.00278	1	10/10/2018 09:48	WG1178568
1,1-Dichloroethane	U		0.000640	0.00278	1	10/10/2018 09:48	WG1178568
1,2-Dichloroethane	U		0.000529	0.00278	1	10/10/2018 09:48	WG1178568
1,1-Dichloroethene	U		0.000557	0.00278	1	10/10/2018 09:48	WG1178568
cis-1,2-Dichloroethene	U		0.000768	0.00278	1	10/10/2018 09:48	WG1178568
trans-1,2-Dichloroethene	U		0.00159	0.00557	1	10/10/2018 09:48	WG1178568
1,2-Dichloropropane	U		0.00141	0.00557	1	10/10/2018 09:48	WG1178568
1,1-Dichloropropene	U		0.000780	0.00278	1	10/10/2018 09:48	WG1178568
1,3-Dichloropropane	U		0.00195	0.00557	1	10/10/2018 09:48	WG1178568
cis-1,3-Dichloropropene	U		0.000755	0.00278	1	10/10/2018 09:48	WG1178568
trans-1,3-Dichloropropene	U		0.00170	0.00557	1	10/10/2018 09:48	WG1178568
2,2-Dichloropropane	U		0.000883	0.00278	1	10/10/2018 09:48	WG1178568
Di-isopropyl ether	U		0.000390	0.00111	1	10/10/2018 09:48	WG1178568
Ethylbenzene	U		0.000590	0.00278	1	10/10/2018 09:48	WG1178568
Hexachloro-1,3-butadiene	U		0.0141	0.0278	1	10/10/2018 09:48	WG1178568
Isopropylbenzene	U		0.000961	0.00278	1	10/10/2018 09:48	WG1178568
p-Isopropyltoluene	U		0.00259	0.00557	1	10/10/2018 09:48	WG1178568
2-Butanone (MEK)	0.0280		0.0139	0.0278	1	10/10/2018 09:48	WG1178568
Methylene Chloride	U		0.00739	0.0278	1	10/10/2018 09:48	WG1178568
4-Methyl-2-pentanone (MIBK)	U		0.0111	0.0278	1	10/10/2018 09:48	WG1178568
Methyl tert-butyl ether	U		0.000329	0.00111	1	10/10/2018 09:48	WG1178568
Naphthalene	U		0.00347	0.0139	1	10/10/2018 09:48	WG1178568
n-Propylbenzene	U		0.00131	0.00557	1	10/10/2018 09:48	WG1178568
Styrene	U		0.00304	0.0139	1	10/10/2018 09:48	WG1178568
1,1,1,2-Tetrachloroethane	U		0.000557	0.00278	1	10/10/2018 09:48	WG1178568
1,1,2,2-Tetrachloroethane	U		0.000434	0.00278	1	10/10/2018 09:48	WG1178568

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
1,1,2-Trichlorotrifluoroethane	U		0.000752	0.00278	1	10/10/2018 09:48	WG1178568
Tetrachloroethene	U		0.000780	0.00278	1	10/10/2018 09:48	WG1178568
Toluene	0.00149	J	0.00139	0.00557	1	10/10/2018 09:48	WG1178568
1,2,3-Trichlorobenzene	U		0.000696	0.00278	1	10/10/2018 09:48	WG1178568
1,2,4-Trichlorobenzene	U		0.00537	0.0139	1	10/10/2018 09:48	WG1178568
1,1,1-Trichloroethane	U		0.000306	0.00278	1	10/10/2018 09:48	WG1178568
1,1,2-Trichloroethane	U		0.000983	0.00278	1	10/10/2018 09:48	WG1178568
Trichloroethene	U		0.000445	0.00111	1	10/10/2018 09:48	WG1178568
Trichlorofluoromethane	U		0.000557	0.00278	1	10/10/2018 09:48	WG1178568
1,2,3-Trichloropropane	U		0.00568	0.0139	1	10/10/2018 09:48	WG1178568
1,2,4-Trimethylbenzene	U		0.00129	0.00557	1	10/10/2018 09:48	WG1178568
1,2,3-Trimethylbenzene	U		0.00128	0.00557	1	10/10/2018 09:48	WG1178568
1,3,5-Trimethylbenzene	U		0.00120	0.00557	1	10/10/2018 09:48	WG1178568
Vinyl chloride	U		0.000761	0.00278	1	10/10/2018 09:48	WG1178568
Xylenes, Total	U		0.00532	0.00724	1	10/10/2018 09:48	WG1178568
(S) Toluene-d8	*122*			*75.0-131*		*10/10/2018 09:48*	WG1178568
(S) Dibromofluoromethane	*95.2*			*65.0-129*		*10/10/2018 09:48*	WG1178568
(S) 4-Bromofluorobenzene	*95.9*			*67.0-138*		*10/10/2018 09:48*	WG1178568

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
Anthracene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Acenaphthene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Acenaphthylene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Benzo(a)anthracene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Benzo(a)pyrene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Benzo(b)fluoranthene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Benzo(g,h,i)perylene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Benzo(k)fluoranthene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Chrysene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Dibenz(a,h)anthracene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Fluoranthene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Fluorene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Indeno(1,2,3-cd)pyrene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Naphthalene	U		0.00223	0.0223	1	10/10/2018 21:29	WG1178306
Phenanthrene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
Pyrene	U		0.000668	0.00668	1	10/10/2018 21:29	WG1178306
1-Methylnaphthalene	U		0.00223	0.0223	1	10/10/2018 21:29	WG1178306
2-Methylnaphthalene	U		0.00223	0.0223	1	10/10/2018 21:29	WG1178306
(S) Nitrobenzene-d5	*113*			*14.0-149*		*10/10/2018 21:29*	WG1178306
(S) 2-Fluorobiphenyl	*103*			*34.0-125*		*10/10/2018 21:29*	WG1178306
(S) p-Terphenyl-d14	*92.4*			*23.0-120*		*10/10/2018 21:29*	WG1178306

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	87.8		1	10/09/2018 13:59	WG1178080

Mercury by Method 7471A

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Mercury	0.0259		0.00319	0.0228	1	10/08/2018 20:01	WG1176321

Metals (ICP) by Method 6010B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Arsenic	3.07		0.524	1.14	1	10/09/2018 19:28	WG1178006
Barium	76.1		0.194	0.569	1	10/09/2018 19:28	WG1178006
Cadmium	0.335		0.0797	0.228	1	10/09/2018 19:28	WG1178006
Chromium	17.9		0.159	1.14	1	10/09/2018 19:28	WG1178006
Lead	209		0.216	0.569	1	10/09/2018 19:28	WG1178006
Selenium	U		0.706	2.28	1	10/09/2018 19:28	WG1178006
Silver	U		0.137	0.569	1	10/09/2018 19:28	WG1178006

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	85.4		1	10/09/2018 13:59	WG1178080

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Acetone	U		0.0160	0.0293	1	10/10/2018 10:08	WG1178568
Acrylonitrile	U		0.00222	0.0146	1	10/10/2018 10:08	WG1178568
Benzene	U		0.000468	0.00117	1	10/10/2018 10:08	WG1178568
Bromobenzene	U		0.00123	0.0146	1	10/10/2018 10:08	WG1178568
Bromodichloromethane	U		0.000922	0.00293	1	10/10/2018 10:08	WG1178568
Bromoform	U		0.00700	0.0293	1	10/10/2018 10:08	WG1178568
Bromomethane	U		0.00433	0.0146	1	10/10/2018 10:08	WG1178568
n-Butylbenzene	U		0.00450	0.0146	1	10/10/2018 10:08	WG1178568
sec-Butylbenzene	U		0.00296	0.0146	1	10/10/2018 10:08	WG1178568
tert-Butylbenzene	U		0.00181	0.00585	1	10/10/2018 10:08	WG1178568
Carbon tetrachloride	U		0.00126	0.00585	1	10/10/2018 10:08	WG1178568
Chlorobenzene	U		0.000671	0.00293	1	10/10/2018 10:08	WG1178568
Chlorodibromomethane	U		0.000527	0.00293	1	10/10/2018 10:08	WG1178568
Chloroethane	U		0.00126	0.00585	1	10/10/2018 10:08	WG1178568
Chloroform	U		0.000486	0.00293	1	10/10/2018 10:08	WG1178568
Chloromethane	U		0.00163	0.0146	1	10/10/2018 10:08	WG1178568
2-Chlorotoluene	U		0.00108	0.00293	1	10/10/2018 10:08	WG1178568
4-Chlorotoluene	U		0.00132	0.00585	1	10/10/2018 10:08	WG1178568
1,2-Dibromo-3-Chloropropane	U		0.00597	0.0293	1	10/10/2018 10:08	WG1178568
1,2-Dibromoethane	U		0.000615	0.00293	1	10/10/2018 10:08	WG1178568
Dibromomethane	U		0.00117	0.00585	1	10/10/2018 10:08	WG1178568
1,2-Dichlorobenzene	U		0.00170	0.00585	1	10/10/2018 10:08	WG1178568
1,3-Dichlorobenzene	U		0.00199	0.00585	1	10/10/2018 10:08	WG1178568
1,4-Dichlorobenzene	U		0.00231	0.00585	1	10/10/2018 10:08	WG1178568
Dichlorodifluoromethane	U		0.000958	0.00293	1	10/10/2018 10:08	WG1178568
1,1-Dichloroethane	U		0.000673	0.00293	1	10/10/2018 10:08	WG1178568
1,2-Dichloroethane	U		0.000556	0.00293	1	10/10/2018 10:08	WG1178568
1,1-Dichloroethene	U		0.000585	0.00293	1	10/10/2018 10:08	WG1178568
cis-1,2-Dichloroethene	U		0.000808	0.00293	1	10/10/2018 10:08	WG1178568
trans-1,2-Dichloroethene	U		0.00167	0.00585	1	10/10/2018 10:08	WG1178568
1,2-Dichloropropane	U		0.00149	0.00585	1	10/10/2018 10:08	WG1178568
1,1-Dichloropropene	U		0.000819	0.00293	1	10/10/2018 10:08	WG1178568
1,3-Dichloropropane	U		0.00205	0.00585	1	10/10/2018 10:08	WG1178568
cis-1,3-Dichloropropene	U		0.000794	0.00293	1	10/10/2018 10:08	WG1178568
trans-1,3-Dichloropropene	U		0.00179	0.00585	1	10/10/2018 10:08	WG1178568
2,2-Dichloropropane	U		0.000928	0.00293	1	10/10/2018 10:08	WG1178568
Di-isopropyl ether	U		0.000410	0.00117	1	10/10/2018 10:08	WG1178568
Ethylbenzene	U		0.000620	0.00293	1	10/10/2018 10:08	WG1178568
Hexachloro-1,3-butadiene	U		0.0149	0.0293	1	10/10/2018 10:08	WG1178568
Isopropylbenzene	U		0.00101	0.00293	1	10/10/2018 10:08	WG1178568
p-Isopropyltoluene	U		0.00273	0.00585	1	10/10/2018 10:08	WG1178568
2-Butanone (MEK)	0.0297		0.0146	0.0293	1	10/10/2018 10:08	WG1178568
Methylene Chloride	U		0.00777	0.0293	1	10/10/2018 10:08	WG1178568
4-Methyl-2-pentanone (MIBK)	U		0.0117	0.0293	1	10/10/2018 10:08	WG1178568
Methyl tert-butyl ether	U		0.000345	0.00117	1	10/10/2018 10:08	WG1178568
Naphthalene	U		0.00365	0.0146	1	10/10/2018 10:08	WG1178568
n-Propylbenzene	U		0.00138	0.00585	1	10/10/2018 10:08	WG1178568
Styrene	U		0.00320	0.0146	1	10/10/2018 10:08	WG1178568
1,1,1,2-Tetrachloroethane	U		0.000585	0.00293	1	10/10/2018 10:08	WG1178568
1,1,2,2-Tetrachloroethane	U		0.000457	0.00293	1	10/10/2018 10:08	WG1178568

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
1,1,2-Trichlorotrifluoroethane	U		0.000790	0.00293	1	10/10/2018 10:08	WG1178568
Tetrachloroethene	U		0.000819	0.00293	1	10/10/2018 10:08	WG1178568
Toluene	0.00154	J	0.00146	0.00585	1	10/10/2018 10:08	WG1178568
1,2,3-Trichlorobenzene	U		0.000732	0.00293	1	10/10/2018 10:08	WG1178568
1,2,4-Trichlorobenzene	U		0.00564	0.0146	1	10/10/2018 10:08	WG1178568
1,1,1-Trichloroethane	U		0.000322	0.00293	1	10/10/2018 10:08	WG1178568
1,1,2-Trichloroethane	U		0.00103	0.00293	1	10/10/2018 10:08	WG1178568
Trichloroethene	U		0.000468	0.00117	1	10/10/2018 10:08	WG1178568
Trichlorofluoromethane	U		0.000585	0.00293	1	10/10/2018 10:08	WG1178568
1,2,3-Trichloropropane	U		0.00597	0.0146	1	10/10/2018 10:08	WG1178568
1,2,4-Trimethylbenzene	U		0.00136	0.00585	1	10/10/2018 10:08	WG1178568
1,2,3-Trimethylbenzene	U		0.00135	0.00585	1	10/10/2018 10:08	WG1178568
1,3,5-Trimethylbenzene	U		0.00126	0.00585	1	10/10/2018 10:08	WG1178568
Vinyl chloride	U		0.000800	0.00293	1	10/10/2018 10:08	WG1178568
Xylenes, Total	U		0.00560	0.00761	1	10/10/2018 10:08	WG1178568
(S) Toluene-d8	*124*			*75.0-131*		*10/10/2018 10:08*	WG1178568
(S) Dibromofluoromethane	*95.1*			*65.0-129*		*10/10/2018 10:08*	WG1178568
(S) 4-Bromofluorobenzene	*96.0*			*67.0-138*		*10/10/2018 10:08*	WG1178568

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
Anthracene	0.00425	J	0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Acenaphthene	0.00231	J	0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Acenaphthylene	U		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Benzo(a)anthracene	0.0180		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Benzo(a)pyrene	0.0200		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Benzo(b)fluoranthene	0.0265		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Benzo(g,h,i)perylene	0.0158		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Benzo(k)fluoranthene	0.0102		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Chrysene	0.0268		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Dibenz(a,h)anthracene	0.00310	J	0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Fluoranthene	0.0521		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Fluorene	0.00253	J	0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Indeno(1,2,3-cd)pyrene	0.0125		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Naphthalene	0.00723	J	0.00234	0.0234	1	10/10/2018 21:50	WG1178306
Phenanthrene	0.0351		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
Pyrene	0.0349		0.000702	0.00702	1	10/10/2018 21:50	WG1178306
1-Methylnaphthalene	0.00581	J	0.00234	0.0234	1	10/10/2018 21:50	WG1178306
2-Methylnaphthalene	0.00786	J	0.00234	0.0234	1	10/10/2018 21:50	WG1178306
(S) Nitrobenzene-d5	*113*			*14.0-149*		*10/10/2018 21:50*	WG1178306
(S) 2-Fluorobiphenyl	*104*			*34.0-125*		*10/10/2018 21:50*	WG1178306
(S) p-Terphenyl-d14	*96.5*			*23.0-120*		*10/10/2018 21:50*	WG1178306

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	77.6		1	10/09/2018 13:43	WG1178081

Mercury by Method 7471A

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Mercury	0.0467		0.00361	0.0258	1	10/08/2018 20:11	WG1176321

Metals (ICP) by Method 6010B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Arsenic	116		0.593	1.29	1	10/09/2018 19:31	WG1178006
Barium	58.9		0.219	0.645	1	10/09/2018 19:31	WG1178006
Cadmium	2.01		0.0903	0.258	1	10/09/2018 19:31	WG1178006
Chromium	14.0		0.181	1.29	1	10/09/2018 19:31	WG1178006
Lead	272		0.245	0.645	1	10/09/2018 19:31	WG1178006
Selenium	0.932	J	0.799	2.58	1	10/09/2018 19:31	WG1178006
Silver	U		0.155	0.645	1	10/09/2018 19:31	WG1178006

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	85.0		1	10/09/2018 13:43	WG1178081

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Acetone	0.0363		0.0161	0.0294	1	10/09/2018 02:27	WG1177860
Acrylonitrile	U		0.00223	0.0147	1	10/09/2018 02:27	WG1177860
Benzene	0.000791	J	0.000470	0.00118	1	10/09/2018 02:27	WG1177860
Bromobenzene	U		0.00123	0.0147	1	10/09/2018 02:27	WG1177860
Bromodichloromethane	U		0.000927	0.00294	1	10/09/2018 02:27	WG1177860
Bromoform	U		0.00703	0.0294	1	10/09/2018 02:27	WG1177860
Bromomethane	U		0.00435	0.0147	1	10/09/2018 02:27	WG1177860
n-Butylbenzene	U		0.00452	0.0147	1	10/09/2018 02:27	WG1177860
sec-Butylbenzene	U		0.00298	0.0147	1	10/09/2018 02:27	WG1177860
tert-Butylbenzene	U		0.00182	0.00588	1	10/09/2018 02:27	WG1177860
Carbon tetrachloride	U		0.00127	0.00588	1	10/09/2018 02:27	WG1177860
Chlorobenzene	U		0.000674	0.00294	1	10/09/2018 02:27	WG1177860
Chlorodibromomethane	U		0.000529	0.00294	1	10/09/2018 02:27	WG1177860
Chloroethane	U		0.00127	0.00588	1	10/09/2018 02:27	WG1177860
Chloroform	U		0.000488	0.00294	1	10/09/2018 02:27	WG1177860
Chloromethane	U		0.00163	0.0147	1	10/09/2018 02:27	WG1177860
2-Chlorotoluene	U		0.00108	0.00294	1	10/09/2018 02:27	WG1177860
4-Chlorotoluene	U		0.00133	0.00588	1	10/09/2018 02:27	WG1177860
1,2-Dibromo-3-Chloropropane	U		0.00600	0.0294	1	10/09/2018 02:27	WG1177860
1,2-Dibromoethane	U		0.000617	0.00294	1	10/09/2018 02:27	WG1177860
Dibromomethane	U		0.00118	0.00588	1	10/09/2018 02:27	WG1177860
1,2-Dichlorobenzene	U		0.00171	0.00588	1	10/09/2018 02:27	WG1177860
1,3-Dichlorobenzene	U		0.00200	0.00588	1	10/09/2018 02:27	WG1177860
1,4-Dichlorobenzene	U		0.00232	0.00588	1	10/09/2018 02:27	WG1177860
Dichlorodifluoromethane	U		0.000962	0.00294	1	10/09/2018 02:27	WG1177860
1,1-Dichloroethane	U		0.000676	0.00294	1	10/09/2018 02:27	WG1177860
1,2-Dichloroethane	U		0.000559	0.00294	1	10/09/2018 02:27	WG1177860
1,1-Dichloroethene	U		0.000588	0.00294	1	10/09/2018 02:27	WG1177860
cis-1,2-Dichloroethene	U		0.000811	0.00294	1	10/09/2018 02:27	WG1177860
trans-1,2-Dichloroethene	U		0.00168	0.00588	1	10/09/2018 02:27	WG1177860
1,2-Dichloropropane	U		0.00149	0.00588	1	10/09/2018 02:27	WG1177860
1,1-Dichloropropene	U		0.000823	0.00294	1	10/09/2018 02:27	WG1177860
1,3-Dichloropropane	U		0.00206	0.00588	1	10/09/2018 02:27	WG1177860
cis-1,3-Dichloropropene	U		0.000797	0.00294	1	10/09/2018 02:27	WG1177860
trans-1,3-Dichloropropene	U		0.00180	0.00588	1	10/09/2018 02:27	WG1177860
2,2-Dichloropropane	U		0.000933	0.00294	1	10/09/2018 02:27	WG1177860
Di-isopropyl ether	U		0.000412	0.00118	1	10/09/2018 02:27	WG1177860
Ethylbenzene	0.000998	J	0.000623	0.00294	1	10/09/2018 02:27	WG1177860
Hexachloro-1,3-butadiene	U		0.0149	0.0294	1	10/09/2018 02:27	WG1177860
Isopropylbenzene	U		0.00101	0.00294	1	10/09/2018 02:27	WG1177860
p-Isopropyltoluene	U		0.00274	0.00588	1	10/09/2018 02:27	WG1177860
2-Butanone (MEK)	0.0274	J	0.0147	0.0294	1	10/09/2018 02:27	WG1177860
Methylene Chloride	U		0.00781	0.0294	1	10/09/2018 02:27	WG1177860
4-Methyl-2-pentanone (MIBK)	U		0.0118	0.0294	1	10/09/2018 02:27	WG1177860
Methyl tert-butyl ether	U		0.000347	0.00118	1	10/09/2018 02:27	WG1177860
Naphthalene	0.00448	J	0.00367	0.0147	1	10/09/2018 02:27	WG1177860
n-Propylbenzene	U		0.00139	0.00588	1	10/09/2018 02:27	WG1177860
Styrene	U		0.00321	0.0147	1	10/09/2018 02:27	WG1177860
1,1,1,2-Tetrachloroethane	U		0.000588	0.00294	1	10/09/2018 02:27	WG1177860
1,1,2,2-Tetrachloroethane	U		0.000459	0.00294	1	10/09/2018 02:27	WG1177860

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
1,1,2-Trichlorotrifluoroethane	U		0.000794	0.00294	1	10/09/2018 02:27	WG1177860
Tetrachloroethene	U		0.000823	0.00294	1	10/09/2018 02:27	WG1177860
Toluene	0.00569	J	0.00147	0.00588	1	10/09/2018 02:27	WG1177860
1,2,3-Trichlorobenzene	U		0.000735	0.00294	1	10/09/2018 02:27	WG1177860
1,2,4-Trichlorobenzene	U		0.00567	0.0147	1	10/09/2018 02:27	WG1177860
1,1,1-Trichloroethane	U		0.000323	0.00294	1	10/09/2018 02:27	WG1177860
1,1,2-Trichloroethane	U		0.00104	0.00294	1	10/09/2018 02:27	WG1177860
Trichloroethene	U		0.000470	0.00118	1	10/09/2018 02:27	WG1177860
Trichlorofluoromethane	U		0.000588	0.00294	1	10/09/2018 02:27	WG1177860
1,2,3-Trichloropropane	U		0.00600	0.0147	1	10/09/2018 02:27	WG1177860
1,2,4-Trimethylbenzene	0.00242	J	0.00136	0.00588	1	10/09/2018 02:27	WG1177860
1,2,3-Trimethylbenzene	0.00162	J	0.00135	0.00588	1	10/09/2018 02:27	WG1177860
1,3,5-Trimethylbenzene	U		0.00127	0.00588	1	10/09/2018 02:27	WG1177860
Vinyl chloride	U		0.000803	0.00294	1	10/09/2018 02:27	WG1177860
Xylenes, Total	0.00684	J	0.00562	0.00764	1	10/09/2018 02:27	WG1177860
(S) Toluene-d8	*118*			*75.0-131*		*10/09/2018 02:27*	WG1177860
(S) Dibromofluoromethane	*95.4*			*65.0-129*		*10/09/2018 02:27*	WG1177860
(S) 4-Bromofluorobenzene	*95.7*			*67.0-138*		*10/09/2018 02:27*	WG1177860

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
Anthracene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Acenaphthene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Acenaphthylene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Benzo(a)anthracene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Benzo(a)pyrene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Benzo(b)fluoranthene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Benzo(g,h,i)perylene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Benzo(k)fluoranthene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Chrysene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Dibenz(a,h)anthracene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Fluoranthene	0.000857	J	0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Fluorene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Indeno(1,2,3-cd)pyrene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Naphthalene	U		0.00235	0.0235	1	10/10/2018 22:11	WG1178306
Phenanthrene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
Pyrene	U		0.000706	0.00706	1	10/10/2018 22:11	WG1178306
1-Methylnaphthalene	U		0.00235	0.0235	1	10/10/2018 22:11	WG1178306
2-Methylnaphthalene	U		0.00235	0.0235	1	10/10/2018 22:11	WG1178306
(S) Nitrobenzene-d5	*106*			*14.0-149*		*10/10/2018 22:11*	WG1178306
(S) 2-Fluorobiphenyl	*100*			*34.0-125*		*10/10/2018 22:11*	WG1178306
(S) p-Terphenyl-d14	*93.9*			*23.0-120*		*10/10/2018 22:11*	WG1178306

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	90.9		1	10/09/2018 13:43	WG1178081

Mercury by Method 7471A

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Mercury	0.110		0.00308	0.0220	1	10/08/2018 20:14	WG1176321

Metals (ICP) by Method 6010B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Arsenic	7.55		0.506	1.10	1	10/09/2018 19:33	WG1178006
Barium	49.3		0.187	0.550	1	10/09/2018 19:33	WG1178006
Cadmium	0.753		0.0770	0.220	1	10/09/2018 19:33	WG1178006
Chromium	11.5		0.154	1.10	1	10/09/2018 19:33	WG1178006
Lead	205		0.209	0.550	1	10/09/2018 19:33	WG1178006
Selenium	0.873	J	0.682	2.20	1	10/09/2018 19:33	WG1178006
Silver	U		0.132	0.550	1	10/09/2018 19:33	WG1178006

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	81.2		1	10/09/2018 13:43	WG1178081

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Acetone	0.0394		0.0169	0.0308	1	10/09/2018 02:48	WG1177860
Acrylonitrile	U		0.00234	0.0154	1	10/09/2018 02:48	WG1177860
Benzene	U		0.000492	0.00123	1	10/09/2018 02:48	WG1177860
Bromobenzene	U		0.00129	0.0154	1	10/09/2018 02:48	WG1177860
Bromodichloromethane	U		0.000970	0.00308	1	10/09/2018 02:48	WG1177860
Bromoform	U		0.00736	0.0308	1	10/09/2018 02:48	WG1177860
Bromomethane	U		0.00456	0.0154	1	10/09/2018 02:48	WG1177860
n-Butylbenzene	U		0.00473	0.0154	1	10/09/2018 02:48	WG1177860
sec-Butylbenzene	U		0.00311	0.0154	1	10/09/2018 02:48	WG1177860
tert-Butylbenzene	U		0.00191	0.00616	1	10/09/2018 02:48	WG1177860
Carbon tetrachloride	U		0.00133	0.00616	1	10/09/2018 02:48	WG1177860
Chlorobenzene	U		0.000705	0.00308	1	10/09/2018 02:48	WG1177860
Chlorodibromomethane	U		0.000554	0.00308	1	10/09/2018 02:48	WG1177860
Chloroethane	U		0.00133	0.00616	1	10/09/2018 02:48	WG1177860
Chloroform	U		0.000511	0.00308	1	10/09/2018 02:48	WG1177860
Chloromethane	U		0.00171	0.0154	1	10/09/2018 02:48	WG1177860
2-Chlorotoluene	U		0.00113	0.00308	1	10/09/2018 02:48	WG1177860
4-Chlorotoluene	U		0.00139	0.00616	1	10/09/2018 02:48	WG1177860
1,2-Dibromo-3-Chloropropane	U		0.00628	0.0308	1	10/09/2018 02:48	WG1177860
1,2-Dibromoethane	U		0.000646	0.00308	1	10/09/2018 02:48	WG1177860
Dibromomethane	U		0.00123	0.00616	1	10/09/2018 02:48	WG1177860
1,2-Dichlorobenzene	U		0.00179	0.00616	1	10/09/2018 02:48	WG1177860
1,3-Dichlorobenzene	U		0.00209	0.00616	1	10/09/2018 02:48	WG1177860
1,4-Dichlorobenzene	U		0.00243	0.00616	1	10/09/2018 02:48	WG1177860
Dichlorodifluoromethane	U		0.00101	0.00308	1	10/09/2018 02:48	WG1177860
1,1-Dichloroethane	U		0.000708	0.00308	1	10/09/2018 02:48	WG1177860
1,2-Dichloroethane	U		0.000585	0.00308	1	10/09/2018 02:48	WG1177860
1,1-Dichloroethene	U		0.000616	0.00308	1	10/09/2018 02:48	WG1177860
cis-1,2-Dichloroethene	U		0.000849	0.00308	1	10/09/2018 02:48	WG1177860
trans-1,2-Dichloroethene	U		0.00176	0.00616	1	10/09/2018 02:48	WG1177860
1,2-Dichloropropane	U		0.00156	0.00616	1	10/09/2018 02:48	WG1177860
1,1-Dichloropropene	U		0.000862	0.00308	1	10/09/2018 02:48	WG1177860
1,3-Dichloropropane	U		0.00215	0.00616	1	10/09/2018 02:48	WG1177860
cis-1,3-Dichloropropene	U		0.000835	0.00308	1	10/09/2018 02:48	WG1177860
trans-1,3-Dichloropropene	U		0.00188	0.00616	1	10/09/2018 02:48	WG1177860
2,2-Dichloropropane	U		0.000976	0.00308	1	10/09/2018 02:48	WG1177860
Di-isopropyl ether	U		0.000431	0.00123	1	10/09/2018 02:48	WG1177860
Ethylbenzene	U		0.000652	0.00308	1	10/09/2018 02:48	WG1177860
Hexachloro-1,3-butadiene	U		0.0156	0.0308	1	10/09/2018 02:48	WG1177860
Isopropylbenzene	U		0.00106	0.00308	1	10/09/2018 02:48	WG1177860
p-Isopropyltoluene	U		0.00287	0.00616	1	10/09/2018 02:48	WG1177860
2-Butanone (MEK)	0.0349		0.0154	0.0308	1	10/09/2018 02:48	WG1177860
Methylene Chloride	U		0.00817	0.0308	1	10/09/2018 02:48	WG1177860
4-Methyl-2-pentanone (MIBK)	U		0.0123	0.0308	1	10/09/2018 02:48	WG1177860
Methyl tert-butyl ether	U		0.000363	0.00123	1	10/09/2018 02:48	WG1177860
Naphthalene	U		0.00384	0.0154	1	10/09/2018 02:48	WG1177860
n-Propylbenzene	U		0.00145	0.00616	1	10/09/2018 02:48	WG1177860
Styrene	U		0.00336	0.0154	1	10/09/2018 02:48	WG1177860
1,1,1,2-Tetrachloroethane	U		0.000616	0.00308	1	10/09/2018 02:48	WG1177860
1,1,2,2-Tetrachloroethane	U		0.000480	0.00308	1	10/09/2018 02:48	WG1177860

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
1,1,2-Trichlorotrifluoroethane	U		0.000831	0.00308	1	10/09/2018 02:48	WG1177860
Tetrachloroethene	U		0.000862	0.00308	1	10/09/2018 02:48	WG1177860
Toluene	U		0.00154	0.00616	1	10/09/2018 02:48	WG1177860
1,2,3-Trichlorobenzene	U		0.000769	0.00308	1	10/09/2018 02:48	WG1177860
1,2,4-Trichlorobenzene	U		0.00593	0.0154	1	10/09/2018 02:48	WG1177860
1,1,1-Trichloroethane	U		0.000339	0.00308	1	10/09/2018 02:48	WG1177860
1,1,2-Trichloroethane	U		0.00109	0.00308	1	10/09/2018 02:48	WG1177860
Trichloroethene	U		0.000492	0.00123	1	10/09/2018 02:48	WG1177860
Trichlorofluoromethane	U		0.000616	0.00308	1	10/09/2018 02:48	WG1177860
1,2,3-Trichloropropane	U		0.00628	0.0154	1	10/09/2018 02:48	WG1177860
1,2,4-Trimethylbenzene	U		0.00143	0.00616	1	10/09/2018 02:48	WG1177860
1,2,3-Trimethylbenzene	U		0.00142	0.00616	1	10/09/2018 02:48	WG1177860
1,3,5-Trimethylbenzene	U		0.00133	0.00616	1	10/09/2018 02:48	WG1177860
Vinyl chloride	U		0.000841	0.00308	1	10/09/2018 02:48	WG1177860
Xylenes, Total	U		0.00588	0.00800	1	10/09/2018 02:48	WG1177860
(S) Toluene-d8	*120*			*75.0-131*		*10/09/2018 02:48*	WG1177860
(S) Dibromofluoromethane	*98.6*			*65.0-129*		*10/09/2018 02:48*	WG1177860
(S) 4-Bromofluorobenzene	*97.5*			*67.0-138*		*10/09/2018 02:48*	WG1177860

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result (dry) mg/kg	Qualifier	MDL (dry) mg/kg	RDL (dry) mg/kg	Dilution	Analysis date / time	Batch
Anthracene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Acenaphthene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Acenaphthylene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Benzo(a)anthracene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Benzo(a)pyrene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Benzo(b)fluoranthene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Benzo(g,h,i)perylene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Benzo(k)fluoranthene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Chrysene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Dibenz(a,h)anthracene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Fluoranthene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Fluorene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Indeno(1,2,3-cd)pyrene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Naphthalene	U		0.00246	0.0246	1	10/10/2018 22:32	WG1178306
Phenanthrene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
Pyrene	U		0.000739	0.00739	1	10/10/2018 22:32	WG1178306
1-Methylnaphthalene	U		0.00246	0.0246	1	10/10/2018 22:32	WG1178306
2-Methylnaphthalene	U		0.00246	0.0246	1	10/10/2018 22:32	WG1178306
(S) Nitrobenzene-d5	*98.9*			*14.0-149*		*10/10/2018 22:32*	WG1178306
(S) 2-Fluorobiphenyl	*93.1*			*34.0-125*		*10/10/2018 22:32*	WG1178306
(S) p-Terphenyl-d14	*85.6*			*23.0-120*		*10/10/2018 22:32*	WG1178306

Method Blank (MB)

(MB) R3349195-1 10/09/18 13:59

Analyte	MB Result %	MB Qualifier	MB MDL %	MB RDL %
Total Solids	0.000			

L1031756-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1031756-01 10/09/18 13:59 • (DUP) R3349195-3 10/09/18 13:59

Analyte	Original Result %	DUP Result %	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Total Solids	81.1	82.0	1	1.12		10

Laboratory Control Sample (LCS)

(LCS) R3349195-2 10/09/18 13:59

Analyte	Spike Amount %	LCS Result %	LCS Rec. %	Rec. Limits %	LCS Qualifier
Total Solids	50.0	50.0	100	85.0-115	

Method Blank (MB)

(MB) R3349192-1 10/09/18 13:43

Analyte	MB Result %	MB Qualifier	MB MDL %	MB RDL %
Total Solids	0.000			

L1031764-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1031764-01 10/09/18 13:43 • (DUP) R3349192-3 10/09/18 13:43

Analyte	Original Result %	DUP Result %	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Total Solids	84.4	86.5	1	2.51		10

Laboratory Control Sample (LCS)

(LCS) R3349192-2 10/09/18 13:43

Analyte	Spike Amount %	LCS Result %	LCS Rec. %	Rec. Limits %	LCS Qualifier
Total Solids	50.0	50.0	100	85.0-115	

Method Blank (MB)

(MB) R3348723-5 10/08/18 20:42

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Mercury	U		0.00280	0.0200

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348723-1 10/08/18 19:22 • (LCSD) R3348723-2 10/08/18 19:25

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Mercury	0.300	0.271	0.280	90.3	93.4	80.0-120			3.42	20

L1031650-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1031650-01 10/08/18 19:27 • (MS) R3348723-3 10/08/18 19:30 • (MSD) R3348723-4 10/08/18 19:38

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Mercury	0.300	0.0305	0.279	0.307	82.7	92.0	1	75.0-125			9.61	20

Method Blank (MB)

(MB) R3349137-1 10/09/18 18:51

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Arsenic	U		0.460	1.00
Barium	U		0.170	0.500
Cadmium	U		0.0700	0.200
Chromium	U		0.140	1.00
Lead	U		0.190	0.500
Selenium	U		0.620	2.00
Silver	U		0.120	0.500

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349137-2 10/09/18 18:53 • (LCSD) R3349137-3 10/09/18 18:56

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Arsenic	100	96.4	96.7	96.4	96.7	80.0-120			0.338	20
Barium	100	99.7	100	99.7	100	80.0-120			0.614	20
Cadmium	100	96.1	97.0	96.1	97.0	80.0-120			0.927	20
Chromium	100	96.1	97.4	96.1	97.4	80.0-120			1.32	20
Lead	100	97.7	97.5	97.7	97.5	80.0-120			0.110	20
Selenium	100	95.2	94.9	95.2	94.9	80.0-120			0.370	20
Silver	20.0	17.7	18.0	88.4	90.0	80.0-120			1.80	20

L1031650-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1031650-01 10/09/18 18:58 • (MS) R3349137-6 10/09/18 19:05 • (MSD) R3349137-7 10/09/18 19:08

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Arsenic	119	2.78	117	114	96.6	94.0	1	75.0-125			2.63	20
Barium	119	62.3	179	176	98.0	95.5	1	75.0-125			1.65	20
Cadmium	119	ND	116	115	97.6	96.7	1	75.0-125			0.946	20
Chromium	119	18.3	134	133	97.8	96.2	1	75.0-125			1.40	20
Lead	119	3.36	124	122	102	99.7	1	75.0-125			2.10	20
Selenium	119	ND	114	111	95.8	93.8	1	75.0-125			2.04	20
Silver	23.7	ND	20.9	20.8	87.9	87.6	1	75.0-125			0.329	20

Method Blank (MB)

(MB) R3349008-2 10/08/18 22:53

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Acetone	U		0.0137	0.0250
Acrylonitrile	U		0.00190	0.0125
Benzene	U		0.000400	0.00100
Bromobenzene	U		0.00105	0.0125
Bromodichloromethane	U		0.000788	0.00250
Bromoform	U		0.00598	0.0250
Bromomethane	U		0.00370	0.0125
n-Butylbenzene	U		0.00384	0.0125
sec-Butylbenzene	U		0.00253	0.0125
tert-Butylbenzene	U		0.00155	0.00500
Carbon tetrachloride	U		0.00108	0.00500
Chlorobenzene	U		0.000573	0.00250
Chlorodibromomethane	U		0.000450	0.00250
Chloroethane	U		0.00108	0.00500
Chloroform	U		0.000415	0.00250
Chloromethane	U		0.00139	0.0125
2-Chlorotoluene	U		0.000920	0.00250
4-Chlorotoluene	U		0.00113	0.00500
1,2-Dibromo-3-Chloropropane	U		0.00510	0.0250
1,2-Dibromoethane	U		0.000525	0.00250
Dibromomethane	U		0.00100	0.00500
1,2-Dichlorobenzene	U		0.00145	0.00500
1,3-Dichlorobenzene	U		0.00170	0.00500
1,4-Dichlorobenzene	U		0.00197	0.00500
Dichlorodifluoromethane	U		0.000818	0.00250
1,1-Dichloroethane	U		0.000575	0.00250
1,2-Dichloroethane	U		0.000475	0.00250
1,1-Dichloroethene	U		0.000500	0.00250
cis-1,2-Dichloroethene	U		0.000690	0.00250
trans-1,2-Dichloroethene	U		0.00143	0.00500
1,2-Dichloropropane	U		0.00127	0.00500
1,1-Dichloropropene	U		0.000700	0.00250
1,3-Dichloropropane	U		0.00175	0.00500
cis-1,3-Dichloropropene	U		0.000678	0.00250
trans-1,3-Dichloropropene	U		0.00153	0.00500
2,2-Dichloropropane	U		0.000793	0.00250
Di-isopropyl ether	U		0.000350	0.00100
Ethylbenzene	U		0.000530	0.00250
Hexachloro-1,3-butadiene	U		0.0127	0.0250
Isopropylbenzene	U		0.000863	0.00250

Method Blank (MB)

(MB) R3349008-2 10/08/18 22:53

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
p-Isopropyltoluene	U		0.00233	0.00500
2-Butanone (MEK)	U		0.0125	0.0250
Methylene Chloride	U		0.00664	0.0250
4-Methyl-2-pentanone (MIBK)	U		0.0100	0.0250
Methyl tert-butyl ether	U		0.000295	0.00100
Naphthalene	U		0.00312	0.0125
n-Propylbenzene	U		0.00118	0.00500
Styrene	U		0.00273	0.0125
1,1,1,2-Tetrachloroethane	U		0.000500	0.00250
1,1,2,2-Tetrachloroethane	U		0.000390	0.00250
Tetrachloroethene	U		0.000700	0.00250
Toluene	U		0.00125	0.00500
1,1,2-Trichlorotrifluoroethane	U		0.000675	0.00250
1,2,3-Trichlorobenzene	U		0.000625	0.00250
1,2,4-Trichlorobenzene	U		0.00482	0.0125
1,1,1-Trichloroethane	U		0.000275	0.00250
1,1,2-Trichloroethane	U		0.000883	0.00250
Trichloroethene	U		0.000400	0.00100
Trichlorofluoromethane	U		0.000500	0.00250
1,2,3-Trichloropropane	U		0.00510	0.0125
1,2,3-Trimethylbenzene	U		0.00115	0.00500
1,2,4-Trimethylbenzene	U		0.00116	0.00500
1,3,5-Trimethylbenzene	U		0.00108	0.00500
Vinyl chloride	U		0.000683	0.00250
Xylenes, Total	U		0.00478	0.00650
(S) Toluene-d8	*125*			*75.0-131*
(S) Dibromofluoromethane	*97.1*			*65.0-129*
(S) 4-Bromofluorobenzene	*96.3*			*67.0-138*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349008-1 10/08/18 21:32 • (LCSD) R3349008-3 10/08/18 23:44

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Acetone	0.625	0.673	0.742	108	119	10.0-160			9.76	31
Acrylonitrile	0.625	0.642	0.681	103	109	45.0-153			5.98	22
Benzene	0.125	0.121	0.125	97.0	100	70.0-123			3.18	20
Bromobenzene	0.125	0.112	0.110	89.8	88.3	73.0-121			1.73	20
Bromodichloromethane	0.125	0.129	0.129	103	104	73.0-121			0.0950	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349008-1 10/08/18 21:32 • (LCSD) R3349008-3 10/08/18 23:44

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Bromoform	0.125	0.0896	0.0879	71.6	70.4	64.0-132			1.81	20
Bromomethane	0.125	0.135	0.135	108	108	56.0-147			0.525	20
n-Butylbenzene	0.125	0.108	0.110	86.1	87.7	68.0-135			1.87	20
sec-Butylbenzene	0.125	0.117	0.112	93.4	89.2	74.0-130			4.57	20
tert-Butylbenzene	0.125	0.113	0.107	90.7	86.0	75.0-127			5.39	20
Carbon tetrachloride	0.125	0.109	0.118	87.1	94.1	66.0-128			7.76	20
Chlorobenzene	0.125	0.107	0.111	85.3	88.7	76.0-128			3.87	20
Chlorodibromomethane	0.125	0.101	0.104	81.2	82.9	74.0-127			2.08	20
Chloroethane	0.125	0.138	0.135	111	108	61.0-134			2.64	20
Chloroform	0.125	0.131	0.137	105	110	72.0-123			4.06	20
Chloromethane	0.125	0.149	0.148	119	118	51.0-138			0.740	20
2-Chlorotoluene	0.125	0.112	0.111	89.7	88.6	75.0-124			1.24	20
4-Chlorotoluene	0.125	0.122	0.116	97.9	93.0	75.0-124			5.09	20
1,2-Dibromo-3-Chloropropane	0.125	0.0937	0.0927	75.0	74.2	59.0-130			1.11	20
1,2-Dibromoethane	0.125	0.119	0.118	95.4	94.4	74.0-128			0.997	20
Dibromomethane	0.125	0.115	0.112	92.0	89.9	75.0-122			2.40	20
1,2-Dichlorobenzene	0.125	0.113	0.114	90.5	91.2	76.0-124			0.668	20
1,3-Dichlorobenzene	0.125	0.108	0.113	86.1	90.2	76.0-125			4.68	20
1,4-Dichlorobenzene	0.125	0.105	0.105	84.1	84.3	77.0-121			0.231	20
Dichlorodifluoromethane	0.125	0.166	0.174	132	140	43.0-156			5.23	20
1,1-Dichloroethane	0.125	0.134	0.133	107	107	70.0-127			0.516	20
1,2-Dichloroethane	0.125	0.139	0.137	111	110	65.0-131			0.910	20
1,1-Dichloroethene	0.125	0.123	0.127	98.5	102	65.0-131			3.03	20
cis-1,2-Dichloroethene	0.125	0.127	0.125	102	100	73.0-125			1.59	20
trans-1,2-Dichloroethene	0.125	0.118	0.116	94.2	92.8	71.0-125			1.50	20
1,2-Dichloropropane	0.125	0.128	0.122	102	97.5	74.0-125			4.67	20
1,1-Dichloropropene	0.125	0.111	0.126	88.7	101	73.0-125			12.9	20
1,3-Dichloropropane	0.125	0.130	0.128	104	102	80.0-125			1.89	20
cis-1,3-Dichloropropene	0.125	0.112	0.117	89.3	93.6	76.0-127			4.80	20
trans-1,3-Dichloropropene	0.125	0.112	0.108	89.3	86.8	73.0-127			2.88	20
2,2-Dichloropropane	0.125	0.116	0.122	93.1	97.4	59.0-135			4.57	20
Di-isopropyl ether	0.125	0.138	0.138	111	110	60.0-136			0.488	20
Ethylbenzene	0.125	0.123	0.121	98.7	96.5	74.0-126			2.35	20
Hexachloro-1,3-butadiene	0.125	0.0906	0.0982	72.5	78.6	57.0-150			8.06	20
Isopropylbenzene	0.125	0.111	0.105	89.1	84.3	72.0-127			5.53	20
p-Isopropyltoluene	0.125	0.114	0.111	91.2	88.9	72.0-133			2.55	20
2-Butanone (MEK)	0.625	0.730	0.720	117	115	30.0-160			1.47	24
Methylene Chloride	0.125	0.123	0.134	98.4	107	68.0-123			8.44	20
4-Methyl-2-pentanone (MIBK)	0.625	0.764	0.734	122	117	56.0-143			4.03	20
Methyl tert-butyl ether	0.125	0.138	0.131	110	105	66.0-132			5.38	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349008-1 10/08/18 21:32 • (LCSD) R3349008-3 10/08/18 23:44

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Naphthalene	0.125	0.0924	0.0946	73.9	75.7	59.0-130			2.39	20
n-Propylbenzene	0.125	0.113	0.107	90.4	85.8	74.0-126			5.24	20
Styrene	0.125	0.0988	0.0905	79.1	72.4	72.0-127			8.79	20
1,1,1,2-Tetrachloroethane	0.125	0.117	0.116	93.2	93.0	74.0-129			0.283	20
1,1,2,2-Tetrachloroethane	0.125	0.109	0.103	87.0	82.3	68.0-128			5.54	20
Tetrachloroethene	0.125	0.124	0.133	99.6	106	70.0-136			6.31	20
Toluene	0.125	0.124	0.128	99.6	103	75.0-121			3.12	20
1,1,2-Trichlorotrifluoroethane	0.125	0.113	0.118	90.2	94.4	61.0-139			4.64	20
1,2,3-Trichlorobenzene	0.125	0.100	0.107	80.4	86.0	59.0-139			6.71	20
1,2,4-Trichlorobenzene	0.125	0.0889	0.0951	71.1	76.1	62.0-137			6.71	20
1,1,1-Trichloroethane	0.125	0.109	0.116	87.2	92.8	69.0-126			6.28	20
1,1,2-Trichloroethane	0.125	0.127	0.124	101	99.5	78.0-123			2.01	20
Trichloroethene	0.125	0.102	0.102	81.8	81.4	76.0-126			0.515	20
Trichlorofluoromethane	0.125	0.135	0.139	108	112	61.0-142			2.91	20
1,2,3-Trichloropropane	0.125	0.125	0.116	99.8	92.9	67.0-129			7.22	20
1,2,3-Trimethylbenzene	0.125	0.115	0.116	91.7	92.7	74.0-124			1.09	20
1,2,4-Trimethylbenzene	0.125	0.110	0.109	88.0	87.5	70.0-126			0.564	20
1,3,5-Trimethylbenzene	0.125	0.110	0.107	88.2	85.3	73.0-127			3.33	20
Vinyl chloride	0.125	0.129	0.132	103	105	63.0-134			1.84	20
Xylenes, Total	0.375	0.332	0.346	88.5	92.3	72.0-127			4.13	20
(S) Toluene-d8				*106*	*109*	*75.0-131*				
(S) Dibromofluoromethane				*107*	*113*	*65.0-129*				
(S) 4-Bromofluorobenzene				*99.2*	*97.7*	*67.0-138*				

L1031426-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1031426-01 10/09/18 01:26 • (MS) R3349008-4 10/09/18 08:15 • (MSD) R3349008-5 10/09/18 08:36

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Acetone	0.679	ND	0.650	0.639	92.1	90.5	1	10.0-160			1.75	40
Acrylonitrile	0.679	ND	0.702	0.628	103	92.5	1	10.0-160			11.1	40
Benzene	0.136	ND	0.139	0.142	102	104	1	10.0-149			2.16	37
Bromobenzene	0.136	ND	0.125	0.129	92.0	94.9	1	10.0-156			3.05	38
Bromodichloromethane	0.136	ND	0.142	0.145	105	107	1	10.0-143			1.89	37
Bromoform	0.136	ND	0.0894	0.0947	65.8	69.7	1	10.0-146			5.78	36
Bromomethane	0.136	ND	0.119	0.122	87.5	89.9	1	10.0-149			2.74	38
n-Butylbenzene	0.136	ND	0.134	0.136	98.9	100	1	10.0-160			1.47	40
sec-Butylbenzene	0.136	ND	0.135	0.142	99.1	105	1	10.0-159			5.56	39
tert-Butylbenzene	0.136	ND	0.122	0.135	90.0	99.3	1	10.0-156			9.84	39

L1031426-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1031426-01 10/09/18 01:26 • (MS) R3349008-4 10/09/18 08:15 • (MSD) R3349008-5 10/09/18 08:36

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Carbon tetrachloride	0.136	ND	0.134	0.134	98.6	98.9	1	10.0-145			0.250	37
Chlorobenzene	0.136	ND	0.127	0.126	93.7	92.6	1	10.0-152			1.18	39
Chlorodibromomethane	0.136	ND	0.105	0.111	77.1	81.8	1	10.0-146			6.02	37
Chloroethane	0.136	ND	0.134	0.137	98.7	101	1	10.0-146			2.50	40
Chloroform	0.136	ND	0.152	0.149	112	110	1	10.0-146			1.97	37
Chloromethane	0.136	ND	0.141	0.143	104	106	1	10.0-159			1.47	37
2-Chlorotoluene	0.136	ND	0.126	0.121	92.7	89.2	1	10.0-159			3.90	38
4-Chlorotoluene	0.136	ND	0.139	0.143	102	106	1	10.0-155			3.06	39
1,2-Dibromo-3-Chloropropane	0.136	ND	0.0958	0.110	70.5	80.8	1	10.0-151			13.6	39
1,2-Dibromoethane	0.136	ND	0.129	0.135	95.2	99.5	1	10.0-148			4.44	34
Dibromomethane	0.136	ND	0.121	0.125	89.0	92.0	1	10.0-147			3.38	35
1,2-Dichlorobenzene	0.136	ND	0.129	0.134	95.0	98.5	1	10.0-155			3.61	37
1,3-Dichlorobenzene	0.136	ND	0.123	0.131	90.3	96.4	1	10.0-153			6.46	38
1,4-Dichlorobenzene	0.136	ND	0.127	0.121	93.2	89.4	1	10.0-151			4.10	38
Dichlorodifluoromethane	0.136	ND	0.159	0.158	117	117	1	10.0-160			0.671	35
1,1-Dichloroethane	0.136	ND	0.154	0.154	113	114	1	10.0-147			0.171	37
1,2-Dichloroethane	0.136	ND	0.152	0.156	112	115	1	10.0-148			2.34	35
1,1-Dichloroethene	0.136	ND	0.139	0.140	102	103	1	10.0-155			1.29	37
cis-1,2-Dichloroethene	0.136	ND	0.143	0.149	106	110	1	10.0-149			3.94	37
trans-1,2-Dichloroethene	0.136	ND	0.129	0.134	94.7	98.9	1	10.0-150			4.38	37
1,2-Dichloropropane	0.136	ND	0.141	0.145	104	107	1	10.0-148			3.07	37
1,1-Dichloropropene	0.136	ND	0.149	0.145	110	107	1	10.0-153			2.85	35
1,3-Dichloropropane	0.136	ND	0.147	0.140	108	103	1	10.0-154			4.48	35
cis-1,3-Dichloropropene	0.136	ND	0.127	0.130	93.3	95.8	1	10.0-151			2.62	37
trans-1,3-Dichloropropene	0.136	ND	0.117	0.121	86.0	89.2	1	10.0-148			3.64	37
2,2-Dichloropropane	0.136	ND	0.153	0.146	113	107	1	10.0-138			5.09	36
Di-isopropyl ether	0.136	ND	0.152	0.157	112	116	1	10.0-147			3.73	36
Ethylbenzene	0.136	ND	0.140	0.143	103	105	1	10.0-160			2.26	38
Hexachloro-1,3-butadiene	0.136	ND	0.115	0.111	84.9	81.9	1	10.0-160			3.61	40
Isopropylbenzene	0.136	ND	0.127	0.128	93.3	94.2	1	10.0-155			0.984	38
p-Isopropyltoluene	0.136	ND	0.132	0.139	97.0	103	1	10.0-160			5.58	40
2-Butanone (MEK)	0.679	0.0792	0.749	0.729	98.6	95.7	1	10.0-160			2.69	40
Methylene Chloride	0.136	ND	0.140	0.138	103	102	1	10.0-141			1.24	37
4-Methyl-2-pentanone (MIBK)	0.679	ND	0.842	0.828	124	122	1	10.0-160			1.65	35
Methyl tert-butyl ether	0.136	ND	0.141	0.146	104	107	1	11.0-147			3.48	35
Naphthalene	0.136	ND	0.116	0.117	85.5	86.0	1	10.0-160			0.570	36
n-Propylbenzene	0.136	ND	0.129	0.136	94.7	100	1	10.0-158			5.82	38
Styrene	0.136	ND	0.109	0.109	80.5	80.1	1	10.0-160			0.466	40
1,1,1,2-Tetrachloroethane	0.136	ND	0.133	0.133	98.2	98.0	1	10.0-149			0.227	39

L1031426-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1031426-01 10/09/18 01:26 • (MS) R3349008-4 10/09/18 08:15 • (MSD) R3349008-5 10/09/18 08:36

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
1,1,2,2-Tetrachloroethane	0.136	ND	0.123	0.132	90.3	96.8	1	10.0-160			7.00	35
Tetrachloroethene	0.136	ND	0.147	0.143	108	106	1	10.0-156			2.34	39
Toluene	0.136	ND	0.146	0.146	107	107	1	10.0-156			0.189	38
1,1,2-Trichlorotrifluoroethane	0.136	ND	0.140	0.138	103	101	1	10.0-160			1.21	36
1,2,3-Trichlorobenzene	0.136	ND	0.122	0.135	90.1	99.1	1	10.0-160			9.54	40
1,2,4-Trichlorobenzene	0.136	ND	0.107	0.111	78.8	81.7	1	10.0-160			3.50	40
1,1,1-Trichloroethane	0.136	ND	0.130	0.132	95.9	97.5	1	10.0-144			1.57	35
1,1,2-Trichloroethane	0.136	ND	0.146	0.143	107	105	1	10.0-160			1.84	35
Trichloroethene	0.136	ND	0.112	0.115	82.6	84.9	1	10.0-156			2.72	38
Trichlorofluoromethane	0.136	ND	0.148	0.155	109	114	1	10.0-160			4.36	40
1,2,3-Trichloropropane	0.136	ND	0.137	0.136	101	99.8	1	10.0-156			1.25	35
1,2,3-Trimethylbenzene	0.136	ND	0.130	0.136	95.7	100	1	10.0-160			4.62	36
1,2,4-Trimethylbenzene	0.136	ND	0.127	0.129	93.1	94.8	1	10.0-160			1.78	36
1,3,5-Trimethylbenzene	0.136	ND	0.125	0.129	91.9	95.0	1	10.0-160			3.31	38
Vinyl chloride	0.136	ND	0.109	0.108	80.6	79.2	1	10.0-160			1.77	37
Xylenes, Total	0.408	ND	0.398	0.398	97.6	97.6	1	10.0-160			0.000	38
(S) Toluene-d8					*109*	*107*		*75.0-131*				
(S) Dibromofluoromethane					*106*	*108*		*65.0-129*				
(S) 4-Bromofluorobenzene					*97.1*	*96.5*		*67.0-138*				

Method Blank (MB)

(MB) R3349358-3 10/10/18 08:15

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Acetone	U		0.0137	0.0250
Acrylonitrile	U		0.00190	0.0125
Benzene	U		0.000400	0.00100
Bromobenzene	U		0.00105	0.0125
Bromodichloromethane	U		0.000788	0.00250
Bromoform	U		0.00598	0.0250
Bromomethane	U		0.00370	0.0125
n-Butylbenzene	U		0.00384	0.0125
sec-Butylbenzene	U		0.00253	0.0125
tert-Butylbenzene	U		0.00155	0.00500
Carbon tetrachloride	U		0.00108	0.00500
Chlorobenzene	U		0.000573	0.00250
Chlorodibromomethane	U		0.000450	0.00250
Chloroethane	U		0.00108	0.00500
Chloroform	U		0.000415	0.00250
Chloromethane	U		0.00139	0.0125
2-Chlorotoluene	U		0.000920	0.00250
4-Chlorotoluene	U		0.00113	0.00500
1,2-Dibromo-3-Chloropropane	U		0.00510	0.0250
1,2-Dibromoethane	U		0.000525	0.00250
Dibromomethane	U		0.00100	0.00500
1,2-Dichlorobenzene	U		0.00145	0.00500
1,3-Dichlorobenzene	U		0.00170	0.00500
1,4-Dichlorobenzene	U		0.00197	0.00500
Dichlorodifluoromethane	U		0.000818	0.00250
1,1-Dichloroethane	U		0.000575	0.00250
1,2-Dichloroethane	U		0.000475	0.00250
1,1-Dichloroethene	U		0.000500	0.00250
cis-1,2-Dichloroethene	U		0.000690	0.00250
trans-1,2-Dichloroethene	U		0.00143	0.00500
1,2-Dichloropropane	U		0.00127	0.00500
1,1-Dichloropropene	U		0.000700	0.00250
1,3-Dichloropropane	U		0.00175	0.00500
cis-1,3-Dichloropropene	U		0.000678	0.00250
trans-1,3-Dichloropropene	U		0.00153	0.00500
2,2-Dichloropropane	U		0.000793	0.00250
Di-isopropyl ether	U		0.000350	0.00100
Ethylbenzene	U		0.000530	0.00250
Hexachloro-1,3-butadiene	U		0.0127	0.0250
Isopropylbenzene	U		0.000863	0.00250

Method Blank (MB)

(MB) R3349358-3 10/10/18 08:15

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
p-Isopropyltoluene	U		0.00233	0.00500
2-Butanone (MEK)	U		0.0125	0.0250
Methylene Chloride	0.00666	J	0.00664	0.0250
4-Methyl-2-pentanone (MIBK)	U		0.0100	0.0250
Methyl tert-butyl ether	U		0.000295	0.00100
Naphthalene	U		0.00312	0.0125
n-Propylbenzene	U		0.00118	0.00500
Styrene	U		0.00273	0.0125
1,1,1,2-Tetrachloroethane	U		0.000500	0.00250
1,1,2,2-Tetrachloroethane	U		0.000390	0.00250
Tetrachloroethene	U		0.000700	0.00250
Toluene	U		0.00125	0.00500
1,1,2-Trichlorotrifluoroethane	U		0.000675	0.00250
1,2,3-Trichlorobenzene	U		0.000625	0.00250
1,2,4-Trichlorobenzene	U		0.00482	0.0125
1,1,1-Trichloroethane	U		0.000275	0.00250
1,1,2-Trichloroethane	U		0.000883	0.00250
Trichloroethene	U		0.000400	0.00100
Trichlorofluoromethane	U		0.000500	0.00250
1,2,3-Trichloropropane	U		0.00510	0.0125
1,2,3-Trimethylbenzene	U		0.00115	0.00500
1,2,4-Trimethylbenzene	U		0.00116	0.00500
1,3,5-Trimethylbenzene	U		0.00108	0.00500
Vinyl chloride	U		0.000683	0.00250
Xylenes, Total	U		0.00478	0.00650
(S) Toluene-d8	*122*			*75.0-131*
(S) Dibromofluoromethane	*95.7*			*65.0-129*
(S) 4-Bromofluorobenzene	*95.4*			*67.0-138*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349358-1 10/10/18 06:54 • (LCSD) R3349358-2 10/10/18 07:14

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Acetone	0.625	0.715	0.674	114	108	10.0-160			5.93	31
Acrylonitrile	0.625	0.642	0.600	103	95.9	45.0-153			6.87	22
Benzene	0.125	0.122	0.122	97.3	97.8	70.0-123			0.561	20
Bromobenzene	0.125	0.116	0.133	92.7	106	73.0-121			13.7	20
Bromodichloromethane	0.125	0.127	0.134	101	107	73.0-121			5.53	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349358-1 10/10/18 06:54 • (LCSD) R3349358-2 10/10/18 07:14

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Bromoform	0.125	0.0949	0.106	75.9	84.5	64.0-132			10.7	20
Bromomethane	0.125	0.130	0.129	104	103	56.0-147			0.854	20
n-Butylbenzene	0.125	0.116	0.131	92.4	105	68.0-135			12.5	20
sec-Butylbenzene	0.125	0.121	0.136	97.2	109	74.0-130			11.3	20
tert-Butylbenzene	0.125	0.111	0.129	88.5	103	75.0-127			15.4	20
Carbon tetrachloride	0.125	0.121	0.119	96.7	95.3	66.0-128			1.50	20
Chlorobenzene	0.125	0.110	0.120	87.8	96.0	76.0-128			8.97	20
Chlorodibromomethane	0.125	0.102	0.108	81.4	86.8	74.0-127			6.40	20
Chloroethane	0.125	0.131	0.137	104	110	61.0-134			5.11	20
Chloroform	0.125	0.133	0.133	107	106	72.0-123			0.505	20
Chloromethane	0.125	0.141	0.145	113	116	51.0-138			2.82	20
2-Chlorotoluene	0.125	0.116	0.128	92.5	102	75.0-124			10.0	20
4-Chlorotoluene	0.125	0.124	0.142	99.1	114	75.0-124			13.6	20
1,2-Dibromo-3-Chloropropane	0.125	0.103	0.115	82.2	92.2	59.0-130			11.5	20
1,2-Dibromoethane	0.125	0.123	0.127	98.1	102	74.0-128			3.78	20
Dibromomethane	0.125	0.111	0.118	88.8	94.7	75.0-122			6.41	20
1,2-Dichlorobenzene	0.125	0.124	0.133	99.3	106	76.0-124			6.61	20
1,3-Dichlorobenzene	0.125	0.119	0.127	95.2	102	76.0-125			6.52	20
1,4-Dichlorobenzene	0.125	0.115	0.122	91.6	97.2	77.0-121			5.93	20
Dichlorodifluoromethane	0.125	0.155	0.156	124	125	43.0-156			0.900	20
1,1-Dichloroethane	0.125	0.132	0.135	105	108	70.0-127			2.33	20
1,2-Dichloroethane	0.125	0.136	0.132	108	105	65.0-131			2.90	20
1,1-Dichloroethene	0.125	0.127	0.128	101	102	65.0-131			0.984	20
cis-1,2-Dichloroethene	0.125	0.126	0.129	101	103	73.0-125			1.98	20
trans-1,2-Dichloroethene	0.125	0.116	0.118	92.8	94.7	71.0-125			2.02	20
1,2-Dichloropropane	0.125	0.119	0.126	95.1	101	74.0-125			5.61	20
1,1-Dichloropropene	0.125	0.127	0.130	102	104	73.0-125			2.63	20
1,3-Dichloropropane	0.125	0.131	0.140	105	112	80.0-125			6.34	20
cis-1,3-Dichloropropene	0.125	0.110	0.125	87.7	100	76.0-127			13.2	20
trans-1,3-Dichloropropene	0.125	0.105	0.115	83.8	92.2	73.0-127			9.63	20
2,2-Dichloropropane	0.125	0.120	0.125	96.4	100	59.0-135			3.90	20
Di-isopropyl ether	0.125	0.140	0.136	112	108	60.0-136			3.12	20
Ethylbenzene	0.125	0.124	0.133	99.0	106	74.0-126			6.96	20
Hexachloro-1,3-butadiene	0.125	0.0996	0.118	79.7	94.8	57.0-150			17.4	20
Isopropylbenzene	0.125	0.114	0.131	91.1	105	72.0-127			13.7	20
p-Isopropyltoluene	0.125	0.122	0.138	97.4	110	72.0-133			12.2	20
2-Butanone (MEK)	0.625	0.712	0.689	114	110	30.0-160			3.20	24
Methylene Chloride	0.125	0.119	0.118	94.9	94.5	68.0-123			0.389	20
4-Methyl-2-pentanone (MIBK)	0.625	0.801	0.827	128	132	56.0-143			3.22	20
Methyl tert-butyl ether	0.125	0.138	0.134	111	107	66.0-132			3.36	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349358-1 10/10/18 06:54 • (LCSD) R3349358-2 10/10/18 07:14

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Naphthalene	0.125	0.110	0.117	87.9	93.5	59.0-130			6.13	20
n-Propylbenzene	0.125	0.117	0.135	93.7	108	74.0-126			14.0	20
Styrene	0.125	0.0941	0.110	75.3	88.0	72.0-127			15.6	20
1,1,1,2-Tetrachloroethane	0.125	0.126	0.128	100	103	74.0-129			2.32	20
1,1,2,2-Tetrachloroethane	0.125	0.121	0.131	97.2	105	68.0-128			7.80	20
Tetrachloroethene	0.125	0.125	0.136	100	109	70.0-136			8.07	20
Toluene	0.125	0.127	0.138	101	110	75.0-121			8.13	20
1,1,2-Trichlorotrifluoroethane	0.125	0.123	0.118	98.1	94.5	61.0-139			3.73	20
1,2,3-Trichlorobenzene	0.125	0.117	0.127	93.6	102	59.0-139			8.50	20
1,2,4-Trichlorobenzene	0.125	0.0989	0.112	79.1	89.9	62.0-137			12.7	20
1,1,1-Trichloroethane	0.125	0.114	0.113	91.1	90.2	69.0-126			0.910	20
1,1,2-Trichloroethane	0.125	0.126	0.133	101	106	78.0-123			5.33	20
Trichloroethene	0.125	0.0979	0.108	78.3	86.5	76.0-126			9.92	20
Trichlorofluoromethane	0.125	0.141	0.143	113	114	61.0-142			1.48	20
1,2,3-Trichloropropane	0.125	0.130	0.154	104	123	67.0-129			16.6	20
1,2,3-Trimethylbenzene	0.125	0.123	0.133	98.3	106	74.0-124			7.96	20
1,2,4-Trimethylbenzene	0.125	0.114	0.130	91.2	104	70.0-126			12.8	20
1,3,5-Trimethylbenzene	0.125	0.112	0.130	89.7	104	73.0-127			14.4	20
Vinyl chloride	0.125	0.128	0.135	103	108	63.0-134			5.01	20
Xylenes, Total	0.375	0.340	0.365	90.7	97.3	72.0-127			7.09	20
(S) Toluene-d8				*109*	*110*	*75.0-131*				
(S) Dibromofluoromethane				*111*	*106*	*65.0-129*				
(S) 4-Bromofluorobenzene				*98.3*	*106*	*67.0-138*				

Method Blank (MB)

(MB) R3349569-3 10/10/18 18:20

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Anthracene	U		0.000600	0.00600
Acenaphthene	U		0.000600	0.00600
Acenaphthylene	U		0.000600	0.00600
Benzo(a)anthracene	U		0.000600	0.00600
Benzo(a)pyrene	U		0.000600	0.00600
Benzo(b)fluoranthene	U		0.000600	0.00600
Benzo(g,h,i)perylene	U		0.000600	0.00600
Benzo(k)fluoranthene	U		0.000600	0.00600
Chrysene	U		0.000600	0.00600
Dibenz(a,h)anthracene	U		0.000600	0.00600
Fluoranthene	U		0.000600	0.00600
Fluorene	U		0.000600	0.00600
Indeno(1,2,3-cd)pyrene	U		0.000600	0.00600
Naphthalene	U		0.00200	0.0200
Phenanthrene	U		0.000600	0.00600
Pyrene	U		0.000600	0.00600
1-Methylnaphthalene	U		0.00200	0.0200
2-Methylnaphthalene	U		0.00200	0.0200
(S) Nitrobenzene-d5	*109*			*14.0-149*
(S) 2-Fluorobiphenyl	*124*			*34.0-125*
(S) p-Terphenyl-d14	*109*			*23.0-120*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349569-1 10/10/18 17:37 • (LCSD) R3349569-2 10/10/18 17:59

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Anthracene	0.0800	0.0720	0.0777	90.0	97.1	50.0-126			7.62	20
Acenaphthene	0.0800	0.0766	0.0762	95.8	95.3	50.0-120			0.524	20
Acenaphthylene	0.0800	0.0778	0.0771	97.3	96.4	50.0-120			0.904	20
Benzo(a)anthracene	0.0800	0.0757	0.0741	94.6	92.6	45.0-120			2.14	20
Benzo(a)pyrene	0.0800	0.0651	0.0644	81.4	80.5	42.0-120			1.08	20
Benzo(b)fluoranthene	0.0800	0.0782	0.0728	97.8	91.0	42.0-121			7.15	20
Benzo(g,h,i)perylene	0.0800	0.0794	0.0720	99.3	90.0	45.0-125			9.78	20
Benzo(k)fluoranthene	0.0800	0.0908	0.0844	114	105	49.0-125			7.31	20
Chrysene	0.0800	0.0850	0.0863	106	108	49.0-122			1.52	20
Dibenz(a,h)anthracene	0.0800	0.0793	0.0724	99.1	90.5	47.0-125			9.10	20
Fluoranthene	0.0800	0.0875	0.0895	109	112	49.0-129			2.26	20
Fluorene	0.0800	0.0751	0.0742	93.9	92.8	49.0-120			1.21	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349569-1 10/10/18 17:37 • (LCSD) R3349569-2 10/10/18 17:59

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Indeno(1,2,3-cd)pyrene	0.0800	0.0794	0.0722	99.3	90.3	46.0-125			9.50	20
Naphthalene	0.0800	0.0777	0.0773	97.1	96.6	50.0-120			0.516	20
Phenanthrene	0.0800	0.0752	0.0746	94.0	93.3	47.0-120			0.801	20
Pyrene	0.0800	0.0675	0.0657	84.4	82.1	43.0-123			2.70	20
1-Methylnaphthalene	0.0800	0.0825	0.0819	103	102	51.0-121			0.730	20
2-Methylnaphthalene	0.0800	0.0707	0.0710	88.4	88.8	50.0-120			0.423	20
(S) Nitrobenzene-d5				*125*	*122*	*14.0-149*				
(S) 2-Fluorobiphenyl				*111*	*110*	*34.0-125*				
(S) p-Terphenyl-d14				*108*	*106*	*23.0-120*				

L1031811-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1031811-04 10/10/18 23:35 • (MS) R3349569-4 10/10/18 23:56 • (MSD) R3349569-5 10/11/18 00:17

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Anthracene	0.0894	U	0.0804	0.0817	89.9	91.4	1	10.0-145			1.66	30
Acenaphthene	0.0894	U	0.0801	0.0817	89.6	91.4	1	14.0-127			1.93	27
Acenaphthylene	0.0894	U	0.0800	0.0839	89.5	93.9	1	21.0-124			4.77	25
Benzo(a)anthracene	0.0894	0.00507	0.0985	0.0990	104	105	1	10.0-139			0.566	30
Benzo(a)pyrene	0.0894	0.00584	0.103	0.111	108	117	1	10.0-141			7.66	31
Benzo(b)fluoranthene	0.0894	0.00847	0.108	0.115	111	119	1	10.0-140			6.41	36
Benzo(g,h,i)perylene	0.0894	0.00594	0.107	0.120	112	127	1	10.0-140			11.6	33
Benzo(k)fluoranthene	0.0894	0.00303	0.0908	0.0969	98.1	105	1	10.0-137			6.55	31
Chrysene	0.0894	0.00808	0.115	0.117	120	122	1	10.0-145			1.92	30
Dibenz(a,h)anthracene	0.0894	0.00108	0.0882	0.0993	97.4	110	1	10.0-132			11.8	31
Fluoranthene	0.0894	0.0149	0.153	0.146	155	147	1	10.0-153	J5		4.48	33
Fluorene	0.0894	U	0.0772	0.0794	86.4	88.8	1	11.0-130			2.71	29
Indeno(1,2,3-cd)pyrene	0.0894	0.00433	0.0995	0.112	106	120	1	10.0-137			11.6	32
Naphthalene	0.0894	U	0.0809	0.0864	90.5	96.6	1	10.0-135			6.55	27
Phenanthrene	0.0894	0.00468	0.105	0.103	112	110	1	10.0-144			1.94	31
Pyrene	0.0894	0.0132	0.131	0.123	132	123	1	10.0-148			6.17	35
1-Methylnaphthalene	0.0894	U	0.0796	0.0888	89.0	99.3	1	10.0-142			10.9	28
2-Methylnaphthalene	0.0894	U	0.0692	0.0774	77.4	86.5	1	10.0-137			11.1	28
(S) Nitrobenzene-d5					*118*	*128*		*14.0-149*				
(S) 2-Fluorobiphenyl					*101*	*106*		*34.0-125*				
(S) p-Terphenyl-d14					*104*	*106*		*23.0-120*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

(dry)	Results are reported based on the dry weight of the sample. [this will only be present on a dry report basis for soils].
MDL	Method Detection Limit.
MDL (dry)	Method Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
RDL	Reported Detection Limit.
RDL (dry)	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.
J5	The sample matrix interfered with the ability to make any accurate determination; spike value is high.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana [1]	LA180010	Texas	T 104704245-17-14
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

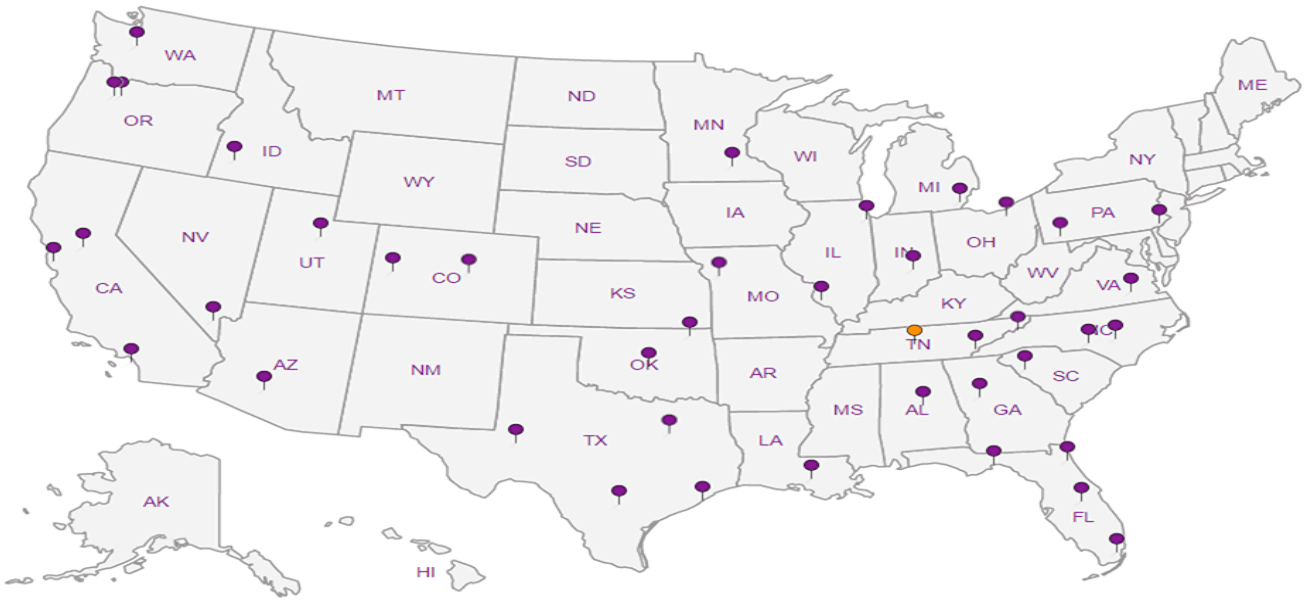
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.



Partner Engineering & Science - IL

805 North Milwaukee Avenue
Suite 401
Chicago, IL 60642

Billing Information:
Accounts Payable
2154 Torrance Blvd., Ste. 200
Torrance, CA 90501

Report to: Lucas Martin

Email To: LMartin@partnereci.com

Project Description: Fox Shores Apartments

City/State Collected: Kaukauna, WI

Phone: ~~773-966-2029~~ Fax: 224-244-0736

Client Project # 18-215232.3

Lab Project # PARENGCIL-18215233

Collected by (print): L. Martin

Site/Facility ID # 400 Fox Shores Dr.

P.O. #

Collected by (signature):

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed

Email? ___No ___Yes
FAX? ___No ___Yes

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	MRCRA 8 2oz Clr - No Pres	SV8270PAHSIM, TS 4oz Clr-No Pres	V8260 40ml Amb/ MeOH 5ml/Syr								Rem./Contaminant	Sample # (lab only)
B1 (0.5-1)	Grab	SS	0.5-1	10/3/18	1040	1	X											-01
B1 (6-7)		SS	6-7		1045	2		X	X									02
B2 (0.5-1)		SS	0.5-1		1120	1	X											03
B2 (7-8)		SS	7-8		1125	2		X	X									04
B3 (0.5-1)		SS	0.5-1		1145	1	X											05
B3 (3-4)		SS	3-4		1150	2		X	X									06
B4 (0.5-1)		SS	0.5-1		1205	1	X											07
B4 (6-7)		SS	6-7		1210	2		X	X									08
B5 (0.5-1)		SS	0.5-1		1100	1	X											09
B5 (3.5-4.5)		SS	3.5-4.5		1105	2		X	X									10

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ___

Remarks: RAD SCREEN: <0.5 mR/hr

4624 2993 6211

pH ___ Temp ___

Flow ___ Other ___

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
	10/3/18	1500	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)
			861

Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ ___

Temp: 1.6 -1.3°C 1.3 Bottles Received: 15+1TB

Date: 10/4/18 Time: 8:45

Hold #

Condition: (lab use only) OK

COC Seal Intact: ___Y ___N ___NA

pH Checked: NCF:

Chain of Custody Page ___ of ___

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Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L 1031756

E061

Acctnum: PARENGCIL
Template: T141198
Prelogin: P674192
TSR: 341 - John Hawkins
PB:
Shipped Via: FedEx Ground

Pace Analytical National Center for Testing & Innovation
Cooler Receipt Form

Client: PARENCIL	SDG#	L1031756	
Cooler Received/Opened On: 10/4 /18	Temperature:	1.3	
Received By: Kevin Turner			
Signature:			

Receipt Check List	NP	Yes	No
COC Seal Present / Intact?		✓	
COC Signed / Accurate?		✓	
Bottles arrive intact?		✓	
Correct bottles used?		✓	
Sufficient volume sent?		✓	
If Applicable			
VOA Zero headspace?			
Preservation Correct / Checked?			

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

October 11, 2018

Partner Engineering & Science - IL

Sample Delivery Group:	L1031804
Samples Received:	10/04/2018
Project Number:	18-215232.3
Description:	Fox Shores Apartments
Site:	400 FOX SHORES DR. KAUKAUNA,WS
Report To:	Lucas Martin 805 North Milwaukee Avenue Suite 401 C Chicago, IL 60642

Entire Report Reviewed By: John V Hawkins

John Hawkins
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace National is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.



TABLE OF CONTENTS

Cp: Cover Page 1

Tc: Table of Contents 2

Ss: Sample Summary 3

Cn: Case Narrative 4

Sr: Sample Results 5

- B1-GW L1031804-01 5
- B2-GW L1031804-02 7
- B3-GW L1031804-03 9
- B4-GW L1031804-04 11
- B5-GW L1031804-05 13

Qc: Quality Control Summary 15

- Volatile Organic Compounds (GC/MS) by Method 8260B 15
- Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM 19

Gl: Glossary of Terms 21

Al: Accreditations & Locations 22

Sc: Sample Chain of Custody 23

B1-GW L1031804-01 GW

			Collected by	Collected date/time	Received date/time
			L. Martin	10/03/18 12:15	10/04/18 15:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1176767	1	10/05/18 23:59	10/05/18 23:59	DWR
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178297	1.18	10/09/18 17:57	10/10/18 10:01	CJR

B2-GW L1031804-02 GW

			Collected by	Collected date/time	Received date/time
			L. Martin	10/03/18 12:25	10/04/18 15:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1176767	5	10/06/18 00:19	10/06/18 00:19	DWR
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178297	1.43	10/09/18 17:57	10/10/18 10:23	CJR

B3-GW L1031804-03 GW

			Collected by	Collected date/time	Received date/time
			L. Martin	10/03/18 12:30	10/04/18 15:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1176767	1	10/06/18 00:39	10/06/18 00:39	DWR
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178297	10	10/09/18 17:57	10/10/18 16:35	CJR

B4-GW L1031804-04 GW

			Collected by	Collected date/time	Received date/time
			L. Martin	10/03/18 12:35	10/04/18 15:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1176767	1	10/06/18 01:00	10/06/18 01:00	DWR
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178297	1.05	10/09/18 17:57	10/10/18 10:45	CJR

B5-GW L1031804-05 GW

			Collected by	Collected date/time	Received date/time
			L. Martin	10/03/18 12:20	10/04/18 15:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC/MS) by Method 8260B	WG1176767	1	10/06/18 01:20	10/06/18 01:20	DWR
Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM	WG1178297	1.18	10/09/18 17:57	10/10/18 11:06	CJR

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

John Hawkins
Project Manager

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Acetone	U		10.0	50.0	1	10/05/2018 23:59	WG1176767
Acrolein	U		8.87	50.0	1	10/05/2018 23:59	WG1176767
Acrylonitrile	U		1.87	10.0	1	10/05/2018 23:59	WG1176767
Benzene	U		0.331	1.00	1	10/05/2018 23:59	WG1176767
Bromobenzene	U		0.352	1.00	1	10/05/2018 23:59	WG1176767
Bromodichloromethane	U		0.380	1.00	1	10/05/2018 23:59	WG1176767
Bromoform	U		0.469	1.00	1	10/05/2018 23:59	WG1176767
Bromomethane	U		0.866	5.00	1	10/05/2018 23:59	WG1176767
n-Butylbenzene	U		0.361	1.00	1	10/05/2018 23:59	WG1176767
sec-Butylbenzene	U		0.365	1.00	1	10/05/2018 23:59	WG1176767
tert-Butylbenzene	U		0.399	1.00	1	10/05/2018 23:59	WG1176767
Carbon tetrachloride	U		0.379	1.00	1	10/05/2018 23:59	WG1176767
Chlorobenzene	U		0.348	1.00	1	10/05/2018 23:59	WG1176767
Chlorodibromomethane	U		0.327	1.00	1	10/05/2018 23:59	WG1176767
Chloroethane	U	J4	0.453	5.00	1	10/05/2018 23:59	WG1176767
2-Chloroethyl vinyl ether	U		3.01	50.0	1	10/05/2018 23:59	WG1176767
Chloroform	U		0.324	5.00	1	10/05/2018 23:59	WG1176767
Chloromethane	U		0.276	2.50	1	10/05/2018 23:59	WG1176767
2-Chlorotoluene	U		0.375	1.00	1	10/05/2018 23:59	WG1176767
4-Chlorotoluene	U		0.351	1.00	1	10/05/2018 23:59	WG1176767
1,2-Dibromo-3-Chloropropane	U		1.33	5.00	1	10/05/2018 23:59	WG1176767
1,2-Dibromoethane	U		0.381	1.00	1	10/05/2018 23:59	WG1176767
Dibromomethane	U		0.346	1.00	1	10/05/2018 23:59	WG1176767
1,2-Dichlorobenzene	U		0.349	1.00	1	10/05/2018 23:59	WG1176767
1,3-Dichlorobenzene	U		0.220	1.00	1	10/05/2018 23:59	WG1176767
1,4-Dichlorobenzene	U		0.274	1.00	1	10/05/2018 23:59	WG1176767
Dichlorodifluoromethane	U		0.551	5.00	1	10/05/2018 23:59	WG1176767
1,1-Dichloroethane	U		0.259	1.00	1	10/05/2018 23:59	WG1176767
1,2-Dichloroethane	U		0.361	1.00	1	10/05/2018 23:59	WG1176767
1,1-Dichloroethene	U		0.398	1.00	1	10/05/2018 23:59	WG1176767
cis-1,2-Dichloroethene	U		0.260	1.00	1	10/05/2018 23:59	WG1176767
trans-1,2-Dichloroethene	U		0.396	1.00	1	10/05/2018 23:59	WG1176767
1,2-Dichloropropane	U		0.306	1.00	1	10/05/2018 23:59	WG1176767
1,1-Dichloropropene	U		0.352	1.00	1	10/05/2018 23:59	WG1176767
1,3-Dichloropropane	U		0.366	1.00	1	10/05/2018 23:59	WG1176767
cis-1,3-Dichloropropene	U		0.418	1.00	1	10/05/2018 23:59	WG1176767
trans-1,3-Dichloropropene	U		0.419	1.00	1	10/05/2018 23:59	WG1176767
2,2-Dichloropropane	U		0.321	1.00	1	10/05/2018 23:59	WG1176767
Di-isopropyl ether	U		0.320	1.00	1	10/05/2018 23:59	WG1176767
Ethylbenzene	U		0.384	1.00	1	10/05/2018 23:59	WG1176767
Hexachloro-1,3-butadiene	U		0.256	1.00	1	10/05/2018 23:59	WG1176767
Isopropylbenzene	U		0.326	1.00	1	10/05/2018 23:59	WG1176767
p-Isopropyltoluene	1.56		0.350	1.00	1	10/05/2018 23:59	WG1176767
2-Butanone (MEK)	U		3.93	10.0	1	10/05/2018 23:59	WG1176767
Methylene Chloride	U		1.00	5.00	1	10/05/2018 23:59	WG1176767
4-Methyl-2-pentanone (MIBK)	U		2.14	10.0	1	10/05/2018 23:59	WG1176767
Methyl tert-butyl ether	U		0.367	1.00	1	10/05/2018 23:59	WG1176767
Naphthalene	U		1.00	5.00	1	10/05/2018 23:59	WG1176767
n-Propylbenzene	U		0.349	1.00	1	10/05/2018 23:59	WG1176767
Styrene	U		0.307	1.00	1	10/05/2018 23:59	WG1176767
1,1,1,2-Tetrachloroethane	U		0.385	1.00	1	10/05/2018 23:59	WG1176767
1,1,2,2-Tetrachloroethane	U		0.130	1.00	1	10/05/2018 23:59	WG1176767
1,1,2-Trichlorotrifluoroethane	U		0.303	1.00	1	10/05/2018 23:59	WG1176767
Tetrachloroethene	U		0.372	1.00	1	10/05/2018 23:59	WG1176767
Toluene	U		0.412	1.00	1	10/05/2018 23:59	WG1176767
1,2,3-Trichlorobenzene	U		0.230	1.00	1	10/05/2018 23:59	WG1176767

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
1,2,4-Trichlorobenzene	U		0.355	1.00	1	10/05/2018 23:59	WG1176767
1,1,1-Trichloroethane	U		0.319	1.00	1	10/05/2018 23:59	WG1176767
1,1,2-Trichloroethane	U		0.383	1.00	1	10/05/2018 23:59	WG1176767
Trichloroethene	U		0.398	1.00	1	10/05/2018 23:59	WG1176767
Trichlorofluoromethane	U		1.20	5.00	1	10/05/2018 23:59	WG1176767
1,2,3-Trichloropropane	U		0.807	2.50	1	10/05/2018 23:59	WG1176767
1,2,4-Trimethylbenzene	U		0.373	1.00	1	10/05/2018 23:59	WG1176767
1,2,3-Trimethylbenzene	U		0.321	1.00	1	10/05/2018 23:59	WG1176767
1,3,5-Trimethylbenzene	U		0.387	1.00	1	10/05/2018 23:59	WG1176767
Vinyl chloride	U		0.259	1.00	1	10/05/2018 23:59	WG1176767
Xylenes, Total	U		1.06	3.00	1	10/05/2018 23:59	WG1176767
(S) Toluene-d8	*98.4*			*80.0-120*		*10/05/2018 23:59*	WG1176767
(S) Dibromofluoromethane	*117*			*75.0-120*		*10/05/2018 23:59*	WG1176767
(S) 4-Bromofluorobenzene	*115*			*77.0-126*		*10/05/2018 23:59*	WG1176767

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Anthracene	0.160		0.0165	0.0590	1.18	10/10/2018 10:01	WG1178297
Acenaphthene	U		0.0118	0.0590	1.18	10/10/2018 10:01	WG1178297
Acenaphthylene	U		0.0142	0.0590	1.18	10/10/2018 10:01	WG1178297
Benzo(a)anthracene	0.0151	J	0.00484	0.0590	1.18	10/10/2018 10:01	WG1178297
Benzo(a)pyrene	U		0.0137	0.0590	1.18	10/10/2018 10:01	WG1178297
Benzo(b)fluoranthene	0.00990	J J3	0.00250	0.0590	1.18	10/10/2018 10:01	WG1178297
Benzo(g,h,i)perylene	0.00654	J	0.00268	0.0590	1.18	10/10/2018 10:01	WG1178297
Benzo(k)fluoranthene	U		0.0160	0.0590	1.18	10/10/2018 10:01	WG1178297
Chrysene	U	J3	0.0127	0.0590	1.18	10/10/2018 10:01	WG1178297
Dibenz(a,h)anthracene	U	J3	0.00467	0.0590	1.18	10/10/2018 10:01	WG1178297
Fluoranthene	0.0353	J	0.0185	0.0590	1.18	10/10/2018 10:01	WG1178297
Fluorene	U		0.0100	0.0590	1.18	10/10/2018 10:01	WG1178297
Indeno(1,2,3-cd)pyrene	U	J3	0.0175	0.0590	1.18	10/10/2018 10:01	WG1178297
Naphthalene	0.0557	B J	0.0234	0.295	1.18	10/10/2018 10:01	WG1178297
Phenanthrene	0.0293	J	0.00968	0.0590	1.18	10/10/2018 10:01	WG1178297
Pyrene	0.0175	J	0.0138	0.0590	1.18	10/10/2018 10:01	WG1178297
1-Methylnaphthalene	0.0257	J	0.00969	0.295	1.18	10/10/2018 10:01	WG1178297
2-Methylnaphthalene	0.0250	J	0.0106	0.295	1.18	10/10/2018 10:01	WG1178297
(S) Nitrobenzene-d5	*94.0*			*31.0-160*		*10/10/2018 10:01*	WG1178297
(S) 2-Fluorobiphenyl	*95.7*			*48.0-148*		*10/10/2018 10:01*	WG1178297
(S) p-Terphenyl-d14	*73.6*			*37.0-146*		*10/10/2018 10:01*	WG1178297

Sample Narrative:

L1031804-01 WG1178297: Dilution due to sample volume

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Acetone	U		50.0	250	5	10/06/2018 00:19	WG1176767
Acrolein	U		44.4	250	5	10/06/2018 00:19	WG1176767
Acrylonitrile	U		9.35	50.0	5	10/06/2018 00:19	WG1176767
Benzene	U		1.66	5.00	5	10/06/2018 00:19	WG1176767
Bromobenzene	U		1.76	5.00	5	10/06/2018 00:19	WG1176767
Bromodichloromethane	U		1.90	5.00	5	10/06/2018 00:19	WG1176767
Bromoform	U		2.34	5.00	5	10/06/2018 00:19	WG1176767
Bromomethane	U		4.33	25.0	5	10/06/2018 00:19	WG1176767
n-Butylbenzene	U		1.80	5.00	5	10/06/2018 00:19	WG1176767
sec-Butylbenzene	U		1.82	5.00	5	10/06/2018 00:19	WG1176767
tert-Butylbenzene	U		2.00	5.00	5	10/06/2018 00:19	WG1176767
Carbon tetrachloride	U		1.90	5.00	5	10/06/2018 00:19	WG1176767
Chlorobenzene	U		1.74	5.00	5	10/06/2018 00:19	WG1176767
Chlorodibromomethane	U		1.64	5.00	5	10/06/2018 00:19	WG1176767
Chloroethane	U	J4	2.26	25.0	5	10/06/2018 00:19	WG1176767
2-Chloroethyl vinyl ether	U		15.0	250	5	10/06/2018 00:19	WG1176767
Chloroform	U		1.62	25.0	5	10/06/2018 00:19	WG1176767
Chloromethane	U		1.38	12.5	5	10/06/2018 00:19	WG1176767
2-Chlorotoluene	U		1.88	5.00	5	10/06/2018 00:19	WG1176767
4-Chlorotoluene	U		1.76	5.00	5	10/06/2018 00:19	WG1176767
1,2-Dibromo-3-Chloropropane	U		6.65	25.0	5	10/06/2018 00:19	WG1176767
1,2-Dibromoethane	U		1.90	5.00	5	10/06/2018 00:19	WG1176767
Dibromomethane	U		1.73	5.00	5	10/06/2018 00:19	WG1176767
1,2-Dichlorobenzene	U		1.74	5.00	5	10/06/2018 00:19	WG1176767
1,3-Dichlorobenzene	U		1.10	5.00	5	10/06/2018 00:19	WG1176767
1,4-Dichlorobenzene	U		1.37	5.00	5	10/06/2018 00:19	WG1176767
Dichlorodifluoromethane	U		2.76	25.0	5	10/06/2018 00:19	WG1176767
1,1-Dichloroethane	U		1.30	5.00	5	10/06/2018 00:19	WG1176767
1,2-Dichloroethane	U		1.80	5.00	5	10/06/2018 00:19	WG1176767
1,1-Dichloroethene	U		1.99	5.00	5	10/06/2018 00:19	WG1176767
cis-1,2-Dichloroethene	U		1.30	5.00	5	10/06/2018 00:19	WG1176767
trans-1,2-Dichloroethene	U		1.98	5.00	5	10/06/2018 00:19	WG1176767
1,2-Dichloropropane	U		1.53	5.00	5	10/06/2018 00:19	WG1176767
1,1-Dichloropropene	U		1.76	5.00	5	10/06/2018 00:19	WG1176767
1,3-Dichloropropane	U		1.83	5.00	5	10/06/2018 00:19	WG1176767
cis-1,3-Dichloropropene	U		2.09	5.00	5	10/06/2018 00:19	WG1176767
trans-1,3-Dichloropropene	U		2.10	5.00	5	10/06/2018 00:19	WG1176767
2,2-Dichloropropane	U		1.60	5.00	5	10/06/2018 00:19	WG1176767
Di-isopropyl ether	U		1.60	5.00	5	10/06/2018 00:19	WG1176767
Ethylbenzene	U		1.92	5.00	5	10/06/2018 00:19	WG1176767
Hexachloro-1,3-butadiene	U		1.28	5.00	5	10/06/2018 00:19	WG1176767
Isopropylbenzene	U		1.63	5.00	5	10/06/2018 00:19	WG1176767
p-Isopropyltoluene	U		1.75	5.00	5	10/06/2018 00:19	WG1176767
2-Butanone (MEK)	U		19.6	50.0	5	10/06/2018 00:19	WG1176767
Methylene Chloride	U		5.00	25.0	5	10/06/2018 00:19	WG1176767
4-Methyl-2-pentanone (MIBK)	U		10.7	50.0	5	10/06/2018 00:19	WG1176767
Methyl tert-butyl ether	U		1.84	5.00	5	10/06/2018 00:19	WG1176767
Naphthalene	U		5.00	25.0	5	10/06/2018 00:19	WG1176767
n-Propylbenzene	U		1.74	5.00	5	10/06/2018 00:19	WG1176767
Styrene	U		1.54	5.00	5	10/06/2018 00:19	WG1176767
1,1,1,2-Tetrachloroethane	U		1.92	5.00	5	10/06/2018 00:19	WG1176767
1,1,2,2-Tetrachloroethane	U		0.650	5.00	5	10/06/2018 00:19	WG1176767
1,1,2-Trichlorotrifluoroethane	U		1.52	5.00	5	10/06/2018 00:19	WG1176767
Tetrachloroethene	U		1.86	5.00	5	10/06/2018 00:19	WG1176767
Toluene	U		2.06	5.00	5	10/06/2018 00:19	WG1176767
1,2,3-Trichlorobenzene	U		1.15	5.00	5	10/06/2018 00:19	WG1176767

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
1,2,4-Trichlorobenzene	U		1.78	5.00	5	10/06/2018 00:19	WG1176767
1,1,1-Trichloroethane	U		1.60	5.00	5	10/06/2018 00:19	WG1176767
1,1,2-Trichloroethane	U		1.92	5.00	5	10/06/2018 00:19	WG1176767
Trichloroethene	U		1.99	5.00	5	10/06/2018 00:19	WG1176767
Trichlorofluoromethane	U		6.00	25.0	5	10/06/2018 00:19	WG1176767
1,2,3-Trichloropropane	U		4.04	12.5	5	10/06/2018 00:19	WG1176767
1,2,4-Trimethylbenzene	U		1.86	5.00	5	10/06/2018 00:19	WG1176767
1,2,3-Trimethylbenzene	U		1.60	5.00	5	10/06/2018 00:19	WG1176767
1,3,5-Trimethylbenzene	U		1.94	5.00	5	10/06/2018 00:19	WG1176767
Vinyl chloride	U		1.30	5.00	5	10/06/2018 00:19	WG1176767
Xylenes, Total	U		5.30	15.0	5	10/06/2018 00:19	WG1176767
(S) Toluene-d8	*96.4*			*80.0-120*		*10/06/2018 00:19*	WG1176767
(S) Dibromofluoromethane	*115*			*75.0-120*		*10/06/2018 00:19*	WG1176767
(S) 4-Bromofluorobenzene	*113*			*77.0-126*		*10/06/2018 00:19*	WG1176767

Sample Narrative:

L1031804-02 WG1176767: Lowest possible dilution due to sediment in sample vial.

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Anthracene	U		0.0200	0.0715	1.43	10/10/2018 10:23	WG1178297
Acenaphthene	U		0.0143	0.0715	1.43	10/10/2018 10:23	WG1178297
Acenaphthylene	U		0.0172	0.0715	1.43	10/10/2018 10:23	WG1178297
Benzo(a)anthracene	0.00712	J	0.00586	0.0715	1.43	10/10/2018 10:23	WG1178297
Benzo(a)pyrene	U		0.0166	0.0715	1.43	10/10/2018 10:23	WG1178297
Benzo(b)fluoranthene	U	J3	0.00303	0.0715	1.43	10/10/2018 10:23	WG1178297
Benzo(g,h,i)perylene	U		0.00325	0.0715	1.43	10/10/2018 10:23	WG1178297
Benzo(k)fluoranthene	U		0.0194	0.0715	1.43	10/10/2018 10:23	WG1178297
Chrysene	U	J3	0.0154	0.0715	1.43	10/10/2018 10:23	WG1178297
Dibenz(a,h)anthracene	U	J3	0.00566	0.0715	1.43	10/10/2018 10:23	WG1178297
Fluoranthene	U		0.0225	0.0715	1.43	10/10/2018 10:23	WG1178297
Fluorene	U		0.0122	0.0715	1.43	10/10/2018 10:23	WG1178297
Indeno(1,2,3-cd)pyrene	U	J3	0.0212	0.0715	1.43	10/10/2018 10:23	WG1178297
Naphthalene	0.0566	B J	0.0283	0.358	1.43	10/10/2018 10:23	WG1178297
Phenanthrene	U		0.0117	0.0715	1.43	10/10/2018 10:23	WG1178297
Pyrene	U		0.0167	0.0715	1.43	10/10/2018 10:23	WG1178297
1-Methylnaphthalene	0.0180	J	0.0117	0.358	1.43	10/10/2018 10:23	WG1178297
2-Methylnaphthalene	0.0185	J	0.0129	0.358	1.43	10/10/2018 10:23	WG1178297
(S) Nitrobenzene-d5	*90.9*			*31.0-160*		*10/10/2018 10:23*	WG1178297
(S) 2-Fluorobiphenyl	*95.1*			*48.0-148*		*10/10/2018 10:23*	WG1178297
(S) p-Terphenyl-d14	*79.4*			*37.0-146*		*10/10/2018 10:23*	WG1178297

Sample Narrative:

L1031804-02 WG1178297: Dilution due to sample volume

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Acetone	U		10.0	50.0	1	10/06/2018 00:39	WG1176767
Acrolein	U		8.87	50.0	1	10/06/2018 00:39	WG1176767
Acrylonitrile	U		1.87	10.0	1	10/06/2018 00:39	WG1176767
Benzene	U		0.331	1.00	1	10/06/2018 00:39	WG1176767
Bromobenzene	U		0.352	1.00	1	10/06/2018 00:39	WG1176767
Bromodichloromethane	U		0.380	1.00	1	10/06/2018 00:39	WG1176767
Bromoform	U		0.469	1.00	1	10/06/2018 00:39	WG1176767
Bromomethane	U		0.866	5.00	1	10/06/2018 00:39	WG1176767
n-Butylbenzene	U		0.361	1.00	1	10/06/2018 00:39	WG1176767
sec-Butylbenzene	U		0.365	1.00	1	10/06/2018 00:39	WG1176767
tert-Butylbenzene	U		0.399	1.00	1	10/06/2018 00:39	WG1176767
Carbon tetrachloride	U		0.379	1.00	1	10/06/2018 00:39	WG1176767
Chlorobenzene	U		0.348	1.00	1	10/06/2018 00:39	WG1176767
Chlorodibromomethane	U		0.327	1.00	1	10/06/2018 00:39	WG1176767
Chloroethane	U	J4	0.453	5.00	1	10/06/2018 00:39	WG1176767
2-Chloroethyl vinyl ether	U		3.01	50.0	1	10/06/2018 00:39	WG1176767
Chloroform	U		0.324	5.00	1	10/06/2018 00:39	WG1176767
Chloromethane	U		0.276	2.50	1	10/06/2018 00:39	WG1176767
2-Chlorotoluene	U		0.375	1.00	1	10/06/2018 00:39	WG1176767
4-Chlorotoluene	U		0.351	1.00	1	10/06/2018 00:39	WG1176767
1,2-Dibromo-3-Chloropropane	U		1.33	5.00	1	10/06/2018 00:39	WG1176767
1,2-Dibromoethane	U		0.381	1.00	1	10/06/2018 00:39	WG1176767
Dibromomethane	U		0.346	1.00	1	10/06/2018 00:39	WG1176767
1,2-Dichlorobenzene	U		0.349	1.00	1	10/06/2018 00:39	WG1176767
1,3-Dichlorobenzene	U		0.220	1.00	1	10/06/2018 00:39	WG1176767
1,4-Dichlorobenzene	U		0.274	1.00	1	10/06/2018 00:39	WG1176767
Dichlorodifluoromethane	U		0.551	5.00	1	10/06/2018 00:39	WG1176767
1,1-Dichloroethane	U		0.259	1.00	1	10/06/2018 00:39	WG1176767
1,2-Dichloroethane	U		0.361	1.00	1	10/06/2018 00:39	WG1176767
1,1-Dichloroethene	U		0.398	1.00	1	10/06/2018 00:39	WG1176767
cis-1,2-Dichloroethene	U		0.260	1.00	1	10/06/2018 00:39	WG1176767
trans-1,2-Dichloroethene	U		0.396	1.00	1	10/06/2018 00:39	WG1176767
1,2-Dichloropropane	U		0.306	1.00	1	10/06/2018 00:39	WG1176767
1,1-Dichloropropene	U		0.352	1.00	1	10/06/2018 00:39	WG1176767
1,3-Dichloropropane	U		0.366	1.00	1	10/06/2018 00:39	WG1176767
cis-1,3-Dichloropropene	U		0.418	1.00	1	10/06/2018 00:39	WG1176767
trans-1,3-Dichloropropene	U		0.419	1.00	1	10/06/2018 00:39	WG1176767
2,2-Dichloropropane	U		0.321	1.00	1	10/06/2018 00:39	WG1176767
Di-isopropyl ether	U		0.320	1.00	1	10/06/2018 00:39	WG1176767
Ethylbenzene	U		0.384	1.00	1	10/06/2018 00:39	WG1176767
Hexachloro-1,3-butadiene	U		0.256	1.00	1	10/06/2018 00:39	WG1176767
Isopropylbenzene	U		0.326	1.00	1	10/06/2018 00:39	WG1176767
p-Isopropyltoluene	U		0.350	1.00	1	10/06/2018 00:39	WG1176767
2-Butanone (MEK)	U		3.93	10.0	1	10/06/2018 00:39	WG1176767
Methylene Chloride	U		1.00	5.00	1	10/06/2018 00:39	WG1176767
4-Methyl-2-pentanone (MIBK)	U		2.14	10.0	1	10/06/2018 00:39	WG1176767
Methyl tert-butyl ether	U		0.367	1.00	1	10/06/2018 00:39	WG1176767
Naphthalene	U		1.00	5.00	1	10/06/2018 00:39	WG1176767
n-Propylbenzene	U		0.349	1.00	1	10/06/2018 00:39	WG1176767
Styrene	U		0.307	1.00	1	10/06/2018 00:39	WG1176767
1,1,1,2-Tetrachloroethane	U		0.385	1.00	1	10/06/2018 00:39	WG1176767
1,1,2,2-Tetrachloroethane	U		0.130	1.00	1	10/06/2018 00:39	WG1176767
1,1,2-Trichlorotrifluoroethane	U		0.303	1.00	1	10/06/2018 00:39	WG1176767
Tetrachloroethene	U		0.372	1.00	1	10/06/2018 00:39	WG1176767
Toluene	U		0.412	1.00	1	10/06/2018 00:39	WG1176767
1,2,3-Trichlorobenzene	U		0.230	1.00	1	10/06/2018 00:39	WG1176767

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
1,2,4-Trichlorobenzene	U		0.355	1.00	1	10/06/2018 00:39	WG1176767
1,1,1-Trichloroethane	U		0.319	1.00	1	10/06/2018 00:39	WG1176767
1,1,2-Trichloroethane	U		0.383	1.00	1	10/06/2018 00:39	WG1176767
Trichloroethene	U		0.398	1.00	1	10/06/2018 00:39	WG1176767
Trichlorofluoromethane	U		1.20	5.00	1	10/06/2018 00:39	WG1176767
1,2,3-Trichloropropane	U		0.807	2.50	1	10/06/2018 00:39	WG1176767
1,2,4-Trimethylbenzene	U		0.373	1.00	1	10/06/2018 00:39	WG1176767
1,2,3-Trimethylbenzene	U		0.321	1.00	1	10/06/2018 00:39	WG1176767
1,3,5-Trimethylbenzene	U		0.387	1.00	1	10/06/2018 00:39	WG1176767
Vinyl chloride	U		0.259	1.00	1	10/06/2018 00:39	WG1176767
Xylenes, Total	U		1.06	3.00	1	10/06/2018 00:39	WG1176767
(S) Toluene-d8	*98.1*			*80.0-120*		*10/06/2018 00:39*	WG1176767
(S) Dibromofluoromethane	*117*			*75.0-120*		*10/06/2018 00:39*	WG1176767
(S) 4-Bromofluorobenzene	*113*			*77.0-126*		*10/06/2018 00:39*	WG1176767

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Anthracene	0.672		0.140	0.500	10	10/10/2018 16:35	WG1178297
Acenaphthene	0.107	J	0.100	0.500	10	10/10/2018 16:35	WG1178297
Acenaphthylene	U		0.120	0.500	10	10/10/2018 16:35	WG1178297
Benzo(a)anthracene	0.341	J	0.0410	0.500	10	10/10/2018 16:35	WG1178297
Benzo(a)pyrene	0.225	J	0.116	0.500	10	10/10/2018 16:35	WG1178297
Benzo(b)fluoranthene	0.156	J J3	0.0212	0.500	10	10/10/2018 16:35	WG1178297
Benzo(g,h,i)perylene	0.326	J	0.0227	0.500	10	10/10/2018 16:35	WG1178297
Benzo(k)fluoranthene	U		0.136	0.500	10	10/10/2018 16:35	WG1178297
Chrysene	0.454	J J3	0.108	0.500	10	10/10/2018 16:35	WG1178297
Dibenz(a,h)anthracene	U	J3	0.0396	0.500	10	10/10/2018 16:35	WG1178297
Fluoranthene	0.243	J	0.157	0.500	10	10/10/2018 16:35	WG1178297
Fluorene	U		0.0850	0.500	10	10/10/2018 16:35	WG1178297
Indeno(1,2,3-cd)pyrene	U	J3	0.148	0.500	10	10/10/2018 16:35	WG1178297
Naphthalene	0.243	B J	0.198	2.50	10	10/10/2018 16:35	WG1178297
Phenanthrene	0.334	J	0.0820	0.500	10	10/10/2018 16:35	WG1178297
Pyrene	2.22		0.117	0.500	10	10/10/2018 16:35	WG1178297
1-Methylnaphthalene	U		0.0821	2.50	10	10/10/2018 16:35	WG1178297
2-Methylnaphthalene	U		0.0902	2.50	10	10/10/2018 16:35	WG1178297
(S) Nitrobenzene-d5	*86.5*			*31.0-160*		*10/10/2018 16:35*	WG1178297
(S) 2-Fluorobiphenyl	*82.0*			*48.0-148*		*10/10/2018 16:35*	WG1178297
(S) p-Terphenyl-d14	*71.0*			*37.0-146*		*10/10/2018 16:35*	WG1178297

Sample Narrative:

L1031804-03 WG1178297: Dilution due to matrix

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Acetone	U		10.0	50.0	1	10/06/2018 01:00	WG1176767
Acrolein	U		8.87	50.0	1	10/06/2018 01:00	WG1176767
Acrylonitrile	U		1.87	10.0	1	10/06/2018 01:00	WG1176767
Benzene	U		0.331	1.00	1	10/06/2018 01:00	WG1176767
Bromobenzene	U		0.352	1.00	1	10/06/2018 01:00	WG1176767
Bromodichloromethane	U		0.380	1.00	1	10/06/2018 01:00	WG1176767
Bromoform	U		0.469	1.00	1	10/06/2018 01:00	WG1176767
Bromomethane	U		0.866	5.00	1	10/06/2018 01:00	WG1176767
n-Butylbenzene	U		0.361	1.00	1	10/06/2018 01:00	WG1176767
sec-Butylbenzene	U		0.365	1.00	1	10/06/2018 01:00	WG1176767
tert-Butylbenzene	U		0.399	1.00	1	10/06/2018 01:00	WG1176767
Carbon tetrachloride	U		0.379	1.00	1	10/06/2018 01:00	WG1176767
Chlorobenzene	U		0.348	1.00	1	10/06/2018 01:00	WG1176767
Chlorodibromomethane	U		0.327	1.00	1	10/06/2018 01:00	WG1176767
Chloroethane	U	J4	0.453	5.00	1	10/06/2018 01:00	WG1176767
2-Chloroethyl vinyl ether	U		3.01	50.0	1	10/06/2018 01:00	WG1176767
Chloroform	U		0.324	5.00	1	10/06/2018 01:00	WG1176767
Chloromethane	U		0.276	2.50	1	10/06/2018 01:00	WG1176767
2-Chlorotoluene	U		0.375	1.00	1	10/06/2018 01:00	WG1176767
4-Chlorotoluene	U		0.351	1.00	1	10/06/2018 01:00	WG1176767
1,2-Dibromo-3-Chloropropane	U		1.33	5.00	1	10/06/2018 01:00	WG1176767
1,2-Dibromoethane	U		0.381	1.00	1	10/06/2018 01:00	WG1176767
Dibromomethane	U		0.346	1.00	1	10/06/2018 01:00	WG1176767
1,2-Dichlorobenzene	U		0.349	1.00	1	10/06/2018 01:00	WG1176767
1,3-Dichlorobenzene	U		0.220	1.00	1	10/06/2018 01:00	WG1176767
1,4-Dichlorobenzene	U		0.274	1.00	1	10/06/2018 01:00	WG1176767
Dichlorodifluoromethane	U		0.551	5.00	1	10/06/2018 01:00	WG1176767
1,1-Dichloroethane	U		0.259	1.00	1	10/06/2018 01:00	WG1176767
1,2-Dichloroethane	U		0.361	1.00	1	10/06/2018 01:00	WG1176767
1,1-Dichloroethene	U		0.398	1.00	1	10/06/2018 01:00	WG1176767
cis-1,2-Dichloroethene	U		0.260	1.00	1	10/06/2018 01:00	WG1176767
trans-1,2-Dichloroethene	U		0.396	1.00	1	10/06/2018 01:00	WG1176767
1,2-Dichloropropane	U		0.306	1.00	1	10/06/2018 01:00	WG1176767
1,1-Dichloropropene	U		0.352	1.00	1	10/06/2018 01:00	WG1176767
1,3-Dichloropropane	U		0.366	1.00	1	10/06/2018 01:00	WG1176767
cis-1,3-Dichloropropene	U		0.418	1.00	1	10/06/2018 01:00	WG1176767
trans-1,3-Dichloropropene	U		0.419	1.00	1	10/06/2018 01:00	WG1176767
2,2-Dichloropropane	U		0.321	1.00	1	10/06/2018 01:00	WG1176767
Di-isopropyl ether	U		0.320	1.00	1	10/06/2018 01:00	WG1176767
Ethylbenzene	U		0.384	1.00	1	10/06/2018 01:00	WG1176767
Hexachloro-1,3-butadiene	U		0.256	1.00	1	10/06/2018 01:00	WG1176767
Isopropylbenzene	U		0.326	1.00	1	10/06/2018 01:00	WG1176767
p-Isopropyltoluene	U		0.350	1.00	1	10/06/2018 01:00	WG1176767
2-Butanone (MEK)	U		3.93	10.0	1	10/06/2018 01:00	WG1176767
Methylene Chloride	U		1.00	5.00	1	10/06/2018 01:00	WG1176767
4-Methyl-2-pentanone (MIBK)	U		2.14	10.0	1	10/06/2018 01:00	WG1176767
Methyl tert-butyl ether	U		0.367	1.00	1	10/06/2018 01:00	WG1176767
Naphthalene	U		1.00	5.00	1	10/06/2018 01:00	WG1176767
n-Propylbenzene	U		0.349	1.00	1	10/06/2018 01:00	WG1176767
Styrene	U		0.307	1.00	1	10/06/2018 01:00	WG1176767
1,1,1,2-Tetrachloroethane	U		0.385	1.00	1	10/06/2018 01:00	WG1176767
1,1,2,2-Tetrachloroethane	U		0.130	1.00	1	10/06/2018 01:00	WG1176767
1,1,2-Trichlorotrifluoroethane	U		0.303	1.00	1	10/06/2018 01:00	WG1176767
Tetrachloroethene	U		0.372	1.00	1	10/06/2018 01:00	WG1176767
Toluene	U		0.412	1.00	1	10/06/2018 01:00	WG1176767
1,2,3-Trichlorobenzene	U		0.230	1.00	1	10/06/2018 01:00	WG1176767

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
1,2,4-Trichlorobenzene	U		0.355	1.00	1	10/06/2018 01:00	WG1176767
1,1,1-Trichloroethane	U		0.319	1.00	1	10/06/2018 01:00	WG1176767
1,1,2-Trichloroethane	U		0.383	1.00	1	10/06/2018 01:00	WG1176767
Trichloroethene	U		0.398	1.00	1	10/06/2018 01:00	WG1176767
Trichlorofluoromethane	U		1.20	5.00	1	10/06/2018 01:00	WG1176767
1,2,3-Trichloropropane	U		0.807	2.50	1	10/06/2018 01:00	WG1176767
1,2,4-Trimethylbenzene	U		0.373	1.00	1	10/06/2018 01:00	WG1176767
1,2,3-Trimethylbenzene	U		0.321	1.00	1	10/06/2018 01:00	WG1176767
1,3,5-Trimethylbenzene	U		0.387	1.00	1	10/06/2018 01:00	WG1176767
Vinyl chloride	U		0.259	1.00	1	10/06/2018 01:00	WG1176767
Xylenes, Total	U		1.06	3.00	1	10/06/2018 01:00	WG1176767
(S) Toluene-d8	*97.8*			*80.0-120*		*10/06/2018 01:00*	WG1176767
(S) Dibromofluoromethane	*113*			*75.0-120*		*10/06/2018 01:00*	WG1176767
(S) 4-Bromofluorobenzene	*117*			*77.0-126*		*10/06/2018 01:00*	WG1176767

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Anthracene	U		0.0147	0.0525	1.05	10/10/2018 10:45	WG1178297
Acenaphthene	U		0.0105	0.0525	1.05	10/10/2018 10:45	WG1178297
Acenaphthylene	U		0.0126	0.0525	1.05	10/10/2018 10:45	WG1178297
Benzo(a)anthracene	0.00583	J	0.00431	0.0525	1.05	10/10/2018 10:45	WG1178297
Benzo(a)pyrene	U		0.0122	0.0525	1.05	10/10/2018 10:45	WG1178297
Benzo(b)fluoranthene	U	J3	0.00223	0.0525	1.05	10/10/2018 10:45	WG1178297
Benzo(g,h,i)perylene	U		0.00238	0.0525	1.05	10/10/2018 10:45	WG1178297
Benzo(k)fluoranthene	U		0.0143	0.0525	1.05	10/10/2018 10:45	WG1178297
Chrysene	U	J3	0.0113	0.0525	1.05	10/10/2018 10:45	WG1178297
Dibenz(a,h)anthracene	U	J3	0.00416	0.0525	1.05	10/10/2018 10:45	WG1178297
Fluoranthene	U		0.0165	0.0525	1.05	10/10/2018 10:45	WG1178297
Fluorene	U		0.00893	0.0525	1.05	10/10/2018 10:45	WG1178297
Indeno(1,2,3-cd)pyrene	U	J3	0.0155	0.0525	1.05	10/10/2018 10:45	WG1178297
Naphthalene	0.0338	B J	0.0208	0.263	1.05	10/10/2018 10:45	WG1178297
Phenanthrene	U		0.00861	0.0525	1.05	10/10/2018 10:45	WG1178297
Pyrene	U		0.0123	0.0525	1.05	10/10/2018 10:45	WG1178297
1-Methylnaphthalene	0.0152	J	0.00862	0.263	1.05	10/10/2018 10:45	WG1178297
2-Methylnaphthalene	0.0156	J	0.00947	0.263	1.05	10/10/2018 10:45	WG1178297
(S) Nitrobenzene-d5	*88.1*			*31.0-160*		*10/10/2018 10:45*	WG1178297
(S) 2-Fluorobiphenyl	*91.0*			*48.0-148*		*10/10/2018 10:45*	WG1178297
(S) p-Terphenyl-d14	*76.2*			*37.0-146*		*10/10/2018 10:45*	WG1178297

Sample Narrative:

L1031804-04 WG1178297: Dilution due to sample volume

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Acetone	U		10.0	50.0	1	10/06/2018 01:20	WG1176767
Acrolein	U		8.87	50.0	1	10/06/2018 01:20	WG1176767
Acrylonitrile	U		1.87	10.0	1	10/06/2018 01:20	WG1176767
Benzene	U		0.331	1.00	1	10/06/2018 01:20	WG1176767
Bromobenzene	U		0.352	1.00	1	10/06/2018 01:20	WG1176767
Bromodichloromethane	U		0.380	1.00	1	10/06/2018 01:20	WG1176767
Bromoform	U		0.469	1.00	1	10/06/2018 01:20	WG1176767
Bromomethane	U		0.866	5.00	1	10/06/2018 01:20	WG1176767
n-Butylbenzene	U		0.361	1.00	1	10/06/2018 01:20	WG1176767
sec-Butylbenzene	U		0.365	1.00	1	10/06/2018 01:20	WG1176767
tert-Butylbenzene	U		0.399	1.00	1	10/06/2018 01:20	WG1176767
Carbon tetrachloride	U		0.379	1.00	1	10/06/2018 01:20	WG1176767
Chlorobenzene	U		0.348	1.00	1	10/06/2018 01:20	WG1176767
Chlorodibromomethane	U		0.327	1.00	1	10/06/2018 01:20	WG1176767
Chloroethane	U	J4	0.453	5.00	1	10/06/2018 01:20	WG1176767
2-Chloroethyl vinyl ether	U		3.01	50.0	1	10/06/2018 01:20	WG1176767
Chloroform	U		0.324	5.00	1	10/06/2018 01:20	WG1176767
Chloromethane	U		0.276	2.50	1	10/06/2018 01:20	WG1176767
2-Chlorotoluene	U		0.375	1.00	1	10/06/2018 01:20	WG1176767
4-Chlorotoluene	U		0.351	1.00	1	10/06/2018 01:20	WG1176767
1,2-Dibromo-3-Chloropropane	U		1.33	5.00	1	10/06/2018 01:20	WG1176767
1,2-Dibromoethane	U		0.381	1.00	1	10/06/2018 01:20	WG1176767
Dibromomethane	U		0.346	1.00	1	10/06/2018 01:20	WG1176767
1,2-Dichlorobenzene	U		0.349	1.00	1	10/06/2018 01:20	WG1176767
1,3-Dichlorobenzene	U		0.220	1.00	1	10/06/2018 01:20	WG1176767
1,4-Dichlorobenzene	U		0.274	1.00	1	10/06/2018 01:20	WG1176767
Dichlorodifluoromethane	U		0.551	5.00	1	10/06/2018 01:20	WG1176767
1,1-Dichloroethane	U		0.259	1.00	1	10/06/2018 01:20	WG1176767
1,2-Dichloroethane	U		0.361	1.00	1	10/06/2018 01:20	WG1176767
1,1-Dichloroethene	U		0.398	1.00	1	10/06/2018 01:20	WG1176767
cis-1,2-Dichloroethene	U		0.260	1.00	1	10/06/2018 01:20	WG1176767
trans-1,2-Dichloroethene	U		0.396	1.00	1	10/06/2018 01:20	WG1176767
1,2-Dichloropropane	U		0.306	1.00	1	10/06/2018 01:20	WG1176767
1,1-Dichloropropene	U		0.352	1.00	1	10/06/2018 01:20	WG1176767
1,3-Dichloropropane	U		0.366	1.00	1	10/06/2018 01:20	WG1176767
cis-1,3-Dichloropropene	U		0.418	1.00	1	10/06/2018 01:20	WG1176767
trans-1,3-Dichloropropene	U		0.419	1.00	1	10/06/2018 01:20	WG1176767
2,2-Dichloropropane	U		0.321	1.00	1	10/06/2018 01:20	WG1176767
Di-isopropyl ether	U		0.320	1.00	1	10/06/2018 01:20	WG1176767
Ethylbenzene	U		0.384	1.00	1	10/06/2018 01:20	WG1176767
Hexachloro-1,3-butadiene	U		0.256	1.00	1	10/06/2018 01:20	WG1176767
Isopropylbenzene	U		0.326	1.00	1	10/06/2018 01:20	WG1176767
p-Isopropyltoluene	U		0.350	1.00	1	10/06/2018 01:20	WG1176767
2-Butanone (MEK)	U		3.93	10.0	1	10/06/2018 01:20	WG1176767
Methylene Chloride	U		1.00	5.00	1	10/06/2018 01:20	WG1176767
4-Methyl-2-pentanone (MIBK)	U		2.14	10.0	1	10/06/2018 01:20	WG1176767
Methyl tert-butyl ether	U		0.367	1.00	1	10/06/2018 01:20	WG1176767
Naphthalene	U		1.00	5.00	1	10/06/2018 01:20	WG1176767
n-Propylbenzene	U		0.349	1.00	1	10/06/2018 01:20	WG1176767
Styrene	U		0.307	1.00	1	10/06/2018 01:20	WG1176767
1,1,1,2-Tetrachloroethane	U		0.385	1.00	1	10/06/2018 01:20	WG1176767
1,1,2,2-Tetrachloroethane	U		0.130	1.00	1	10/06/2018 01:20	WG1176767
1,1,2-Trichlorotrifluoroethane	U		0.303	1.00	1	10/06/2018 01:20	WG1176767
Tetrachloroethene	U		0.372	1.00	1	10/06/2018 01:20	WG1176767
Toluene	U		0.412	1.00	1	10/06/2018 01:20	WG1176767
1,2,3-Trichlorobenzene	U		0.230	1.00	1	10/06/2018 01:20	WG1176767

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
1,2,4-Trichlorobenzene	U		0.355	1.00	1	10/06/2018 01:20	WG1176767
1,1,1-Trichloroethane	U		0.319	1.00	1	10/06/2018 01:20	WG1176767
1,1,2-Trichloroethane	U		0.383	1.00	1	10/06/2018 01:20	WG1176767
Trichloroethene	U		0.398	1.00	1	10/06/2018 01:20	WG1176767
Trichlorofluoromethane	U		1.20	5.00	1	10/06/2018 01:20	WG1176767
1,2,3-Trichloropropane	U		0.807	2.50	1	10/06/2018 01:20	WG1176767
1,2,4-Trimethylbenzene	U		0.373	1.00	1	10/06/2018 01:20	WG1176767
1,2,3-Trimethylbenzene	U		0.321	1.00	1	10/06/2018 01:20	WG1176767
1,3,5-Trimethylbenzene	U		0.387	1.00	1	10/06/2018 01:20	WG1176767
Vinyl chloride	U		0.259	1.00	1	10/06/2018 01:20	WG1176767
Xylenes, Total	U		1.06	3.00	1	10/06/2018 01:20	WG1176767
(S) Toluene-d8	*100*			*80.0-120*		*10/06/2018 01:20*	WG1176767
(S) Dibromofluoromethane	*116*			*75.0-120*		*10/06/2018 01:20*	WG1176767
(S) 4-Bromofluorobenzene	*118*			*77.0-126*		*10/06/2018 01:20*	WG1176767

Semi Volatile Organic Compounds (GC/MS) by Method 8270C-SIM

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Anthracene	0.0292	J	0.0165	0.0590	1.18	10/10/2018 11:06	WG1178297
Acenaphthene	0.0155	J	0.0118	0.0590	1.18	10/10/2018 11:06	WG1178297
Acenaphthylene	U		0.0142	0.0590	1.18	10/10/2018 11:06	WG1178297
Benzo(a)anthracene	0.0698		0.00484	0.0590	1.18	10/10/2018 11:06	WG1178297
Benzo(a)pyrene	0.0766		0.0137	0.0590	1.18	10/10/2018 11:06	WG1178297
Benzo(b)fluoranthene	0.116	J3	0.00250	0.0590	1.18	10/10/2018 11:06	WG1178297
Benzo(g,h,i)perylene	0.0991		0.00268	0.0590	1.18	10/10/2018 11:06	WG1178297
Benzo(k)fluoranthene	0.0328	J	0.0160	0.0590	1.18	10/10/2018 11:06	WG1178297
Chrysene	0.118	J3	0.0127	0.0590	1.18	10/10/2018 11:06	WG1178297
Dibenz(a,h)anthracene	0.0143	J J3	0.00467	0.0590	1.18	10/10/2018 11:06	WG1178297
Fluoranthene	0.203		0.0185	0.0590	1.18	10/10/2018 11:06	WG1178297
Fluorene	U		0.0100	0.0590	1.18	10/10/2018 11:06	WG1178297
Indeno(1,2,3-cd)pyrene	0.0610	J3	0.0175	0.0590	1.18	10/10/2018 11:06	WG1178297
Naphthalene	0.0452	B J	0.0234	0.295	1.18	10/10/2018 11:06	WG1178297
Phenanthrene	0.205		0.00968	0.0590	1.18	10/10/2018 11:06	WG1178297
Pyrene	0.152		0.0138	0.0590	1.18	10/10/2018 11:06	WG1178297
1-Methylnaphthalene	0.0335	J	0.00969	0.295	1.18	10/10/2018 11:06	WG1178297
2-Methylnaphthalene	0.0418	J	0.0106	0.295	1.18	10/10/2018 11:06	WG1178297
(S) Nitrobenzene-d5	*91.9*			*31.0-160*		*10/10/2018 11:06*	WG1178297
(S) 2-Fluorobiphenyl	*95.3*			*48.0-148*		*10/10/2018 11:06*	WG1178297
(S) p-Terphenyl-d14	*68.5*			*37.0-146*		*10/10/2018 11:06*	WG1178297

Method Blank (MB)

(MB) R3348321-4 10/05/18 18:58

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Acetone	U		10.0	50.0
Acrolein	U		8.87	50.0
Acrylonitrile	U		1.87	10.0
Benzene	U		0.331	1.00
Bromobenzene	U		0.352	1.00
Bromodichloromethane	U		0.380	1.00
Bromoform	U		0.469	1.00
Bromomethane	U		0.866	5.00
n-Butylbenzene	U		0.361	1.00
sec-Butylbenzene	U		0.365	1.00
tert-Butylbenzene	U		0.399	1.00
Carbon tetrachloride	U		0.379	1.00
Chlorobenzene	U		0.348	1.00
Chlorodibromomethane	U		0.327	1.00
Chloroethane	U		0.453	5.00
Chloroform	U		0.324	5.00
2-Chloroethyl vinyl ether	U		3.01	50.0
Chloromethane	U		0.276	2.50
1,2-Dibromo-3-Chloropropane	U		1.33	5.00
2-Chlorotoluene	U		0.375	1.00
1,2-Dibromoethane	U		0.381	1.00
4-Chlorotoluene	U		0.351	1.00
Dibromomethane	U		0.346	1.00
1,2-Dichlorobenzene	U		0.349	1.00
1,3-Dichlorobenzene	U		0.220	1.00
1,4-Dichlorobenzene	U		0.274	1.00
Dichlorodifluoromethane	U		0.551	5.00
1,1-Dichloroethane	U		0.259	1.00
1,2-Dichloroethane	U		0.361	1.00
1,1-Dichloroethene	U		0.398	1.00
cis-1,2-Dichloroethene	U		0.260	1.00
trans-1,2-Dichloroethene	U		0.396	1.00
1,2-Dichloropropane	U		0.306	1.00
1,1-Dichloropropene	U		0.352	1.00
cis-1,3-Dichloropropene	U		0.418	1.00
1,3-Dichloropropane	U		0.366	1.00
trans-1,3-Dichloropropene	U		0.419	1.00
2,2-Dichloropropane	U		0.321	1.00
Di-isopropyl ether	U		0.320	1.00
Ethylbenzene	U		0.384	1.00

Method Blank (MB)

(MB) R3348321-4 10/05/18 18:58

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Hexachloro-1,3-butadiene	U		0.256	1.00
2-Butanone (MEK)	U		3.93	10.0
Isopropylbenzene	U		0.326	1.00
p-Isopropyltoluene	U		0.350	1.00
Methylene Chloride	U		1.00	5.00
4-Methyl-2-pentanone (MIBK)	U		2.14	10.0
Methyl tert-butyl ether	U		0.367	1.00
Naphthalene	U		1.00	5.00
n-Propylbenzene	U		0.349	1.00
Styrene	U		0.307	1.00
1,1,1,2-Tetrachloroethane	U		0.385	1.00
1,1,2,2-Tetrachloroethane	U		0.130	1.00
Tetrachloroethene	U		0.372	1.00
Toluene	U		0.412	1.00
1,1,2-Trichlorotrifluoroethane	U		0.303	1.00
1,2,4-Trichlorobenzene	U		0.355	1.00
1,1,1-Trichloroethane	U		0.319	1.00
1,2,3-Trichlorobenzene	U		0.230	1.00
1,1,2-Trichloroethane	U		0.383	1.00
Trichloroethene	U		0.398	1.00
Trichlorofluoromethane	U		1.20	5.00
1,2,3-Trichloropropane	U		0.807	2.50
1,2,4-Trimethylbenzene	U		0.373	1.00
1,2,3-Trimethylbenzene	U		0.321	1.00
1,3,5-Trimethylbenzene	U		0.387	1.00
Vinyl chloride	U		0.259	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*98.9*			*80.0-120*
(S) Dibromofluoromethane	*116*			*75.0-120*
(S) 4-Bromofluorobenzene	*118*			*77.0-126*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348321-1 10/05/18 17:37 • (LCSD) R3348321-2 10/05/18 17:57

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Acetone	125	150	153	120	122	19.0-160			1.89	27
Acrolein	125	167	176	133	141	10.0-160			5.20	26
Acrylonitrile	125	124	124	99.3	99.0	55.0-149			0.232	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348321-1 10/05/18 17:37 • (LCSD) R3348321-2 10/05/18 17:57

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Benzene	25.0	25.4	24.9	102	99.6	70.0-123			1.92	20
Bromobenzene	25.0	27.4	27.3	110	109	73.0-121			0.511	20
Bromodichloromethane	25.0	26.7	27.2	107	109	75.0-120			2.08	20
Bromoform	25.0	26.9	26.8	107	107	68.0-132			0.356	20
Bromomethane	25.0	11.9	12.7	47.6	50.8	10.0-160			6.46	25
n-Butylbenzene	25.0	25.9	25.6	104	103	73.0-125			1.09	20
sec-Butylbenzene	25.0	25.0	24.2	100	96.9	75.0-125			3.28	20
tert-Butylbenzene	25.0	24.9	24.4	99.6	97.4	76.0-124			2.17	20
Carbon tetrachloride	25.0	26.9	27.6	108	110	68.0-126			2.49	20
Chlorobenzene	25.0	22.7	21.6	90.8	86.4	80.0-121			4.87	20
Chlorodibromomethane	25.0	23.4	23.7	93.8	94.9	77.0-125			1.18	20
Chloroethane	25.0	55.6	48.4	222	194	47.0-150	J4	J4	13.9	20
Chloroform	25.0	28.1	28.1	112	112	73.0-120			0.0758	20
Chloromethane	25.0	19.3	18.9	77.2	75.6	41.0-142			2.05	20
1,2-Dibromo-3-Chloropropane	25.0	21.3	21.8	85.3	87.3	58.0-134			2.33	20
1,2-Dibromoethane	25.0	23.3	23.4	93.0	93.4	80.0-122			0.419	20
Dibromomethane	25.0	27.4	27.8	110	111	80.0-120			1.44	20
1,2-Dichlorobenzene	25.0	24.4	24.2	97.7	96.6	79.0-121			1.06	20
1,3-Dichlorobenzene	25.0	24.2	23.5	96.9	94.2	79.0-120			2.87	20
1,4-Dichlorobenzene	25.0	23.7	23.8	94.8	95.4	79.0-120			0.622	20
2-Chloroethyl vinyl ether	125	106	104	84.6	83.4	51.0-160			1.38	20
Dichlorodifluoromethane	25.0	25.3	24.9	101	99.4	51.0-149			1.60	20
1,1-Dichloroethane	25.0	27.6	27.7	110	111	70.0-126			0.544	20
1,2-Dichloroethane	25.0	30.8	30.3	123	121	70.0-128			1.53	20
1,1-Dichloroethene	25.0	26.4	25.3	106	101	71.0-124			4.52	20
2-Chlorotoluene	25.0	26.2	25.4	105	102	76.0-123			3.12	20
4-Chlorotoluene	25.0	26.0	25.4	104	102	75.0-122			2.12	20
cis-1,2-Dichloroethene	25.0	25.6	25.2	102	101	73.0-120			1.37	20
trans-1,2-Dichloroethene	25.0	25.6	25.2	103	101	73.0-120			1.76	20
1,2-Dichloropropane	25.0	26.2	27.0	105	108	77.0-125			3.12	20
cis-1,3-Dichloropropene	25.0	23.4	23.0	93.5	92.1	80.0-123			1.50	20
trans-1,3-Dichloropropene	25.0	24.8	24.8	99.0	99.1	78.0-124			0.0521	20
Di-isopropyl ether	25.0	25.6	26.4	103	106	58.0-138			3.02	20
Ethylbenzene	25.0	21.6	21.0	86.3	84.0	79.0-123			2.63	20
Hexachloro-1,3-butadiene	25.0	20.7	21.6	82.8	86.5	54.0-138			4.40	20
1,1-Dichloropropene	25.0	27.0	26.6	108	106	74.0-126			1.36	20
1,3-Dichloropropane	25.0	23.8	23.4	95.3	93.6	80.0-120			1.81	20
2-Butanone (MEK)	125	130	128	104	102	44.0-160			1.61	20
2,2-Dichloropropane	25.0	26.1	25.6	104	103	58.0-130			1.79	20
Methylene Chloride	25.0	24.7	24.9	98.7	99.6	67.0-120			0.903	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348321-1 10/05/18 17:37 • (LCSD) R3348321-2 10/05/18 17:57

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
4-Methyl-2-pentanone (MIBK)	125	115	114	92.0	91.5	68.0-142			0.524	20
Methyl tert-butyl ether	25.0	25.8	26.0	103	104	68.0-125			0.922	20
Naphthalene	25.0	21.3	22.1	85.3	88.3	54.0-135			3.42	20
n-Propylbenzene	25.0	26.5	25.8	106	103	77.0-124			2.47	20
Styrene	25.0	25.2	25.2	101	101	73.0-130			0.100	20
1,1,1,2-Tetrachloroethane	25.0	22.6	21.5	90.5	85.8	75.0-125			5.30	20
1,1,2,2-Tetrachloroethane	25.0	26.8	26.9	107	108	65.0-130			0.499	20
Isopropylbenzene	25.0	25.7	25.4	103	102	76.0-127			1.35	20
p-Isopropyltoluene	25.0	24.5	24.7	98.1	98.8	76.0-125			0.743	20
Tetrachloroethene	25.0	21.2	20.9	84.9	83.6	72.0-132			1.60	20
Toluene	25.0	22.6	21.7	90.4	86.7	79.0-120			4.19	20
1,1,2-Trichlorotrifluoroethane	25.0	27.8	27.4	111	110	69.0-132			1.36	20
1,2,4-Trichlorobenzene	25.0	23.6	23.4	94.4	93.5	57.0-137			0.901	20
1,1,1-Trichloroethane	25.0	28.7	28.0	115	112	73.0-124			2.63	20
1,1,2-Trichloroethane	25.0	23.4	23.0	93.4	92.1	80.0-120			1.45	20
Trichloroethene	25.0	24.0	23.7	96.2	94.6	78.0-124			1.65	20
Trichlorofluoromethane	25.0	35.9	35.0	144	140	59.0-147			2.55	20
1,2,3-Trichloropropane	25.0	26.5	26.5	106	106	73.0-130			0.305	20
1,2,4-Trimethylbenzene	25.0	25.3	24.6	101	98.5	76.0-121			2.54	20
1,3,5-Trimethylbenzene	25.0	25.0	24.5	100	97.9	76.0-122			2.27	20
Vinyl chloride	25.0	26.8	26.7	107	107	67.0-131			0.271	20
Xylenes, Total	75.0	63.4	61.3	84.5	81.7	79.0-123			3.37	20
1,2,3-Trichlorobenzene	25.0	23.7	23.4	95.0	93.4	50.0-138			1.64	20
1,2,3-Trimethylbenzene	25.0	24.8	24.7	99.2	98.8	77.0-120			0.396	20
(S) Toluene-d8				*95.3*	*94.9*	*80.0-120*				
(S) Dibromofluoromethane				*118*	*116*	*75.0-120*				
(S) 4-Bromofluorobenzene				*113*	*111*	*77.0-126*				

Method Blank (MB)

(MB) R3349367-3 10/10/18 08:54

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Anthracene	U		0.0140	0.0500
Acenaphthene	U		0.0100	0.0500
Acenaphthylene	U		0.0120	0.0500
Benzo(a)anthracene	U		0.00410	0.0500
Benzo(a)pyrene	U		0.0116	0.0500
Benzo(b)fluoranthene	U		0.00212	0.0500
Benzo(g,h,i)perylene	U		0.00227	0.0500
Benzo(k)fluoranthene	U		0.0136	0.0500
Chrysene	U		0.0108	0.0500
Dibenz(a,h)anthracene	U		0.00396	0.0500
Fluoranthene	U		0.0157	0.0500
Fluorene	U		0.00850	0.0500
Indeno(1,2,3-cd)pyrene	U		0.0148	0.0500
Naphthalene	0.0215	J	0.0198	0.250
Phenanthrene	U		0.00820	0.0500
Pyrene	U		0.0117	0.0500
1-Methylnaphthalene	U		0.00821	0.250
2-Methylnaphthalene	U		0.00902	0.250
(S) Nitrobenzene-d5	*84.0*			*31.0-160*
(S) 2-Fluorobiphenyl	*87.0*			*48.0-148*
(S) p-Terphenyl-d14	*79.5*			*37.0-146*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349367-1 10/10/18 08:11 • (LCSD) R3349367-2 10/10/18 08:32

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Anthracene	2.00	1.98	2.25	99.0	112	67.0-150			12.8	20
Acenaphthene	2.00	1.81	1.96	90.5	98.0	65.0-138			7.96	20
Acenaphthylene	2.00	1.80	1.99	90.0	99.5	66.0-140			10.0	20
Benzo(a)anthracene	2.00	1.61	1.71	80.5	85.5	61.0-140			6.02	20
Benzo(a)pyrene	2.00	1.58	1.92	79.0	96.0	60.0-143			19.4	20
Benzo(b)fluoranthene	2.00	1.38	1.81	69.0	90.5	58.0-141		J3	27.0	20
Benzo(g,h,i)perylene	2.00	1.59	1.94	79.5	97.0	52.0-153			19.8	20
Benzo(k)fluoranthene	2.00	1.72	1.99	86.0	99.5	58.0-148			14.6	20
Chrysene	2.00	1.88	2.30	94.0	115	64.0-144		J3	20.1	20
Dibenz(a,h)anthracene	2.00	1.52	1.89	76.0	94.5	52.0-155		J3	21.7	20
Fluoranthene	2.00	2.17	2.40	108	120	69.0-153			10.1	20
Fluorene	2.00	1.67	1.83	83.5	91.5	64.0-136			9.14	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349367-1 10/10/18 08:11 • (LCSD) R3349367-2 10/10/18 08:32

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Indeno(1,2,3-cd)pyrene	2.00	1.55	1.92	77.5	96.0	54.0-153		J3	21.3	20
Naphthalene	2.00	1.79	1.96	89.5	98.0	61.0-137			9.07	20
Phenanthrene	2.00	1.70	1.83	85.0	91.5	62.0-137			7.37	20
Pyrene	2.00	1.66	1.78	83.0	89.0	60.0-142			6.98	20
1-Methylnaphthalene	2.00	1.96	2.14	98.0	107	66.0-142			8.78	20
2-Methylnaphthalene	2.00	1.87	2.04	93.5	102	62.0-136			8.70	20
(S) Nitrobenzene-d5				*88.0*	*99.5*	*31.0-160*				
(S) 2-Fluorobiphenyl				*91.5*	*103*	*48.0-148*				
(S) p-Terphenyl-d14				*78.0*	*89.5*	*37.0-146*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
B	The same analyte is found in the associated blank.
J	The identification of the analyte is acceptable; the reported value is an estimate.
J3	The associated batch QC was outside the established quality control range for precision.
J4	The associated batch QC was outside the established quality control range for accuracy.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana [1]	LA180010	Texas	T 104704245-17-14
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

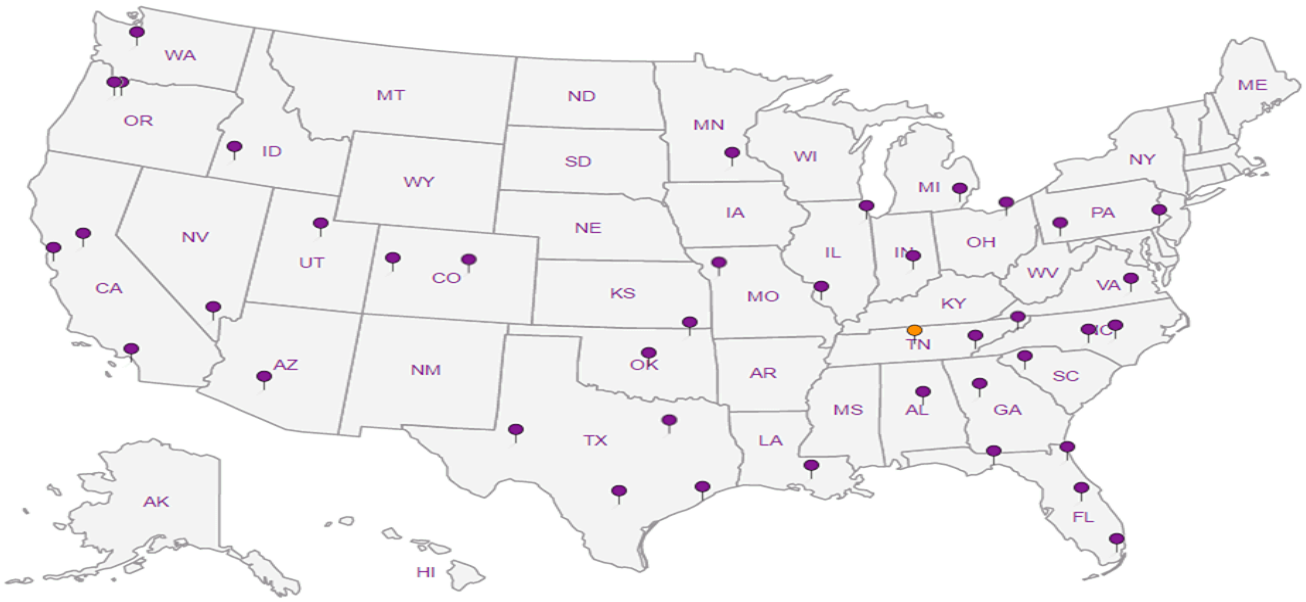
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.



Partner Engineering & Science - IL
805 North Milwaukee Avenue
Suite 401 C
Chicago, IL 60642

Billing Information:
Accounts Payable
2154 Torrance Blvd., Ste. 200
Torrance, CA 90501

Report to: Lucas Martin
Email To: LMartin@partneresi.com

Project Description: Fox Shores Apartments
City/State Collected: Kaukauna, WI

Phone: 224-224-0736
Fax:
Client Project # 18-215232.3
Lab Project # PARENGCIL-182152323

Collected by (print): L. Morton
Site/Facility ID # 400 FOX SHORES DR.
P.O. #

Collected by (Signature):
Immediately Packed on Ice N ___ Y X
Rush? (Lab MUST Be Notified) ___ Same Day ___ Five Day ___ Next Day ___ 5 Day (Rad Only) ___ Two Day ___ 10 Day (Rad Only) ___ Three Day
Quote #
Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	PAHSIMLVI 40mlAmb-NoPres-WT	V8260 40mlAmb-HCl	Remarks	Sample # (lab only)
B1-GW	Grab	GW	-	10/3/18	1215	5	X	X		01
B2-GW		GW	-		1225	5	X	X		02
B3-GW		GW	-		1230	5	X	X		03
B4-GW		GW	-		1235	5	X	X		04
B5-GW		GW	-		1220	5	X	X		-05
-	-	GW	-	-	-	5	X	X		

Chain of Custody Page ___ of ___

Pace Analytical
National Center for Testing & Innovation

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# 103104
A187
Acctnum: PARENGCIL
Template: T141199
Prelogin: P674193
TSR: 341 - John Hawkins
PB: 9/27/18 MG
Shipped Via: FedEX Ground

Analysis / Container / Preservative

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other

Remarks: RAD SCREEN: <0.5 mR/hr
pH ___ Temp ___
Flow ___ Other ___

Samples returned via: __ UPS __ FedEx __ Courier __ ___
Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR
	10/3/18	1500		
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 0.3 °C Bottles Received: 25
				1.10.8
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: 10/4/18 Time: 1510
			Carol Kemp	EK 10/4/18

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

October 11, 2018

Partner Engineering & Science - IL

Sample Delivery Group:	L1031849
Samples Received:	10/04/2018
Project Number:	18-215232.3
Description:	Fox Shores Apartments
Site:	400 FOX SHORES DR. KAUKAUNA,WS
Report To:	Lucas Martin 805 North Milwaukee Avenue Suite 401 C Chicago, IL 60642

Entire Report Reviewed By:

John Hawkins
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace National is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.



TABLE OF CONTENTS

Cp: Cover Page 1

Tc: Table of Contents 2

Ss: Sample Summary 3

Cn: Case Narrative 4

Sr: Sample Results 5

VP-1 L1031849-01 5

VP-2 L1031849-02 7

VP-3 L1031849-03 9

Qc: Quality Control Summary 11

Volatile Organic Compounds (MS) by Method TO-15 11

Gl: Glossary of Terms 18

Al: Accreditations & Locations 19

Sc: Sample Chain of Custody 20

VP-1 L1031849-01 Air

Collected by	Collected date/time	Received date/time
L. Martin	10/03/18 09:29	10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (MS) by Method TO-15	WG1176423	2	10/05/18 23:44	10/05/18 23:44	AMC
Volatile Organic Compounds (MS) by Method TO-15	WG1176970	80	10/07/18 01:59	10/07/18 01:59	AMC

VP-2 L1031849-02 Air

Collected by	Collected date/time	Received date/time
L. Martin	10/03/18 09:37	10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (MS) by Method TO-15	WG1176423	2	10/06/18 00:26	10/06/18 00:26	AMC
Volatile Organic Compounds (MS) by Method TO-15	WG1178062	8000	10/09/18 12:49	10/09/18 12:49	AMC

VP-3 L1031849-03 Air

Collected by	Collected date/time	Received date/time
L. Martin	10/03/18 09:44	10/04/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (MS) by Method TO-15	WG1176423	2	10/06/18 01:09	10/06/18 01:09	AMC
Volatile Organic Compounds (MS) by Method TO-15	WG1176970	80	10/07/18 03:24	10/07/18 03:24	AMC
Volatile Organic Compounds (MS) by Method TO-15	WG1177588	2000	10/08/18 13:18	10/08/18 13:18	AMC

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

John Hawkins
Project Manager

Volatile Organic Compounds (MS) by Method TO-15

Analyte	CAS #	Mol. Wt.	RDL1 ppbv	RDL2 ug/m3	Result ppbv	Result ug/m3	Qualifier	Dilution	Batch
Acetone	67-64-1	58.10	100	238	1130	2680		80	WG1176970
Allyl chloride	107-05-1	76.53	0.400	1.25	ND	ND		2	WG1176423
Benzene	71-43-2	78.10	0.400	1.28	2.69	8.59		2	WG1176423
Benzyl Chloride	100-44-7	127	0.400	2.08	ND	ND		2	WG1176423
Bromodichloromethane	75-27-4	164	0.400	2.68	ND	ND		2	WG1176423
Bromoform	75-25-2	253	1.20	12.4	ND	ND		2	WG1176423
Bromomethane	74-83-9	94.90	0.400	1.55	ND	ND		2	WG1176423
1,3-Butadiene	106-99-0	54.10	4.00	8.85	ND	ND		2	WG1176423
Carbon disulfide	75-15-0	76.10	0.400	1.24	ND	ND		2	WG1176423
Carbon tetrachloride	56-23-5	154	0.400	2.52	ND	ND		2	WG1176423
Chlorobenzene	108-90-7	113	0.400	1.85	ND	ND		2	WG1176423
Chloroethane	75-00-3	64.50	0.400	1.06	ND	ND		2	WG1176423
Chloroform	67-66-3	119	0.400	1.95	ND	ND		2	WG1176423
Chloromethane	74-87-3	50.50	0.400	0.826	ND	ND		2	WG1176423
2-Chlorotoluene	95-49-8	126	0.400	2.06	ND	ND		2	WG1176423
Cyclohexane	110-82-7	84.20	0.400	1.38	2.80	9.63		2	WG1176423
Dibromochloromethane	124-48-1	208	0.400	3.40	ND	ND		2	WG1176423
1,2-Dibromoethane	106-93-4	188	0.400	3.08	ND	ND		2	WG1176423
1,2-Dichlorobenzene	95-50-1	147	0.400	2.40	ND	ND		2	WG1176423
1,3-Dichlorobenzene	541-73-1	147	0.400	2.40	ND	ND		2	WG1176423
1,4-Dichlorobenzene	106-46-7	147	0.400	2.40	ND	ND		2	WG1176423
1,2-Dichloroethane	107-06-2	99	0.400	1.62	ND	ND		2	WG1176423
1,1-Dichloroethane	75-34-3	98	0.400	1.60	ND	ND		2	WG1176423
1,1-Dichloroethene	75-35-4	96.90	0.400	1.59	ND	ND		2	WG1176423
cis-1,2-Dichloroethene	156-59-2	96.90	0.400	1.59	ND	ND		2	WG1176423
trans-1,2-Dichloroethene	156-60-5	96.90	0.400	1.59	ND	ND		2	WG1176423
1,2-Dichloropropane	78-87-5	113	0.400	1.85	ND	ND		2	WG1176423
cis-1,3-Dichloropropene	10061-01-5	111	0.400	1.82	ND	ND		2	WG1176423
trans-1,3-Dichloropropene	10061-02-6	111	0.400	1.82	ND	ND		2	WG1176423
1,4-Dioxane	123-91-1	88.10	0.400	1.44	ND	ND		2	WG1176423
Ethanol	64-17-5	46.10	50.4	95.0	3290	6200		80	WG1176970
Ethylbenzene	100-41-4	106	0.400	1.73	5.18	22.4		2	WG1176423
4-Ethyltoluene	622-96-8	120	0.400	1.96	ND	ND		2	WG1176423
Trichlorofluoromethane	75-69-4	137.40	0.400	2.25	3.28	18.4		2	WG1176423
Dichlorodifluoromethane	75-71-8	120.92	16.0	79.1	1430	7060		80	WG1176970
1,1,2-Trichlorotrifluoroethane	76-13-1	187.40	0.400	3.07	ND	ND		2	WG1176423
1,2-Dichlorotetrafluoroethane	76-14-2	171	0.400	2.80	ND	ND		2	WG1176423
Heptane	142-82-5	100	0.400	1.64	6.90	28.2		2	WG1176423
Hexachloro-1,3-butadiene	87-68-3	261	1.26	13.5	ND	ND		2	WG1176423
n-Hexane	110-54-3	86.20	0.400	1.41	8.02	28.3		2	WG1176423
Isopropylbenzene	98-82-8	120.20	0.400	1.97	ND	ND		2	WG1176423
Methylene Chloride	75-09-2	84.90	0.400	1.39	5.06	17.6		2	WG1176423
Methyl Butyl Ketone	591-78-6	100	2.50	10.2	ND	ND		2	WG1176423
2-Butanone (MEK)	78-93-3	72.10	2.50	7.37	8.85	26.1		2	WG1176423
4-Methyl-2-pentanone (MIBK)	108-10-1	100.10	2.50	10.2	ND	ND		2	WG1176423
Methyl methacrylate	80-62-6	100.12	0.400	1.64	ND	ND		2	WG1176423
MTBE	1634-04-4	88.10	0.400	1.44	ND	ND		2	WG1176423
Naphthalene	91-20-3	128	1.26	6.60	ND	ND		2	WG1176423
2-Propanol	67-63-0	60.10	2.50	6.15	6.43	15.8		2	WG1176423
Propene	115-07-1	42.10	0.800	1.38	ND	ND		2	WG1176423
Styrene	100-42-5	104	0.400	1.70	ND	ND		2	WG1176423
1,1,2,2-Tetrachloroethane	79-34-5	168	0.400	2.75	ND	ND		2	WG1176423
Tetrachloroethylene	127-18-4	166	0.400	2.72	ND	ND		2	WG1176423
Tetrahydrofuran	109-99-9	72.10	0.400	1.18	ND	ND		2	WG1176423
Toluene	108-88-3	92.10	0.400	1.51	11.7	44.0		2	WG1176423
1,2,4-Trichlorobenzene	120-82-1	181	1.26	9.33	ND	ND		2	WG1176423

Volatile Organic Compounds (MS) by Method TO-15

Analyte	CAS #	Mol. Wt.	RDL1 ppbv	RDL2 ug/m3	Result ppbv	Result ug/m3	Qualifier	Dilution	Batch
1,1,1-Trichloroethane	71-55-6	133	0.400	2.18	ND	ND		2	WG1176423
1,1,2-Trichloroethane	79-00-5	133	0.400	2.18	ND	ND		2	WG1176423
Trichloroethylene	79-01-6	131	0.400	2.14	1.19	6.39		2	WG1176423
1,2,4-Trimethylbenzene	95-63-6	120	0.400	1.96	2.17	10.7		2	WG1176423
1,3,5-Trimethylbenzene	108-67-8	120	0.400	1.96	0.502	2.46		2	WG1176423
2,2,4-Trimethylpentane	540-84-1	114.22	0.400	1.87	ND	ND		2	WG1176423
Vinyl chloride	75-01-4	62.50	0.400	1.02	ND	ND		2	WG1176423
Vinyl Bromide	593-60-2	106.95	0.400	1.75	ND	ND		2	WG1176423
Vinyl acetate	108-05-4	86.10	0.400	1.41	ND	ND		2	WG1176423
m&p-Xylene	1330-20-7	106	0.800	3.47	5.50	23.8		2	WG1176423
o-Xylene	95-47-6	106	0.400	1.73	2.24	9.73		2	WG1176423
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*97.1*				WG1176423
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*91.1*				WG1176970

Volatile Organic Compounds (MS) by Method TO-15

Analyte	CAS #	Mol. Wt.	RDL1 ppbv	RDL2 ug/m3	Result ppbv	Result ug/m3	Qualifier	Dilution	Batch
Acetone	67-64-1	58.10	2.50	5.94	5.09	12.1		2	WG1176423
Allyl chloride	107-05-1	76.53	0.400	1.25	ND	ND		2	WG1176423
Benzene	71-43-2	78.10	0.400	1.28	ND	ND		2	WG1176423
Benzyl Chloride	100-44-7	127	0.400	2.08	ND	ND		2	WG1176423
Bromodichloromethane	75-27-4	164	0.400	2.68	ND	ND		2	WG1176423
Bromoform	75-25-2	253	1.20	12.4	ND	ND		2	WG1176423
Bromomethane	74-83-9	94.90	0.400	1.55	ND	ND		2	WG1176423
1,3-Butadiene	106-99-0	54.10	4.00	8.85	ND	ND		2	WG1176423
Carbon disulfide	75-15-0	76.10	0.400	1.24	ND	ND		2	WG1176423
Carbon tetrachloride	56-23-5	154	0.400	2.52	ND	ND		2	WG1176423
Chlorobenzene	108-90-7	113	0.400	1.85	ND	ND		2	WG1176423
Chloroethane	75-00-3	64.50	0.400	1.06	ND	ND		2	WG1176423
Chloroform	67-66-3	119	0.400	1.95	ND	ND		2	WG1176423
Chloromethane	74-87-3	50.50	0.400	0.826	ND	ND		2	WG1176423
2-Chlorotoluene	95-49-8	126	0.400	2.06	ND	ND		2	WG1176423
Cyclohexane	110-82-7	84.20	0.400	1.38	0.529	1.82		2	WG1176423
Dibromochloromethane	124-48-1	208	0.400	3.40	ND	ND		2	WG1176423
1,2-Dibromoethane	106-93-4	188	0.400	3.08	ND	ND		2	WG1176423
1,2-Dichlorobenzene	95-50-1	147	0.400	2.40	ND	ND		2	WG1176423
1,3-Dichlorobenzene	541-73-1	147	0.400	2.40	ND	ND		2	WG1176423
1,4-Dichlorobenzene	106-46-7	147	0.400	2.40	ND	ND		2	WG1176423
1,2-Dichloroethane	107-06-2	99	0.400	1.62	ND	ND		2	WG1176423
1,1-Dichloroethane	75-34-3	98	0.400	1.60	ND	ND		2	WG1176423
1,1-Dichloroethene	75-35-4	96.90	0.400	1.59	ND	ND		2	WG1176423
cis-1,2-Dichloroethene	156-59-2	96.90	0.400	1.59	ND	ND		2	WG1176423
trans-1,2-Dichloroethene	156-60-5	96.90	0.400	1.59	ND	ND		2	WG1176423
1,2-Dichloropropane	78-87-5	113	0.400	1.85	ND	ND		2	WG1176423
cis-1,3-Dichloropropene	10061-01-5	111	0.400	1.82	ND	ND		2	WG1176423
trans-1,3-Dichloropropene	10061-02-6	111	0.400	1.82	ND	ND		2	WG1176423
1,4-Dioxane	123-91-1	88.10	0.400	1.44	ND	ND		2	WG1176423
Ethanol	64-17-5	46.10	1.26	2.38	16.1	30.3		2	WG1176423
Ethylbenzene	100-41-4	106	0.400	1.73	0.461	2.00		2	WG1176423
4-Ethyltoluene	622-96-8	120	0.400	1.96	ND	ND		2	WG1176423
Trichlorofluoromethane	75-69-4	137.40	0.400	2.25	4.44	25.0		2	WG1176423
Dichlorodifluoromethane	75-71-8	120.92	1600	7910	25500	126000		8000	WG1178062
1,1,2-Trichlorotrifluoroethane	76-13-1	187.40	0.400	3.07	ND	ND		2	WG1176423
1,2-Dichlorotetrafluoroethane	76-14-2	171	0.400	2.80	ND	ND		2	WG1176423
Heptane	142-82-5	100	0.400	1.64	2.66	10.9		2	WG1176423
Hexachloro-1,3-butadiene	87-68-3	261	1.26	13.5	ND	ND		2	WG1176423
n-Hexane	110-54-3	86.20	0.400	1.41	2.17	7.65		2	WG1176423
Isopropylbenzene	98-82-8	120.20	0.400	1.97	ND	ND		2	WG1176423
Methylene Chloride	75-09-2	84.90	0.400	1.39	ND	ND		2	WG1176423
Methyl Butyl Ketone	591-78-6	100	2.50	10.2	ND	ND		2	WG1176423
2-Butanone (MEK)	78-93-3	72.10	2.50	7.37	ND	ND		2	WG1176423
4-Methyl-2-pentanone (MIBK)	108-10-1	100.10	2.50	10.2	ND	ND		2	WG1176423
Methyl methacrylate	80-62-6	100.12	0.400	1.64	ND	ND		2	WG1176423
MTBE	1634-04-4	88.10	0.400	1.44	ND	ND		2	WG1176423
Naphthalene	91-20-3	128	1.26	6.60	ND	ND		2	WG1176423
2-Propanol	67-63-0	60.10	2.50	6.15	ND	ND		2	WG1176423
Propene	115-07-1	42.10	0.800	1.38	2.34	4.03		2	WG1176423
Styrene	100-42-5	104	0.400	1.70	ND	ND		2	WG1176423
1,1,2,2-Tetrachloroethane	79-34-5	168	0.400	2.75	ND	ND		2	WG1176423
Tetrachloroethylene	127-18-4	166	0.400	2.72	ND	ND		2	WG1176423
Tetrahydrofuran	109-99-9	72.10	0.400	1.18	ND	ND		2	WG1176423
Toluene	108-88-3	92.10	0.400	1.51	0.693	2.61		2	WG1176423
1,2,4-Trichlorobenzene	120-82-1	181	1.26	9.33	ND	ND		2	WG1176423

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Volatile Organic Compounds (MS) by Method TO-15

Analyte	CAS #	Mol. Wt.	RDL1 ppbv	RDL2 ug/m3	Result ppbv	Result ug/m3	Qualifier	Dilution	Batch
1,1,1-Trichloroethane	71-55-6	133	0.400	2.18	ND	ND		2	WG1176423
1,1,2-Trichloroethane	79-00-5	133	0.400	2.18	ND	ND		2	WG1176423
Trichloroethylene	79-01-6	131	0.400	2.14	ND	ND		2	WG1176423
1,2,4-Trimethylbenzene	95-63-6	120	0.400	1.96	ND	ND		2	WG1176423
1,3,5-Trimethylbenzene	108-67-8	120	0.400	1.96	ND	ND		2	WG1176423
2,2,4-Trimethylpentane	540-84-1	114.22	0.400	1.87	ND	ND		2	WG1176423
Vinyl chloride	75-01-4	62.50	0.400	1.02	ND	ND		2	WG1176423
Vinyl Bromide	593-60-2	106.95	0.400	1.75	ND	ND		2	WG1176423
Vinyl acetate	108-05-4	86.10	0.400	1.41	ND	ND		2	WG1176423
m&p-Xylene	1330-20-7	106	0.800	3.47	ND	ND		2	WG1176423
o-Xylene	95-47-6	106	0.400	1.73	ND	ND		2	WG1176423
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*94.9*				WG1176423
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*88.5*				WG1178062

Volatile Organic Compounds (MS) by Method TO-15

Analyte	CAS #	Mol. Wt.	RDL1 ppbv	RDL2 ug/m3	Result ppbv	Result ug/m3	Qualifier	Dilution	Batch
Acetone	67-64-1	58.10	2.50	5.94	17.5	41.5		2	WG1176423
Allyl chloride	107-05-1	76.53	0.400	1.25	ND	ND		2	WG1176423
Benzene	71-43-2	78.10	0.400	1.28	ND	ND		2	WG1176423
Benzyl Chloride	100-44-7	127	0.400	2.08	ND	ND		2	WG1176423
Bromodichloromethane	75-27-4	164	0.400	2.68	ND	ND		2	WG1176423
Bromoform	75-25-2	253	1.20	12.4	ND	ND		2	WG1176423
Bromomethane	74-83-9	94.90	0.400	1.55	ND	ND		2	WG1176423
1,3-Butadiene	106-99-0	54.10	4.00	8.85	ND	ND		2	WG1176423
Carbon disulfide	75-15-0	76.10	0.400	1.24	ND	ND		2	WG1176423
Carbon tetrachloride	56-23-5	154	0.400	2.52	ND	ND		2	WG1176423
Chlorobenzene	108-90-7	113	0.400	1.85	ND	ND		2	WG1176423
Chloroethane	75-00-3	64.50	0.400	1.06	ND	ND		2	WG1176423
Chloroform	67-66-3	119	0.400	1.95	ND	ND		2	WG1176423
Chloromethane	74-87-3	50.50	0.400	0.826	ND	ND		2	WG1176423
2-Chlorotoluene	95-49-8	126	0.400	2.06	ND	ND		2	WG1176423
Cyclohexane	110-82-7	84.20	0.400	1.38	ND	ND		2	WG1176423
Dibromochloromethane	124-48-1	208	0.400	3.40	ND	ND		2	WG1176423
1,2-Dibromoethane	106-93-4	188	0.400	3.08	ND	ND		2	WG1176423
1,2-Dichlorobenzene	95-50-1	147	0.400	2.40	ND	ND		2	WG1176423
1,3-Dichlorobenzene	541-73-1	147	0.400	2.40	ND	ND		2	WG1176423
1,4-Dichlorobenzene	106-46-7	147	0.400	2.40	ND	ND		2	WG1176423
1,2-Dichloroethane	107-06-2	99	0.400	1.62	ND	ND		2	WG1176423
1,1-Dichloroethane	75-34-3	98	0.400	1.60	ND	ND		2	WG1176423
1,1-Dichloroethene	75-35-4	96.90	0.400	1.59	ND	ND		2	WG1176423
cis-1,2-Dichloroethene	156-59-2	96.90	0.400	1.59	ND	ND		2	WG1176423
trans-1,2-Dichloroethene	156-60-5	96.90	0.400	1.59	ND	ND		2	WG1176423
1,2-Dichloropropane	78-87-5	113	0.400	1.85	ND	ND		2	WG1176423
cis-1,3-Dichloropropene	10061-01-5	111	0.400	1.82	ND	ND		2	WG1176423
trans-1,3-Dichloropropene	10061-02-6	111	0.400	1.82	ND	ND		2	WG1176423
1,4-Dioxane	123-91-1	88.10	0.400	1.44	ND	ND		2	WG1176423
Ethanol	64-17-5	46.10	1.26	2.38	29.5	55.7		2	WG1176423
Ethylbenzene	100-41-4	106	0.400	1.73	0.552	2.39		2	WG1176423
4-Ethyltoluene	622-96-8	120	0.400	1.96	ND	ND		2	WG1176423
Trichlorofluoromethane	75-69-4	137.40	0.400	2.25	12.0	67.4		2	WG1176423
Dichlorodifluoromethane	75-71-8	120.92	400	1980	16000	79000		2000	WG1177588
1,1,2-Trichlorotrifluoroethane	76-13-1	187.40	0.400	3.07	ND	ND		2	WG1176423
1,2-Dichlorotetrafluoroethane	76-14-2	171	0.400	2.80	ND	ND		2	WG1176423
Heptane	142-82-5	100	0.400	1.64	ND	ND		2	WG1176423
Hexachloro-1,3-butadiene	87-68-3	261	1.26	13.5	ND	ND		2	WG1176423
n-Hexane	110-54-3	86.20	0.400	1.41	ND	ND		2	WG1176423
Isopropylbenzene	98-82-8	120.20	0.400	1.97	ND	ND		2	WG1176423
Methylene Chloride	75-09-2	84.90	0.400	1.39	ND	ND		2	WG1176423
Methyl Butyl Ketone	591-78-6	100	2.50	10.2	ND	ND		2	WG1176423
2-Butanone (MEK)	78-93-3	72.10	2.50	7.37	ND	ND		2	WG1176423
4-Methyl-2-pentanone (MIBK)	108-10-1	100.10	2.50	10.2	ND	ND		2	WG1176423
Methyl methacrylate	80-62-6	100.12	0.400	1.64	ND	ND		2	WG1176423
MTBE	1634-04-4	88.10	0.400	1.44	ND	ND		2	WG1176423
Naphthalene	91-20-3	128	1.26	6.60	ND	ND		2	WG1176423
2-Propanol	67-63-0	60.10	100	246	175	430		80	WG1176970
Propene	115-07-1	42.10	0.800	1.38	ND	ND		2	WG1176423
Styrene	100-42-5	104	0.400	1.70	ND	ND		2	WG1176423
1,1,2,2-Tetrachloroethane	79-34-5	168	0.400	2.75	ND	ND		2	WG1176423
Tetrachloroethylene	127-18-4	166	0.400	2.72	1.07	7.27		2	WG1176423
Tetrahydrofuran	109-99-9	72.10	0.400	1.18	ND	ND		2	WG1176423
Toluene	108-88-3	92.10	0.400	1.51	0.705	2.66		2	WG1176423
1,2,4-Trichlorobenzene	120-82-1	181	1.26	9.33	ND	ND		2	WG1176423

Volatile Organic Compounds (MS) by Method TO-15

Analyte	CAS #	Mol. Wt.	RDL1 ppbv	RDL2 ug/m3	Result ppbv	Result ug/m3	Qualifier	Dilution	Batch
1,1,1-Trichloroethane	71-55-6	133	0.400	2.18	ND	ND		2	WG1176423
1,1,2-Trichloroethane	79-00-5	133	0.400	2.18	ND	ND		2	WG1176423
Trichloroethylene	79-01-6	131	0.400	2.14	ND	ND		2	WG1176423
1,2,4-Trimethylbenzene	95-63-6	120	0.400	1.96	ND	ND		2	WG1176423
1,3,5-Trimethylbenzene	108-67-8	120	0.400	1.96	ND	ND		2	WG1176423
2,2,4-Trimethylpentane	540-84-1	114.22	0.400	1.87	ND	ND		2	WG1176423
Vinyl chloride	75-01-4	62.50	0.400	1.02	ND	ND		2	WG1176423
Vinyl Bromide	593-60-2	106.95	0.400	1.75	ND	ND		2	WG1176423
Vinyl acetate	108-05-4	86.10	0.400	1.41	ND	ND		2	WG1176423
m&p-Xylene	1330-20-7	106	0.800	3.47	1.60	6.94		2	WG1176423
o-Xylene	95-47-6	106	0.400	1.73	0.740	3.21		2	WG1176423
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*93.2*				WG1176423
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*90.7*				WG1176970
(S) 1,4-Bromofluorobenzene	*460-00-4*	*175*	*60.0-140*		*90.7*				WG1177588

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3348196-3 10/05/18 09:12

Analyte	MB Result ppbv	MB Qualifier	MB MDL ppbv	MB RDL ppbv
Acetone	0.103	J	0.0569	1.25
Allyl Chloride	U		0.0546	0.200
Benzene	U		0.0460	0.200
Benzyl Chloride	U		0.0598	0.200
Bromodichloromethane	U		0.0436	0.200
Bromoform	U		0.0786	0.600
Bromomethane	U		0.0609	0.200
1,3-Butadiene	U		0.0563	2.00
Carbon disulfide	0.0619	J	0.0544	0.200
Carbon tetrachloride	U		0.0585	0.200
Chlorobenzene	U		0.0601	0.200
Chloroethane	U		0.0489	0.200
Chloroform	U		0.0574	0.200
Chloromethane	U		0.0544	0.200
2-Chlorotoluene	U		0.0605	0.200
Cyclohexane	U		0.0534	0.200
Dibromochloromethane	U		0.0494	0.200
1,2-Dibromoethane	U		0.0185	0.200
1,2-Dichlorobenzene	U		0.0603	0.200
1,3-Dichlorobenzene	U		0.0597	0.200
1,4-Dichlorobenzene	U		0.0557	0.200
1,2-Dichloroethane	U		0.0616	0.200
1,1-Dichloroethane	U		0.0514	0.200
1,1-Dichloroethene	U		0.0490	0.200
cis-1,2-Dichloroethene	U		0.0389	0.200
trans-1,2-Dichloroethene	U		0.0464	0.200
1,2-Dichloropropane	U		0.0599	0.200
cis-1,3-Dichloropropene	U		0.0588	0.200
trans-1,3-Dichloropropene	U		0.0435	0.200
1,4-Dioxane	U		0.0554	0.200
Ethylbenzene	U		0.0506	0.200
4-Ethyltoluene	U		0.0666	0.200
Trichlorofluoromethane	U		0.0673	0.200
1,1,2-Trichlorotrifluoroethane	U		0.0687	0.200
1,2-Dichlorotetrafluoroethane	U		0.0458	0.200
Heptane	U		0.0626	0.200
Hexachloro-1,3-butadiene	0.0805	J	0.0656	0.630
n-Hexane	U		0.0457	0.200
Isopropylbenzene	U		0.0563	0.200
Methylene Chloride	0.0636	J	0.0465	0.200

Method Blank (MB)

(MB) R3348196-3 10/05/18 09:12

Analyte	MB Result ppbv	MB Qualifier	MB MDL ppbv	MB RDL ppbv
Methyl Butyl Ketone	U		0.0682	1.25
2-Butanone (MEK)	U		0.0493	1.25
4-Methyl-2-pentanone (MIBK)	U		0.0650	1.25
Methyl Methacrylate	U		0.0773	0.200
MTBE	U		0.0505	0.200
Naphthalene	0.183	J	0.154	0.630
2-Propanol	U		0.0882	1.25
Propene	U		0.0932	0.400
Styrene	U		0.0465	0.200
1,1,2,2-Tetrachloroethane	U		0.0576	0.200
Tetrachloroethylene	U		0.0497	0.200
Tetrahydrofuran	U		0.0508	0.200
Toluene	U		0.0499	0.200
1,2,4-Trichlorobenzene	U		0.148	0.630
1,1,1-Trichloroethane	U		0.0665	0.200
1,1,2-Trichloroethane	U		0.0287	0.200
Trichloroethylene	U		0.0545	0.200
1,2,4-Trimethylbenzene	U		0.0483	0.200
1,3,5-Trimethylbenzene	U		0.0631	0.200
2,2,4-Trimethylpentane	U		0.0456	0.200
Vinyl chloride	U		0.0457	0.200
Vinyl Bromide	U		0.0727	0.200
Vinyl acetate	U		0.0639	0.200
m&p-Xylene	U		0.0946	0.400
o-Xylene	U		0.0633	0.200
Ethanol	U		0.0832	0.630
(S) 1,4-Bromofluorobenzene	*88.8*			*60.0-140*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348196-1 10/05/18 07:43 • (LCSD) R3348196-2 10/05/18 08:27

Analyte	Spike Amount ppbv	LCS Result ppbv	LCSD Result ppbv	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Ethanol	3.75	3.16	3.27	84.2	87.2	55.0-148			3.52	25
Propene	3.75	3.92	3.65	105	97.3	64.0-144			7.20	25
1,2-Dichlorotetrafluoroethane	3.75	3.89	3.73	104	99.5	70.0-130			4.16	25
Chloromethane	3.75	3.66	3.58	97.6	95.6	70.0-130			2.06	25
Vinyl chloride	3.75	3.79	3.81	101	102	70.0-130			0.595	25
1,3-Butadiene	3.75	3.69	3.71	98.4	98.9	70.0-130			0.499	25

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348196-1 10/05/18 07:43 • (LCSD) R3348196-2 10/05/18 08:27

Analyte	Spike Amount ppbv	LCS Result ppbv	LCSD Result ppbv	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Bromomethane	3.75	3.73	3.73	99.4	99.4	70.0-130			0.00859	25
Chloroethane	3.75	3.68	3.77	98.1	101	70.0-130			2.39	25
Trichlorofluoromethane	3.75	3.74	3.72	99.7	99.3	70.0-130			0.434	25
1,1,2-Trichlorotrifluoroethane	3.75	3.74	3.74	99.7	99.8	70.0-130			0.0920	25
1,1-Dichloroethene	3.75	3.72	3.73	99.2	99.5	70.0-130			0.276	25
1,1-Dichloroethane	3.75	3.74	3.73	99.8	99.5	70.0-130			0.288	25
Acetone	3.75	3.52	3.58	93.8	95.4	70.0-130			1.63	25
2-Propanol	3.75	3.95	3.92	105	105	70.0-139			0.554	25
Carbon disulfide	3.75	3.62	3.61	96.5	96.3	70.0-130			0.124	25
Methylene Chloride	3.75	3.54	3.51	94.4	93.7	70.0-130			0.698	25
MTBE	3.75	3.74	3.75	99.7	99.9	70.0-130			0.246	25
trans-1,2-Dichloroethene	3.75	3.84	3.81	102	102	70.0-130			0.945	25
n-Hexane	3.75	3.70	3.68	98.7	98.0	70.0-130			0.704	25
Vinyl acetate	3.75	4.03	4.06	107	108	70.0-130			0.830	25
Methyl Ethyl Ketone	3.75	3.99	3.97	106	106	70.0-130			0.509	25
cis-1,2-Dichloroethene	3.75	3.81	3.81	102	102	70.0-130			0.0332	25
Chloroform	3.75	3.77	3.70	100	98.6	70.0-130			1.87	25
Cyclohexane	3.75	3.68	3.67	98.1	97.9	70.0-130			0.163	25
1,1,1-Trichloroethane	3.75	3.69	3.68	98.5	98.2	70.0-130			0.276	25
Carbon tetrachloride	3.75	3.69	3.65	98.5	97.2	70.0-130			1.31	25
Benzene	3.75	3.80	3.77	101	101	70.0-130			0.777	25
1,2-Dichloroethane	3.75	3.84	3.86	102	103	70.0-130			0.678	25
Heptane	3.75	3.72	3.70	99.1	98.8	70.0-130			0.351	25
Trichloroethylene	3.75	3.76	3.75	100	100	70.0-130			0.0753	25
1,2-Dichloropropane	3.75	3.75	3.78	100	101	70.0-130			0.678	25
1,4-Dioxane	3.75	3.76	3.84	100	102	70.0-140			2.12	25
Bromodichloromethane	3.75	3.84	3.77	102	101	70.0-130			1.67	25
cis-1,3-Dichloropropene	3.75	3.89	3.86	104	103	70.0-130			0.779	25
4-Methyl-2-pentanone (MIBK)	3.75	3.86	3.87	103	103	70.0-139			0.263	25
Toluene	3.75	3.87	3.84	103	102	70.0-130			0.674	25
trans-1,3-Dichloropropene	3.75	3.97	3.95	106	105	70.0-130			0.638	25
1,1,2-Trichloroethane	3.75	3.94	3.94	105	105	70.0-130			0.0494	25
Tetrachloroethylene	3.75	3.92	3.86	105	103	70.0-130			1.65	25
Methyl Butyl Ketone	3.75	4.20	4.15	112	111	70.0-149			1.14	25
Dibromochloromethane	3.75	3.94	3.89	105	104	70.0-130			1.13	25
1,2-Dibromoethane	3.75	3.99	3.96	106	106	70.0-130			0.801	25
Chlorobenzene	3.75	3.95	3.90	105	104	70.0-130			1.30	25
Ethylbenzene	3.75	3.81	3.73	101	99.5	70.0-130			2.02	25
m&p-Xylene	7.50	7.53	7.49	100	99.9	70.0-130			0.471	25
o-Xylene	3.75	3.72	3.72	99.1	99.1	70.0-130			0.0280	25

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348196-1 10/05/18 07:43 • (LCSD) R3348196-2 10/05/18 08:27

Analyte	Spike Amount ppbv	LCS Result ppbv	LCSD Result ppbv	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Styrene	3.75	3.88	3.87	104	103	70.0-130			0.285	25
Bromoform	3.75	3.85	3.84	103	102	70.0-130			0.180	25
1,1,2,2-Tetrachloroethane	3.75	3.76	3.79	100	101	70.0-130			0.859	25
4-Ethyltoluene	3.75	3.76	3.78	100	101	70.0-130			0.529	25
1,3,5-Trimethylbenzene	3.75	3.73	3.67	99.5	97.8	70.0-130			1.66	25
1,2,4-Trimethylbenzene	3.75	3.79	3.72	101	99.3	70.0-130			1.90	25
1,3-Dichlorobenzene	3.75	3.96	3.95	106	105	70.0-130			0.258	25
1,4-Dichlorobenzene	3.75	3.98	4.05	106	108	70.0-130			1.59	25
Benzyl Chloride	3.75	4.05	4.04	108	108	70.0-152			0.221	25
1,2-Dichlorobenzene	3.75	3.89	3.84	104	102	70.0-130			1.33	25
1,2,4-Trichlorobenzene	3.75	4.19	4.04	112	108	70.0-160			3.77	25
Hexachloro-1,3-butadiene	3.75	3.81	3.73	102	99.5	70.0-151			2.10	25
Naphthalene	3.75	4.34	4.12	116	110	70.0-159			5.11	25
Allyl Chloride	3.75	3.68	3.83	98.1	102	70.0-130			3.91	25
2-Chlorotoluene	3.75	3.74	3.77	99.7	100	70.0-130			0.836	25
Methyl Methacrylate	3.75	3.88	3.90	103	104	70.0-130			0.566	25
Tetrahydrofuran	3.75	3.73	3.68	99.6	98.2	70.0-137			1.38	25
2,2,4-Trimethylpentane	3.75	3.71	3.67	98.9	97.9	70.0-130			1.00	25
Vinyl Bromide	3.75	3.76	3.84	100	102	70.0-130			2.12	25
Isopropylbenzene	3.75	3.76	3.69	100	98.4	70.0-130			1.71	25
(S) 1,4-Bromofluorobenzene				*100*	*98.7*	*60.0-140*				

Method Blank (MB)

(MB) R3348503-3 10/06/18 20:27

Analyte	MB Result ppbv	MB Qualifier	MB MDL ppbv	MB RDL ppbv
Acetone	U		0.0569	1.25
Dichlorodifluoromethane	U		0.0601	0.200
2-Propanol	U		0.0882	1.25
Ethanol	U		0.0832	0.630
(S) 1,4-Bromofluorobenzene	*93.0*			*60.0-140*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348503-1 10/06/18 18:57 • (LCSD) R3348503-2 10/06/18 19:41

Analyte	Spike Amount ppbv	LCS Result ppbv	LCSD Result ppbv	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Ethanol	3.75	3.25	3.25	86.8	86.5	55.0-148			0.265	25
Dichlorodifluoromethane	3.75	4.27	4.26	114	114	64.0-139			0.346	25
Acetone	3.75	3.92	3.91	105	104	70.0-130			0.188	25
2-Propanol	3.75	4.01	3.99	107	107	70.0-139			0.417	25
(S) 1,4-Bromofluorobenzene				*97.5*	*96.8*	*60.0-140*				

Method Blank (MB)

(MB) R3348795-3 10/08/18 10:09

Analyte	MB Result ppbv	MB Qualifier	MB MDL ppbv	MB RDL ppbv
Dichlorodifluoromethane	U		0.0601	0.200
(S) 1,4-Bromofluorobenzene	*90.1*			*60.0-140*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3348795-1 10/08/18 08:41 • (LCSD) R3348795-2 10/08/18 09:25

Analyte	Spike Amount ppbv	LCS Result ppbv	LCSD Result ppbv	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Dichlorodifluoromethane	3.75	4.02	4.02	107	107	64.0-139			0.0182	25
(S) 1,4-Bromofluorobenzene				*97.8*	*99.2*	*60.0-140*				

Method Blank (MB)

(MB) R3349177-3 10/09/18 11:18

Analyte	MB Result ppbv	MB Qualifier	MB MDL ppbv	MB RDL ppbv
Dichlorodifluoromethane	U		0.0601	0.200
(S) 1,4-Bromofluorobenzene	*85.3*			*60.0-140*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3349177-1 10/09/18 08:59 • (LCSD) R3349177-2 10/09/18 10:32

Analyte	Spike Amount ppbv	LCS Result ppbv	LCSD Result ppbv	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Dichlorodifluoromethane	3.75	4.63	4.55	123	121	64.0-139			1.68	25
(S) 1,4-Bromofluorobenzene				*98.4*	*98.8*	*60.0-140*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana [1]	LA180010	Texas	T 104704245-17-14
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

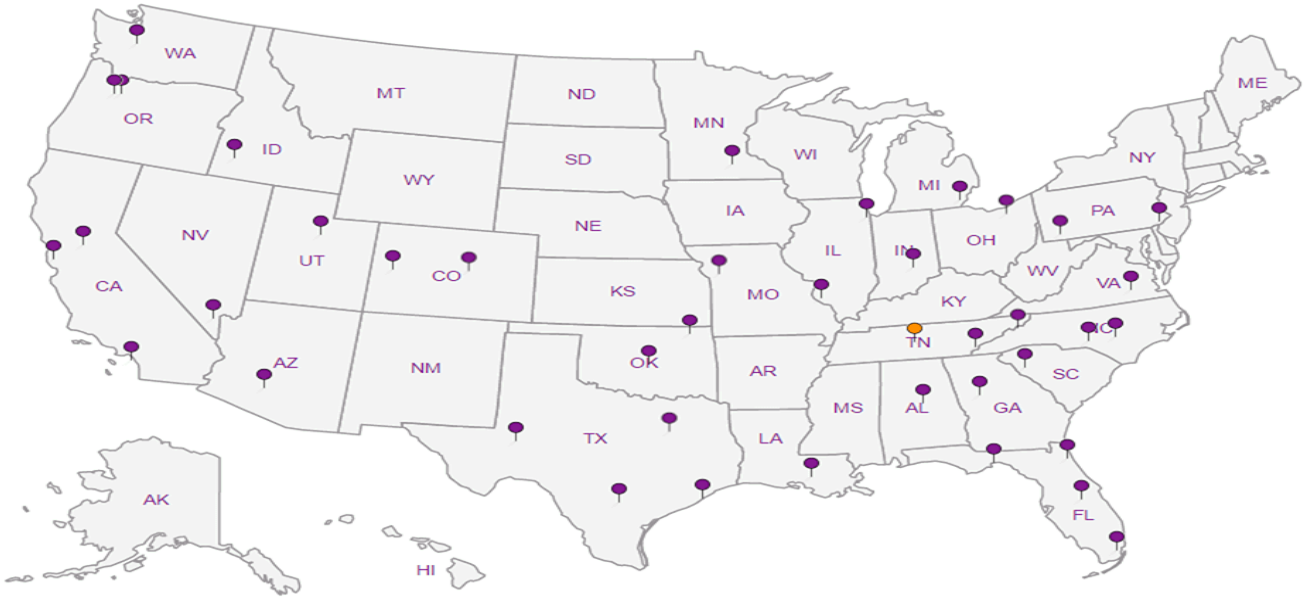
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.



Partner Engineering & Science - IL

805 North Milwaukee Avenue
Suite 401 C
Chicago, IL 60642

Billing Information:
Accounts Payable
2154 Torrance Blvd., Ste. 200
Torrance, CA 90501

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

Pace Analytical®
National Center for Testing & Innovation

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: Lucas Martin

Email To: LMartin@partneresi.com

Project Description: Fox Shores Apartments

City/State Collected: Kaukauna, WI

Phone: 224-224-0736
Fax:

Client Project # 18-215232.3

Lab Project # PARENGCIL-182152323

L# L1031849

Ta M148

Collected by (print): L. Martin

Site/Facility ID # 400 FOX SHORES DR.

P.O. #

Acctnum: PARENGCIL
Template: T141201
Prelogin: P674194
TSR: 341 - John Hawkins
PB: BF 9/27/18
Shipped Via: FedEX Ground

Collected by (signature):

Immediately Packed on Ice N ___ Y ___

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	TO-15 Summa	Remarks	Sample # (lab only)
VP-1	Grab	Air	–	10/3/18	929	1	X		-01
VP-2	↓	Air	–	↓	937	1	X		02
VP-3	↓	Air	–	↓	944	1	X		03

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_____

Remarks:

pH _____ Temp _____
Flow _____ Other _____

Samples returned via:
__ UPS __ FedEx __ Courier __ _____

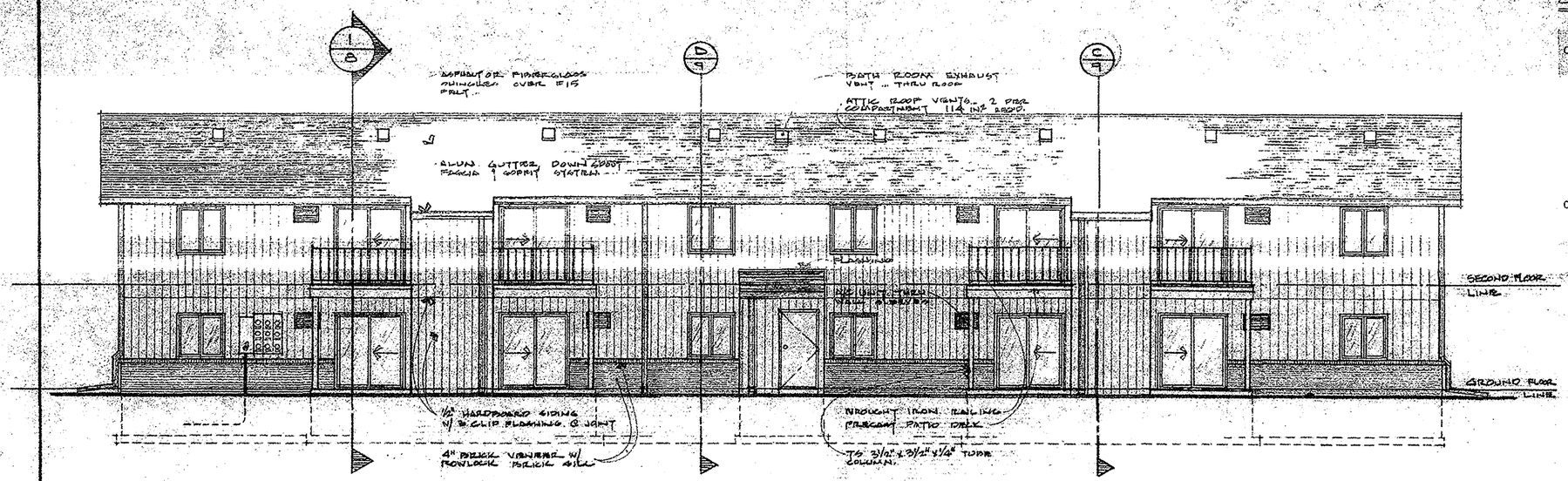
Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: NP __Y __N
COC Signed/Accurate: Y __N
Bottles arrive intact: Y __N
Correct bottles used: Y __N
Sufficient volume sent: Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR	
	10/3/18	1500			
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Temp: Amb °C Bottles Received: 3	If preservation required by Login: Date/Time
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: 10/4/18 Time: 0885	Hold: Condition: NCF / OK

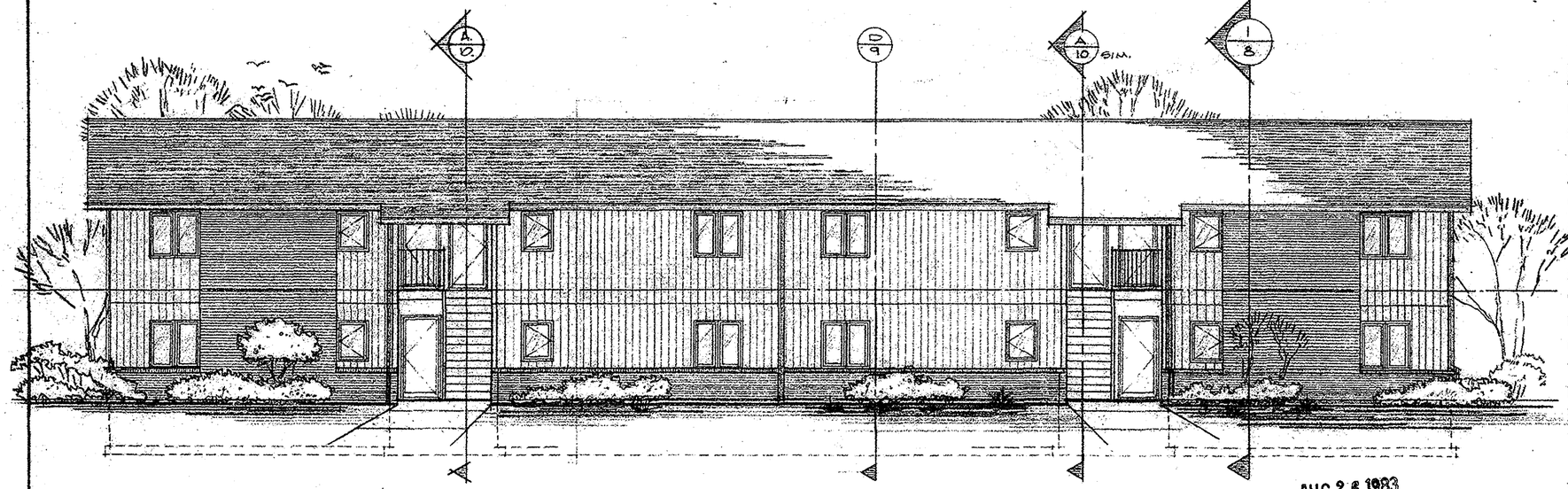
Appendix H

Apartment Building Schematics and Materials Safety Data Sheet



REAR ELEVATION

SCALE: 1/8" = 1'-0"



FRONT ELEVATION

SCALE: 1/8" = 1'-0"

GENERAL NOTES

- o The buildings are designed to conform to Wisconsin D.I.L.H.R. Chapter Ind. 57, Type #8, wood frame unprotected construction as eight family apartment/condominium buildings. All work shall conform to state and local codes which govern for the building site. Any additions to or deletions from the plan shall be in accordance with state and local codes and may require resubmittal. Notify the Architect of such changes.
- o The Division of Work, and Contract requirements shall be as negotiated with the Owner. Project schedule and expedition of work shall be as directed by the Owner or his representative.

BUILDING CONTENT (GROSS)

LOCATION	AREA - s.f.	VOLUME - c.f.
LOWER FLOOR	3808 s.f.	36,176 c.f.
UPPER FLOOR	3,808 s.f.	32,368 c.f.
ATTIC	—	10,790 c.f.
TOTAL	7,616 s.f.	79,334 c.f.
PER UNIT w/ ENTRANCE	952 s.f.	8,568 c.f.

INDEX OF DRAWINGS

1. TITLE, FRONT & REAR ELEVATIONS, CONTENT
2. SITE PLAN w/ SITE NOTES.
3. FIRST FLOOR PLAN, SECOND FLOOR PLAN
4. END ELEVATIONS, DOOR SCHEDULE, ROOM FINISH SCH.
5. APARTMENT UNIT PLAN
6. FOUNDATION PLAN, SECOND FLOOR FRAMING
7. ROOF FRAMING & SPECIFICATION, NOTES, CON'T.
8. CROSS SECTION, CABINET ISOMETRICS, DETAILS
9. WALL SECTIONS
10. STAIR SECTION
11. GENERAL NOTES, SPECIFICATIONS & NOTES.

H.V.1 HEATING, VENTILATION, & AIR CONDITIONING PLANS
H.V.2 SCHEDULES, NOTES, DETAILS

P-1 PLUMBING & DRAINAGE PLANS
P-2 PIPING ISOMETRICS, SCHEDULES, NOTES

E-1 ELECTRICAL BUILDING PLANS
E-2 APARTMENT UNIT PLAN - ELECTRICAL
E-3 SCHEDULE, NOTES, SERVICE DIAGRAM

AUG 26 1983
~~HEATING AND VENTILATING~~
BUILDING PLANS
Conditionally
APPROVED
DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS
Gerald L. Brawand
SEE CORRESPONDENCE
83-08-0293-B

8 Unit Apartment / Condominium Building

JACOBSON, PROMER & PROMER

Kaukauna, Wisconsin

WISCONSIN ALLAN R. BIRSCHBACH A-4501 KAUKAUNA WISCONSIN ARCHITECT

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Registered Architect under the Statutes of the State of Wisconsin.

Allan R. Birschbach

Date APRIL 22, 1982 Reg. No. A-4501

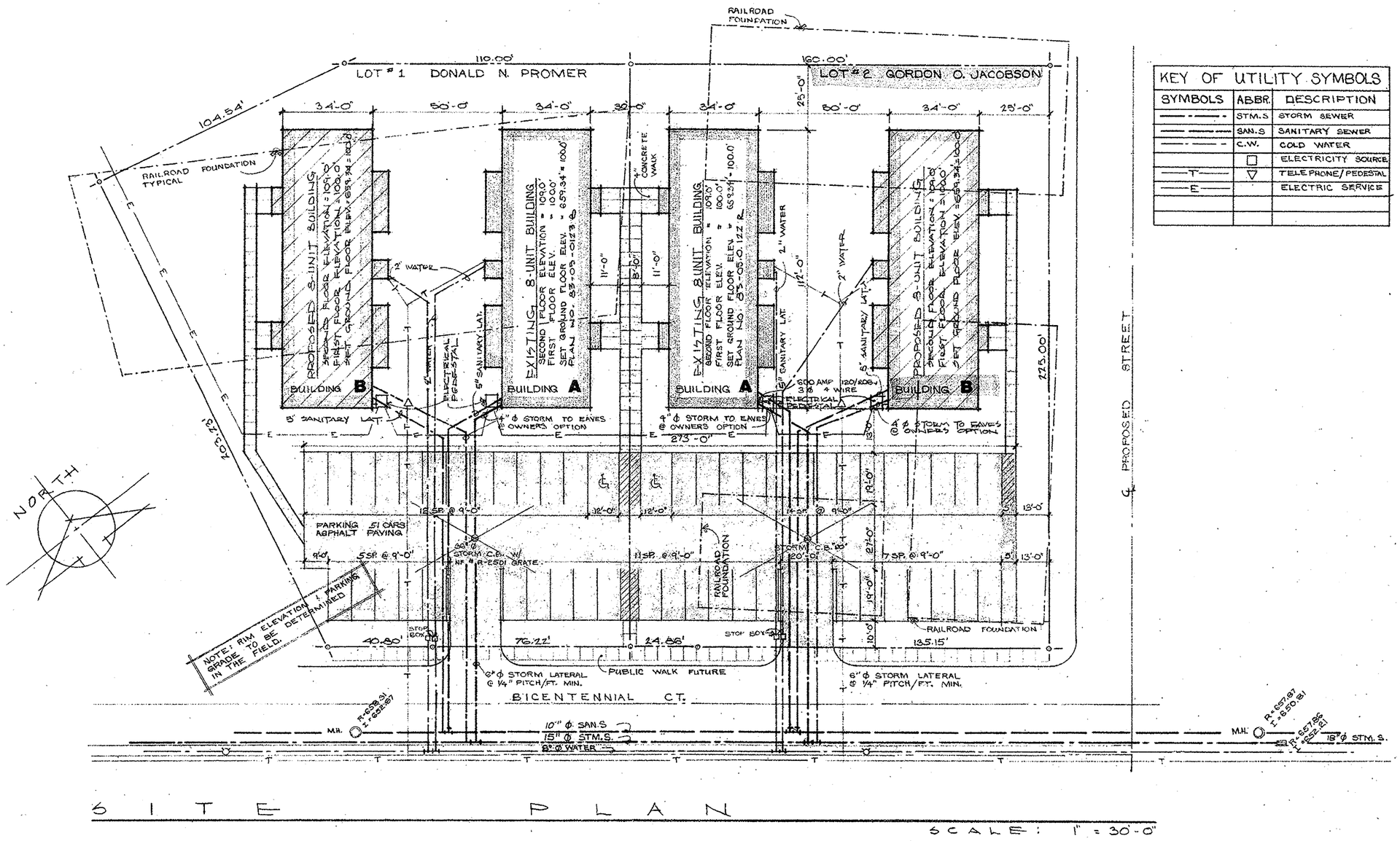
DRAWN BY: AB & TG
APPROVED BY: AB
REVISIONS

BY	DATE

BIRSCHBACH & ASSOCIATES, LTD.
ARCHITECTURE
P.O. BOX 328, 1801 CROOKS AVENUE
KAUKAUNA, WISCONSIN 54130
414-766-4227

EIGHT UNIT APARTMENT / CONDOMINIUM — JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317
DATE 4/22/83
SHEET 1 OF 18



SITE PLAN

SCALE: 1" = 30'-0"

KEY OF UTILITY SYMBOLS		
SYMBOLS	ABBR.	DESCRIPTION
—— · —— · ——	STM.S	STORM SEWER
—— — —— — ——	SAN.S	SANITARY SEWER
—— · · —— · · ——	C.W.	COLD WATER
	□	ELECTRICITY SOURCE
—T—	▽	TELEPHONE/PEDESTAL
—E—		ELECTRIC SERVICE

SITE WORK - GENERAL NOTES & SPECIFICATIONS

- The project will be to construct two(2) Eight-family apartment buildings. One for each of two owners and one each future.
- The sites are Lots #1 and #2 of a certified survey map pending approval. The Lots are part of parcel #3 of Outagamie County Certified Survey Map #59, City of Kaukauna, Outagamie County, Wisconsin.
- Location of utilities where shown on the drawings are based on available records and are not guaranteed to be complete or correct The intention is to assist the contractor in making determination of exact location.
- The buildings on the site shall be staked out and footing elevations set by the concrete contractor and shall be approved by the Architect/Owner before excavation is begun.
- Soil borings, samples, and testing was not done. Soil bearing capactiy is assumed at 3000 PSF sandy clay silt per Ind. 53.12, Table 53-II. The contractor shall notify the Architect immediately if soils other than those indicated are encountered.
- The electrical, telephone, gas and cable television services shall be by the utilities company's supplying service.

2A. EXCAVATION

- This contractor shall strip the site of top soil if any and stockpile for finish grading.
- Excavate to grade lines, for footing, & basement floor slab as shown on the drawings. Stockpile at site material needed for back filling, & rough grading. Footings shall bear on undisturbed soil. Backfill with 6" compacted gravel under slabs and excavated earth on exterior, compact uniformly. Excess excavated material shall be hauled to a site as directed by Owner within 2 mile radius. Coordinate badkfilling with concrete contractor for placement of perimeter insulation.
- The site was formerly a railroad yard. The approximate location of former buildings is shown on the site plan. It is believed that building foundations and slabs remain buried at the site. The Excavation contractor in preparing his bid shall determine to his own satisfaction the extent and type of materials to be excavated.
- After backfillings, rough grade site to obtain gradual slope from building to property lines, drives, walks etc. and spread top soil if any, over areas to be lawn.
- Cutting, & grading of the parking area shall be by the asphalt contractor. Trenching for utilites shall be by the utility contractor.

2B. ASPHALT PAVING

- Asphalt contractor is to excavate and haul away materials for the parking area and drive where shown on the drawings. Provide 8" compacted subbase material of crushed limestone. Provide asphalt concrete paving of 2" thickness. This contractor is to layout work, to provide drainage to the catch basin shown. This contractor is to meet with the utilitiy contactor, architect, and concrete contractor to determine and set grade and elevations if required. Include parking striping as shown on the site plan.

2C. UTILITES

- This contractor is to furnish labor and material to install the sanitary laterals, water service, catch basin, & storm sewer system as shown on the site plan. This contractor is to include in his bid all licenses, permits, and fees necessary to perform work ready for final connection to building by others.
- All work shall conform to state and local codes, and shall meet the requirements of the utility and/or municipality providing the service.
- All materials shall be approved and new. The water service shall be type "K" copper. The sanitary & storm laterals shall be Schedule 30 ABS or PVC. The catch basin shall be 36" diameter by 4'-0" deep, concrete pipe. The rim and grate shall be Neenah Foundry #R-2501; or equal.

DRAWN BY T.G. & S.K.

APPROVED BY FB

REVISIONS

BY	DATE
FB	5-3-83
T.G.	7-8-83

BIRSCHBACH & ASSOCIATES, LTD.
ARCHITECTURE
1801 CROOKS AVENUE
P.O. BOX 328, KAUKAUNA, WISCONSIN 54130
414-766-4227

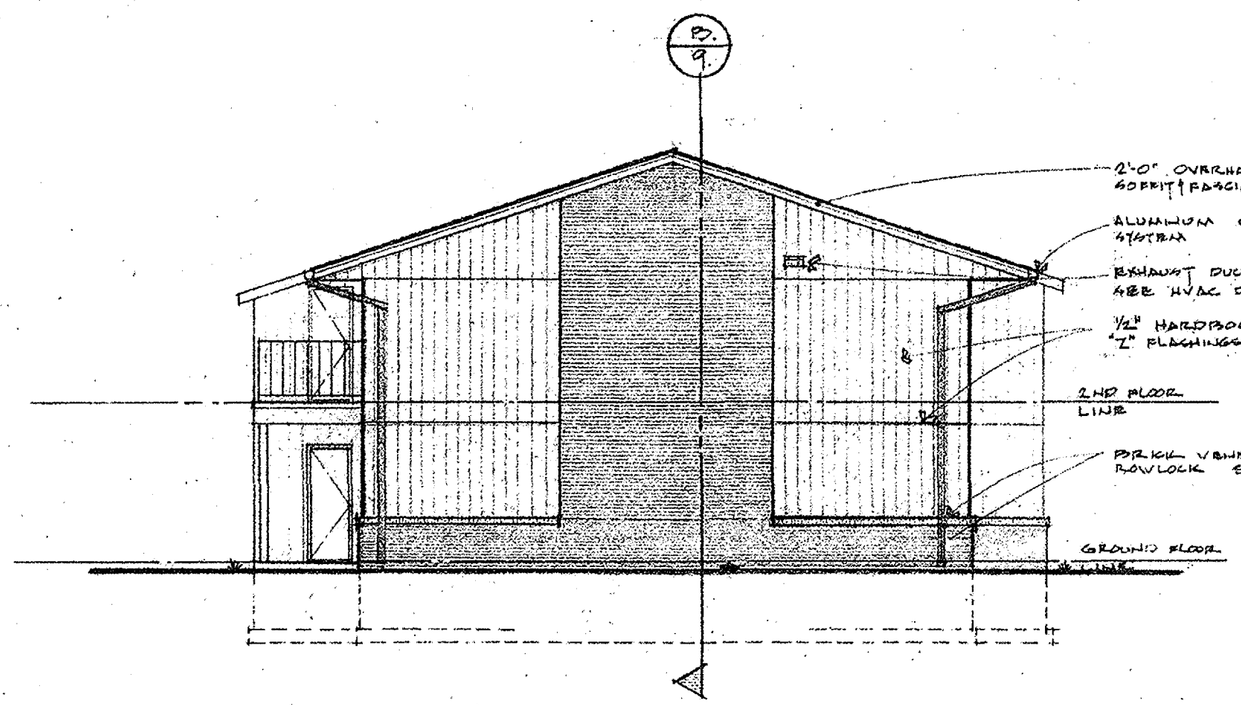
EIGHT UNIT APARTMENT / CONDOMINIUM
JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/22/83

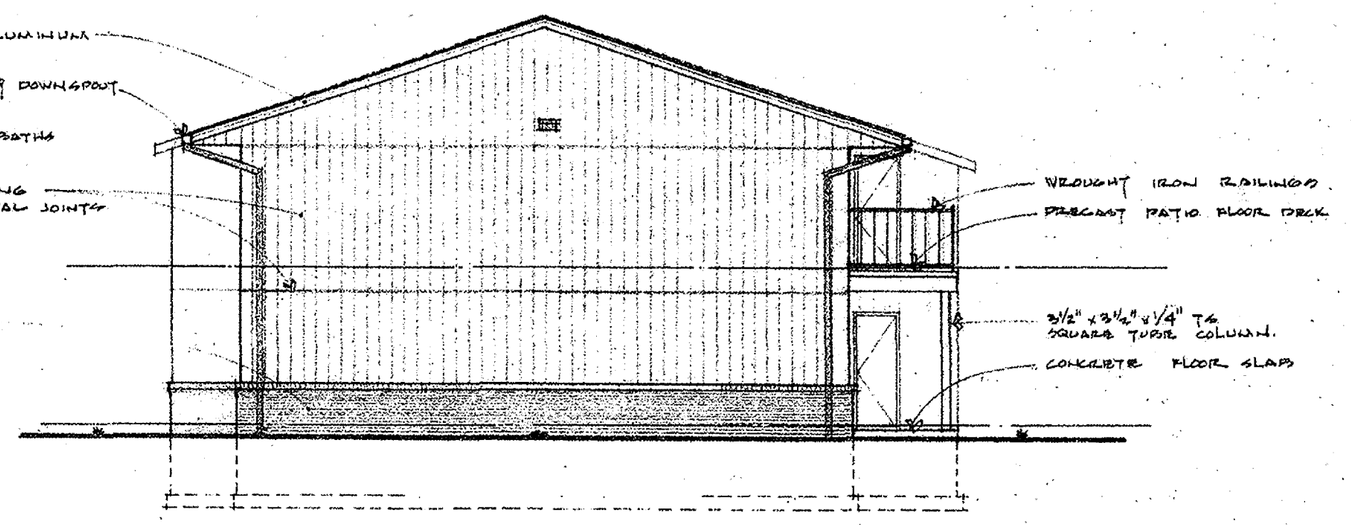
SHEET 2 OF 18.

N2869



SOUTH ELEVATION

SCALE: 1/8" = 1'-0"

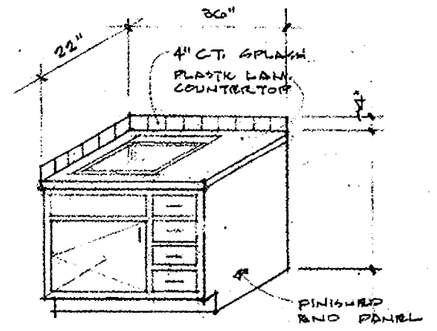


NORTH ELEVATION

SCALE: 1/8" = 1'-0"

ROOM FINISH SCHEDULE

ROOM	FLOOR	BASE	WALLS	CEILING	CEILING HEIGHT	REMARKS
LIVING ROOM	CARPET	2¼" OAK	GYP BD	GYP. BD	8'-0"	
DINING ROOM	CARPET	2¼" OAK				
KITCHEN	VINYL	COVED				
BATHROOM	VINYL	COVED				
BEDROOM 1	CARPET	2¼" OAK				
BEDROOM 2	CARPET	2¼" OAK	⇩	⇩	⇩	
STORAGE UNIT	CONCRETE	BLANDEX	BLANDEX	EXPOSED	VARIES	PLYWOOD FLOOR 2ND FLR.
WASHER/DRYER/UTILITY	VINYL	VINYL COV.	GYPSUM BD	GYPSUM BD	8'-0"	
UTILITY RM. & STOR. WATER SOFTNER	CONCRETE	BLANDEX	BLANDEX	BLANDEX	VARIES	



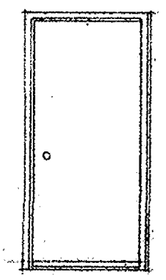
BATHROOM VANITY

SCALE: 3/8" = 1'-0"

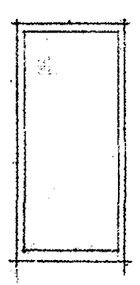
WINDOW SCHEDULE

ROOM NAME	SQ.FT. AREA	WINDOW No.	% REQ'D. AREA (MIN. 8% s.f.)	ACTUAL AREA	REQ'D VENT 4.0%	ACTUAL VENT
LIVING RM.	246. s.f.	PSII 6	19.68 s.f.	31.90	9.84 s.f.	16.3
DINING RM	54. s.f.	—	4.32	—	2.16	—
KITCHEN	90. s.f.	KCX13	7.2	5.05	3.60	5.70
BATH	40. s.f.	—	3.2	—	1.60	—
BEDROOM 1	127. s.f.	KCW24	10.16	10.60	5.08	12.16
BEDROOM 2	134. s.f.	KCW24	12.32	10.60	6.16	12.16
TOTALS	911. s.f.	——	56.88 s.f.	58.15	28.44 s.f.	46.32

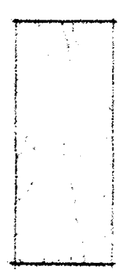
ACTUAL SQUARE FOOT AREAS ARE BASED ON DATA FOR KOLBE & KOLBE WINDOWS AND ANDERSON PATIO DOORS. WINDOWS USED MUST MEET THESE MINIMUM REQUIREMENTS.



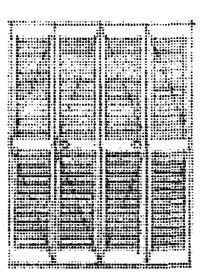
TYPE "A"
- PEASE "EVER-STRAIT"
- MODEL E-1 3'-0" x 6'-8"
- WOOD FRAME
- DOOR SWING - IN
- SWING OUT @ UTILITY



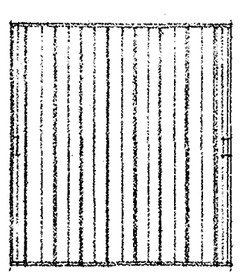
TYPE "B"
- ALUM. STORM/SCREEN
- ALUM. FRAME



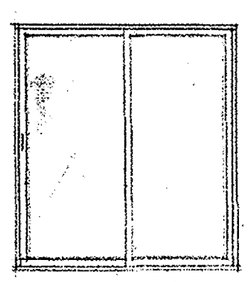
TYPE "C"
- HOLLOW - CORE
- — x 6'-8" x 1⅜"
- LUAN MAHOGANY
- ALT. PREFINISHED LEGACY
- SIZE PER PLAN



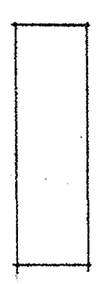
TYPE "D"
- SLIMFOLD MFG. CO.
- "THE LOUVER II" IN NAVAJO WHITE
- SIZE PER PLAN x 6/8



TYPE "E"
- FOLDING CURTAIN
- 6'-4" x 6'-8" OPNG.
- SINGLE DIVIDER
- WOODFOLD SERIES 140H



TYPE "F"
- ANDERSEN #PSII 6
- 6/0 x 6/8
- HOLE SCREEN
- INSULATING TEMPERED GLASS
- SLIDING PER ELEV.



TYPE "G"
- 1¾" x 2'0 x 6/8
- H.M. W/ KD FRAME
- PRE FINISHED ENAMEL
- FLUSH FACE 18 GA.

DRAWN BY T.G. & HB

APPROVED BY HB

REVISIONS

BY	DATE

BIRSCHBACH & ASSOCIATES, LTD.
ARCHITECTURE
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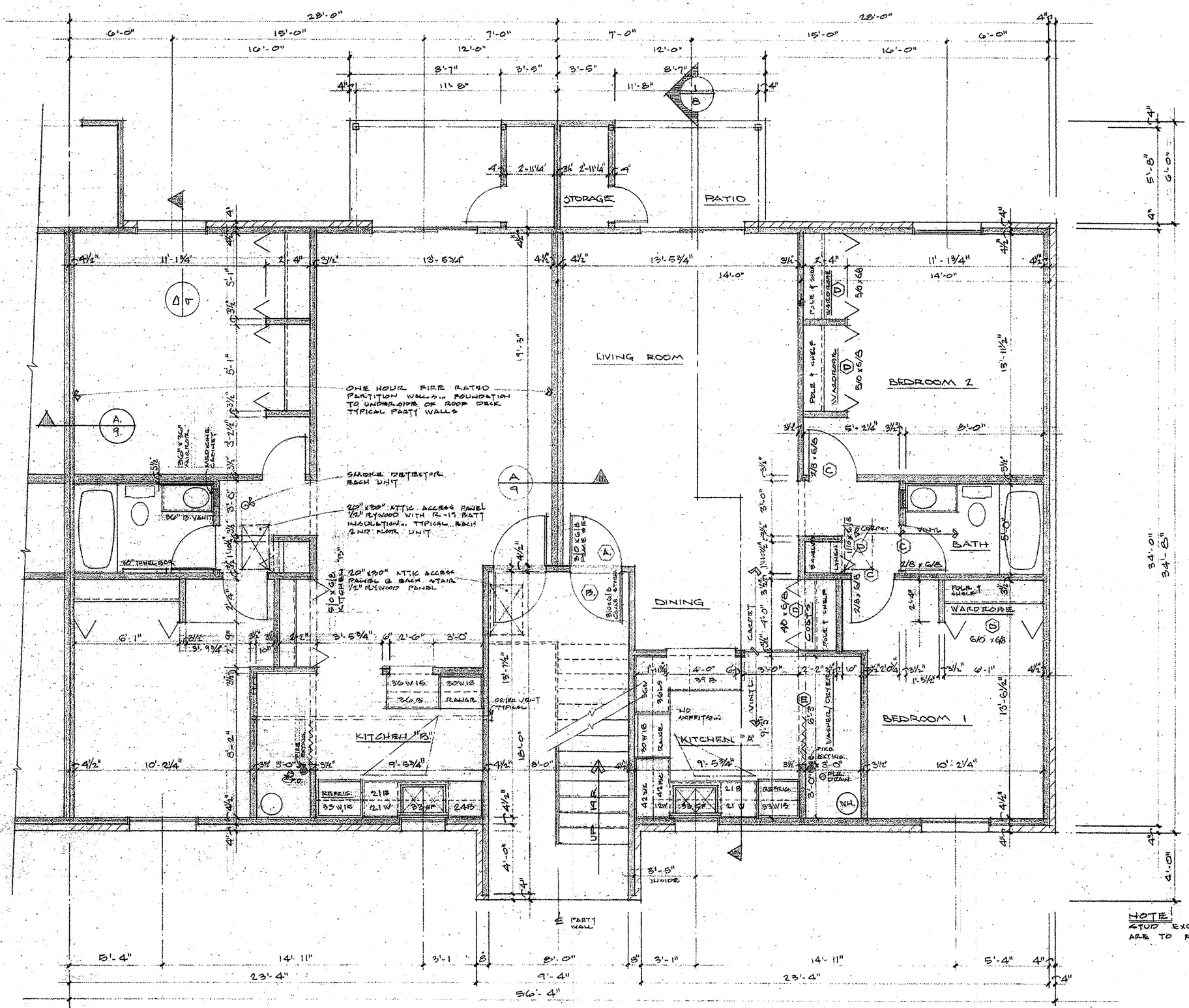
EIGHT UNIT APARTMENT / CONDOMINIUM —
JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/11/83

SHEET 4 OF 15

N2693



TYPICAL UNIT PLAN

SCALE: 1/4" = 1' - 0"

DRAWN BY T.G. & F.B.

APPROVED BY F.B.

REVISIONS

BY	DATE

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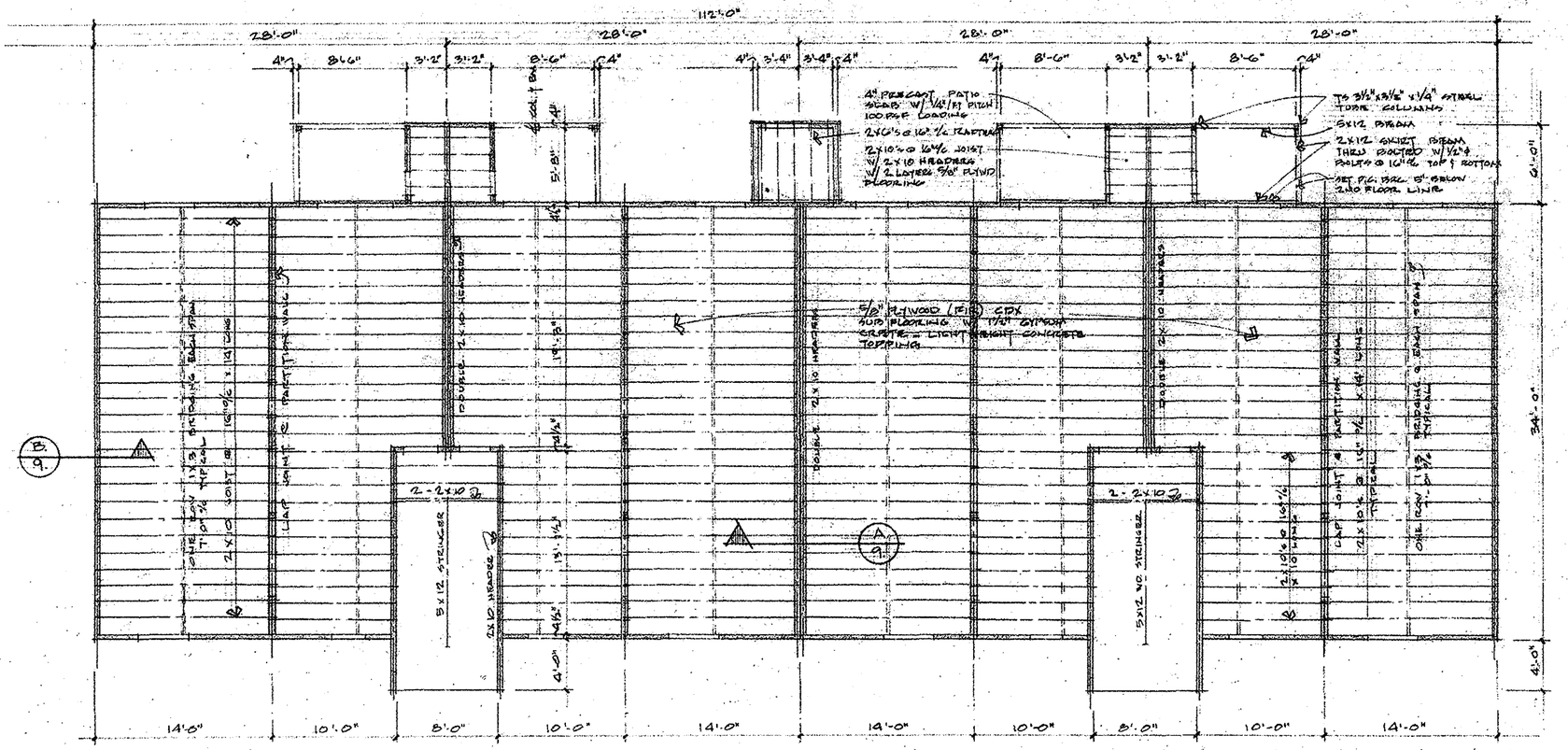
EIGHT UNIT APARTMENT / CONDOMINIUM — JACOBSON, PROMER & PROMER — KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/22/83

SHEET 5 OF 12

IN23693



NOTE!

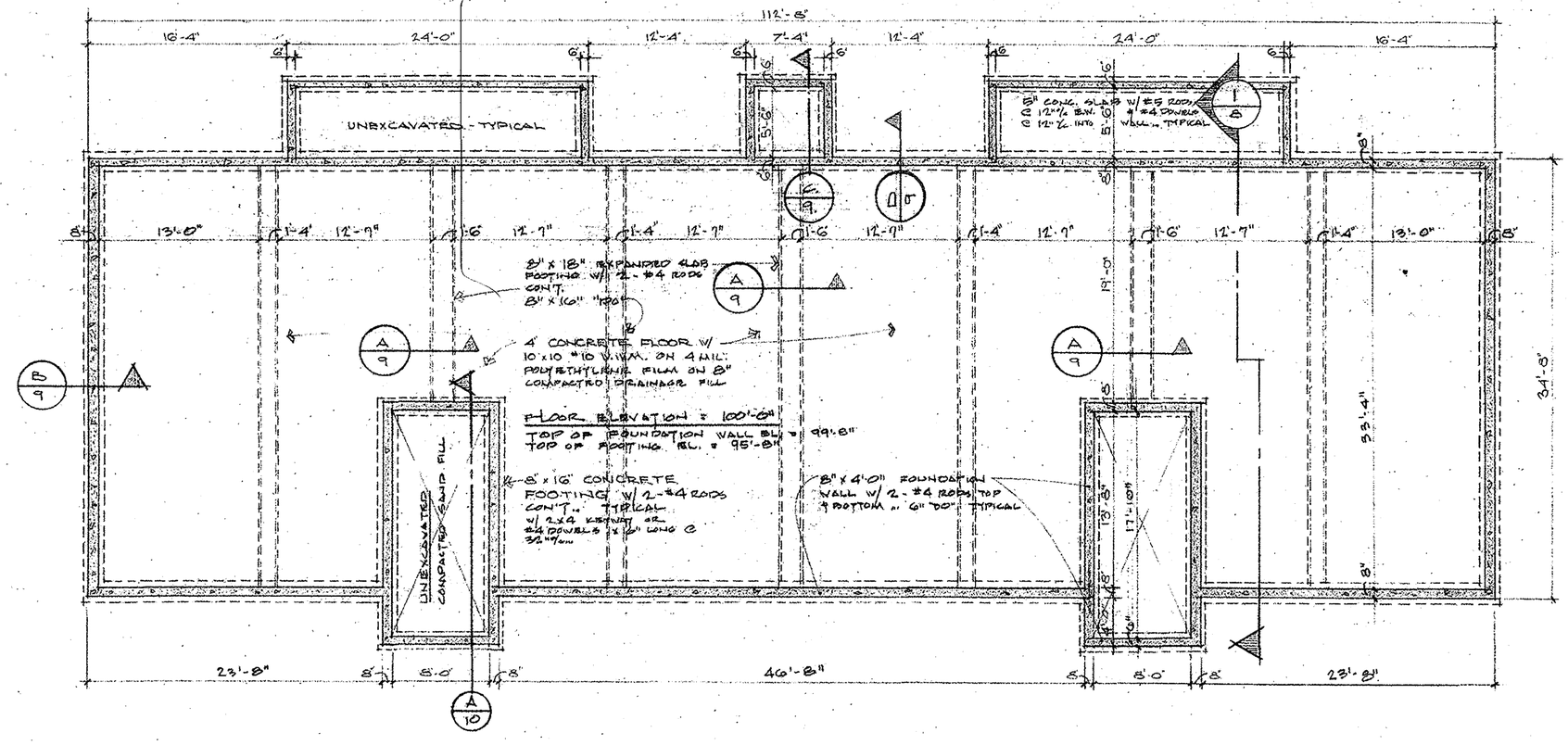
HEADERS 4'-0" TO 6'-0" USE
2 - 2X10's w/ 1/2" PLYWOOD SPACER

HEADERS 3'-0" & 4'-0" USE
2 - 2X8's w/ 1/2" PLYWOOD SPACER

HEADERS 3'-0" & LESS USE
2 - 2X6's w/ 1/2" PLYWOOD SPACER

SECOND FLOOR FRAMING PLAN

SCALE: 1/8" = 1'-0"



FOUNDATION PLAN

SCALE: 1/8" = 1'-0"

DRAWN BY TG & AB

APPROVED BY AB

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EIGHT UNIT APARTMENT / CONDOMINIUM —
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DATE 4/12/89

SHEET 6 of 18

N23693

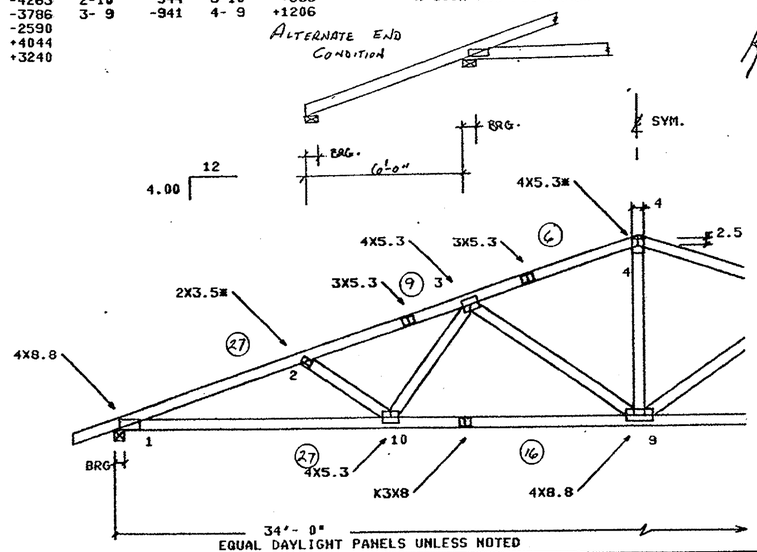
14650 K-05 | 34'- 0" SPAN T64 4/12 | ENGR KJV CHK | JUN 16, 1983 CODE TPI 78

TOP CHORD LIVE LOAD	30.0 PSF	TOP CHORD 2X4	SPR P.F. MSR 1800F-1.6E
TOP CHORD DEAD LOAD	10.0 PSF	BOT CHORD 2X4	SPR P.F. MSR 1800F-1.6E
BOT CHORD DEAD LOAD	10.0 PSF	WEBS 2X4	SPRUCE PINE FIR #3
TOTAL UNIFORM LOAD	50.0 PSF		
TRUSS SPACING 2.00 FT CTRS		LOAD DURATION ADJUSTMENT	5%

REACTION AT 1 = 1671 MIN BRG= 3.50 IN

MEMBER	FORCE	MEMBER	FORCE	MEMBER	FORCE
1- 2	-4263	2-10	-544	3-10	+586
2- 3	-3786	3- 9	-941	4- 9	+1206
3- 4	-2590				
1-10	+4044				
10- 9	+3240				

LM PLATE SERIES:
T 20GA 230 PSI GROSS
K 16GA 200 PSI GROSS



WISCONSIN PROFESSIONAL ENGINEER — KARL L. BICKEL E-14476 ST. LOUIS MO.

LUMBERMATE D.I.L.H.R. APPROVAL NUMBER 810906.

(XX) DENOTES THE NUMBER OF EFFECTIVE SQUARE INCHES REQUIRED AT THE END OF EACH MEMBER.

SECOND PLATE DIMENSION TO BE PARALLEL TO CHORDS UNLESS NOTED. (*)

SPLICES SHALL BE 1/4 PANEL ± 1'-0" UNLESS NOTED.

LUMBERMATE COMPANY
SAINT LOUIS, MISSOURI

THIS DESIGN SUGGESTION IS INTENDED FOR USE BY THE BUILDING ARCHITECT AND ENGINEER IN PREPARATION OF THEIR FINAL DESIGNS. NO RESPONSIBILITY IS ASSUMED FOR THE ERECTION, BRACING, AND ASSEMBLY TO THE COMPLETE STRUCTURE. DESIGN BASED ON CRITERIA ESTABLISHED BY THE TRUSS PLATE INSTITUTE AND "NDS" BY THE NATIONAL FOREST PRODUCTS ASSOCIATION. CUT MEMBERS TO BEAR. LATERALLY SUPPORT CHORDS. LUMBERMATE TRUSS PLATES OF GALVANIZED STEEL ARE INDICATED BY GAGE AND SIZE. PRESS PLATES SECURELY ON BOTH SIDES OF JOINTS. CENTER PLATES ON JOINTS UNLESS NOTED.

& SPECIFICATIONS - Continued from Sheet 11.

PECIALTIES

Provide a shower rod, bathroom towel bar (30") and paper holder in polished chrome finish.
Fire extinguishers shall be "Kidde" model #6TPS: 2A-40BC, 6lb./gal. extinguishers, or approved equal. Provide unit with surface wall mount.
Smoke detectors shall be provided where shown on the electrical plan sheets E-2. Detectors shall be ionization unit, with test button, solid state, white polymer housing, powered by 9-volt alkaline battery, similar to First-Alert, Sears, or equal. (12 req'd. thus).
Wrought iron railings shall be similar to "Logan Co." commerical railing, meeting Wisconsin D.I.L.H.R. code requirements. Railings shall be 42: high, with balusters at 9" and o/c, and able to support a 200 lb. load at any point. Provide all accessories required for complete installation; furnish prefinished in flat black. Submit shop drawings to the office of the Architect for approval.
Appliances by Owner: Ranges (8), Refrigerators (8), Ductless Rangehoods (8), Washers (2), and Dryers (2).

EATING, VENTILATING, and AIR CONDITIONING

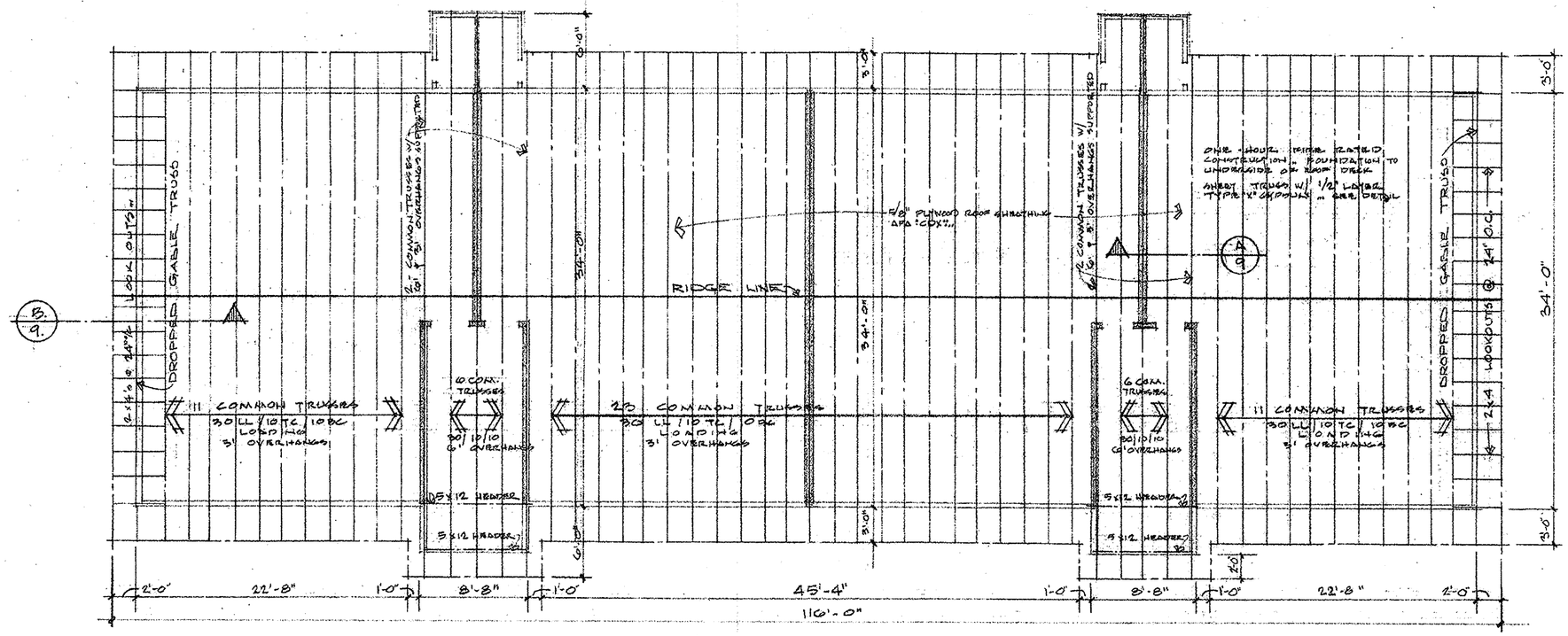
Heating, Ventilating, and Air Conditioning work shall be as shown on the H & V plans sheet HV 1 & 2.

LUMBING

Plumbing work shall consist of a complete and operable plumbing system as shown on Plumbing plans, P-1 & P-2. Utility site work shown on sheet 2 shall be a separate contract. Submit bid separately.

ECTRICAL

lectrical work shall be as specified and shown on the Electrical plans sheet E-1, & E-2, & E-3.



ROOF FRAMING PLAN
SCALE: 1/8" = 1'-0"

NOTE!
LINTEL & HEADER NOTE SAME AS SHEET 6.

DRAWN BY TG. & AS
APPROVED BY KR
REVISIONS

BY	DATE

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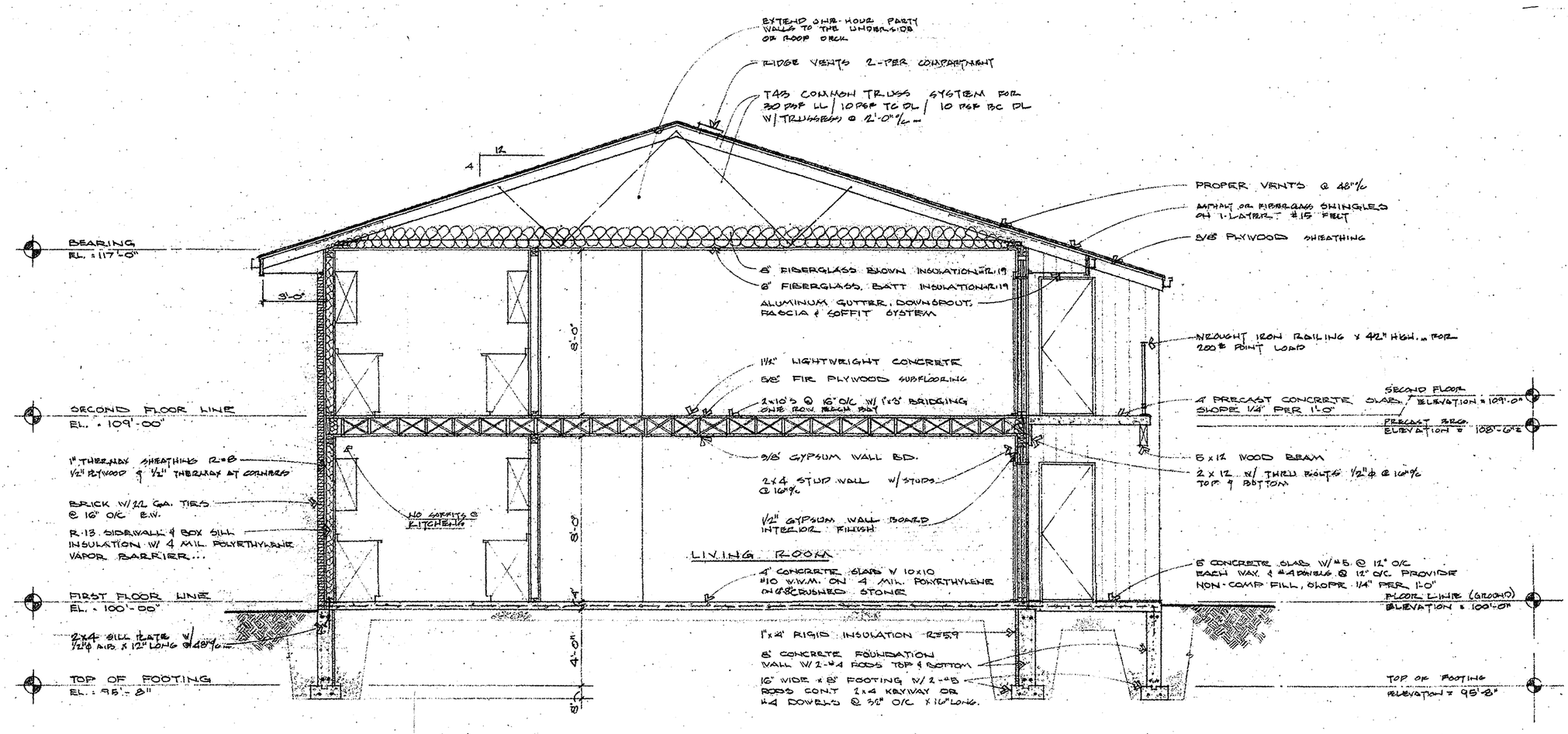
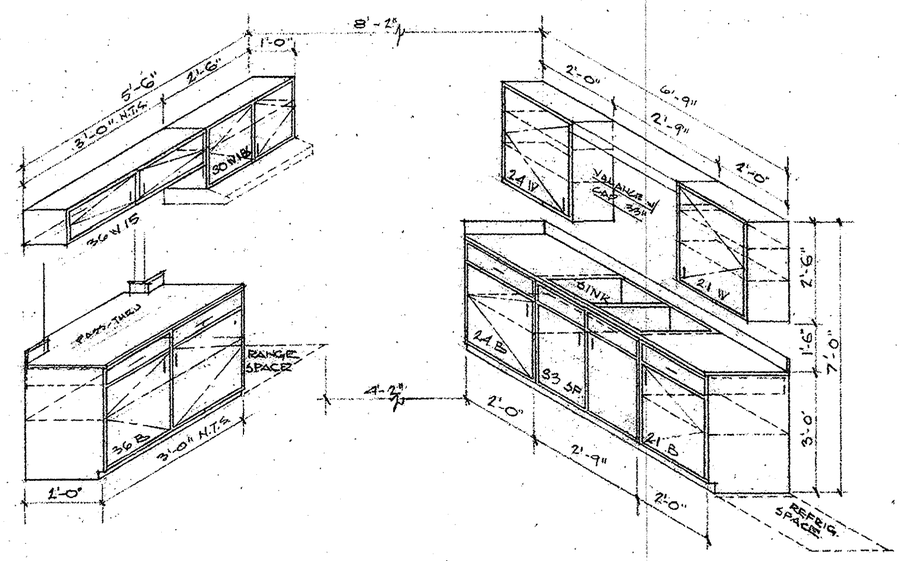
EIGHT UNIT APARTMENT/CONDOMINIUM — JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317
DATE 4/22/83
SHEET 7 OF 18

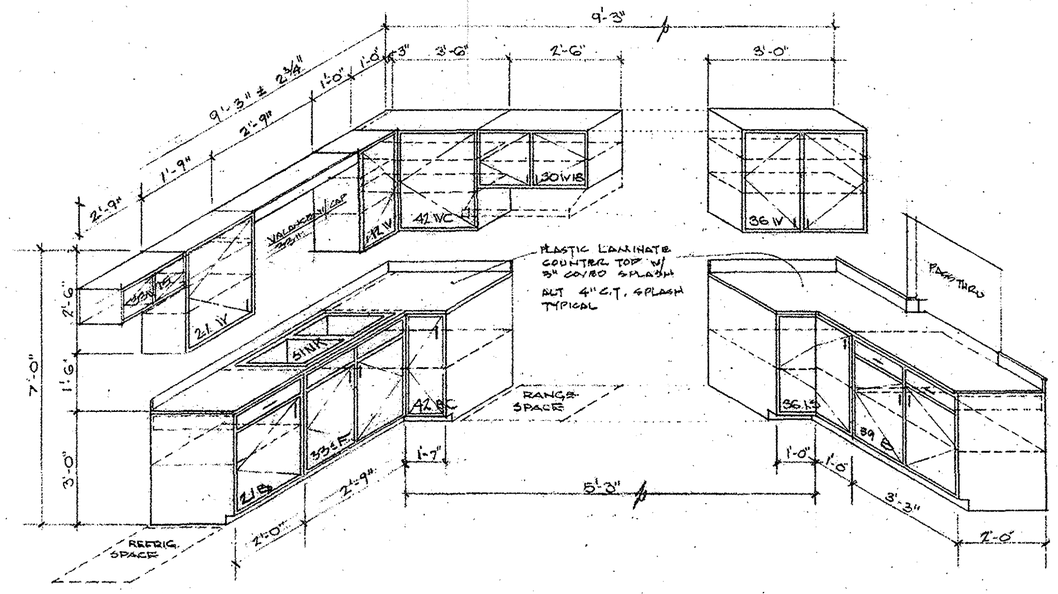
N23/83



1/8 CROSS SECTION
SCALE: 1/4" = 1'-0"



KITCHEN "B" CABINET ISOMETRIC
SCALE: 3/8" = 1'-0"



KITCHEN "A" CABINET ISOMETRIC
SCALE: 3/8" = 1'-0"

DRAWN BY T.G.

APPROVED BY FB

REVISIONS

BY	DATE
TG.	7-7-83

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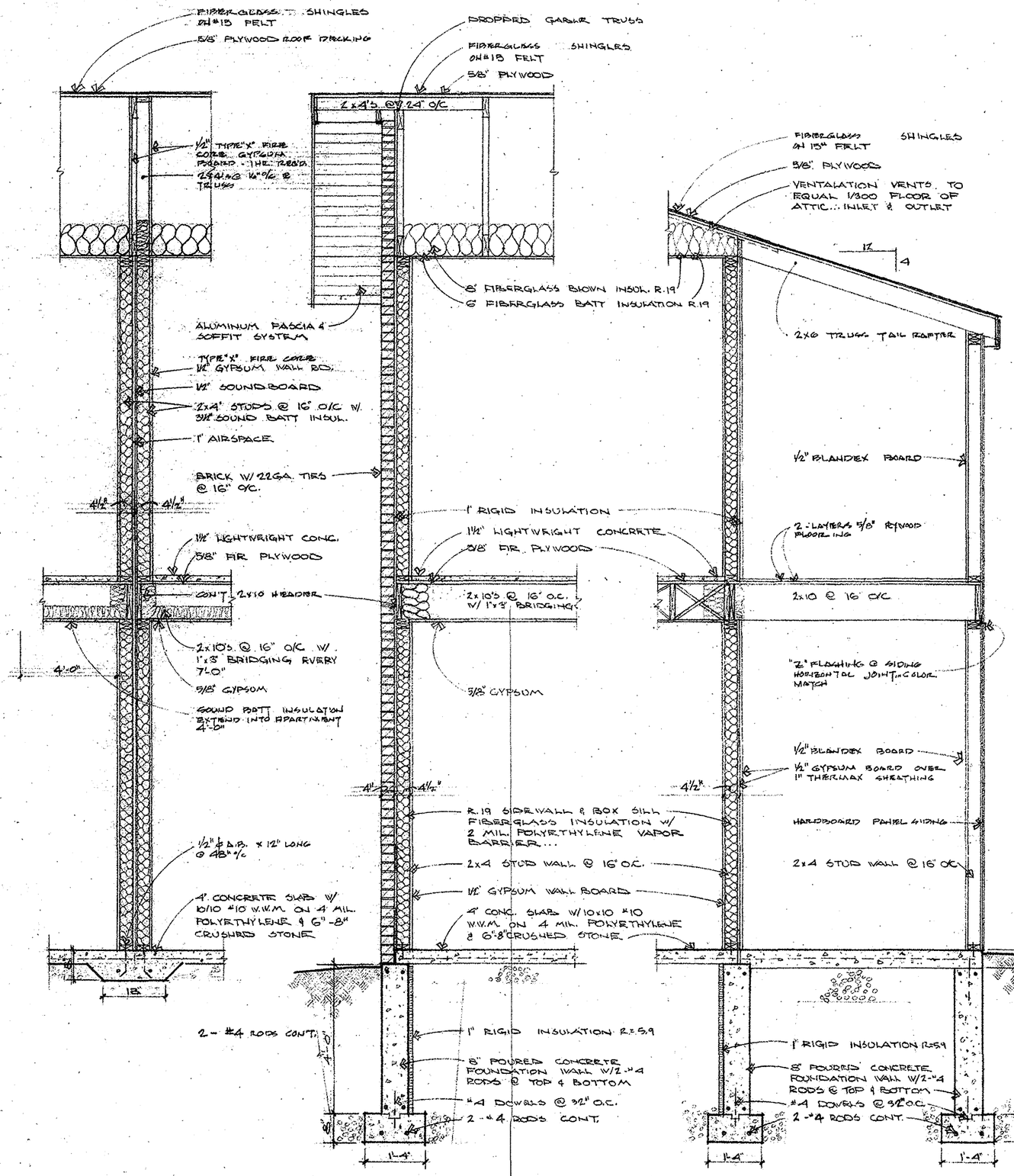
EIGHT UNIT APARTMENT / CONDOMINIUM — JACOBSON, PROMER PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/22/83

SHEET 8 OF 18.



A/9 WALL SECTION
SCALE: 1/2" = 1'-0"

B/9 WALL SECTION
SCALE: 1/2" = 1'-0"

C/9 WALL SECTION
SCALE: 1/2" = 1'-0"

D/9 WALL SECTION
SCALE: 1/2" = 1'-0"

DRAWN BY: T.G.

APPROVED BY: HB

REVISIONS

BY	DATE
T.G.	7-7-83

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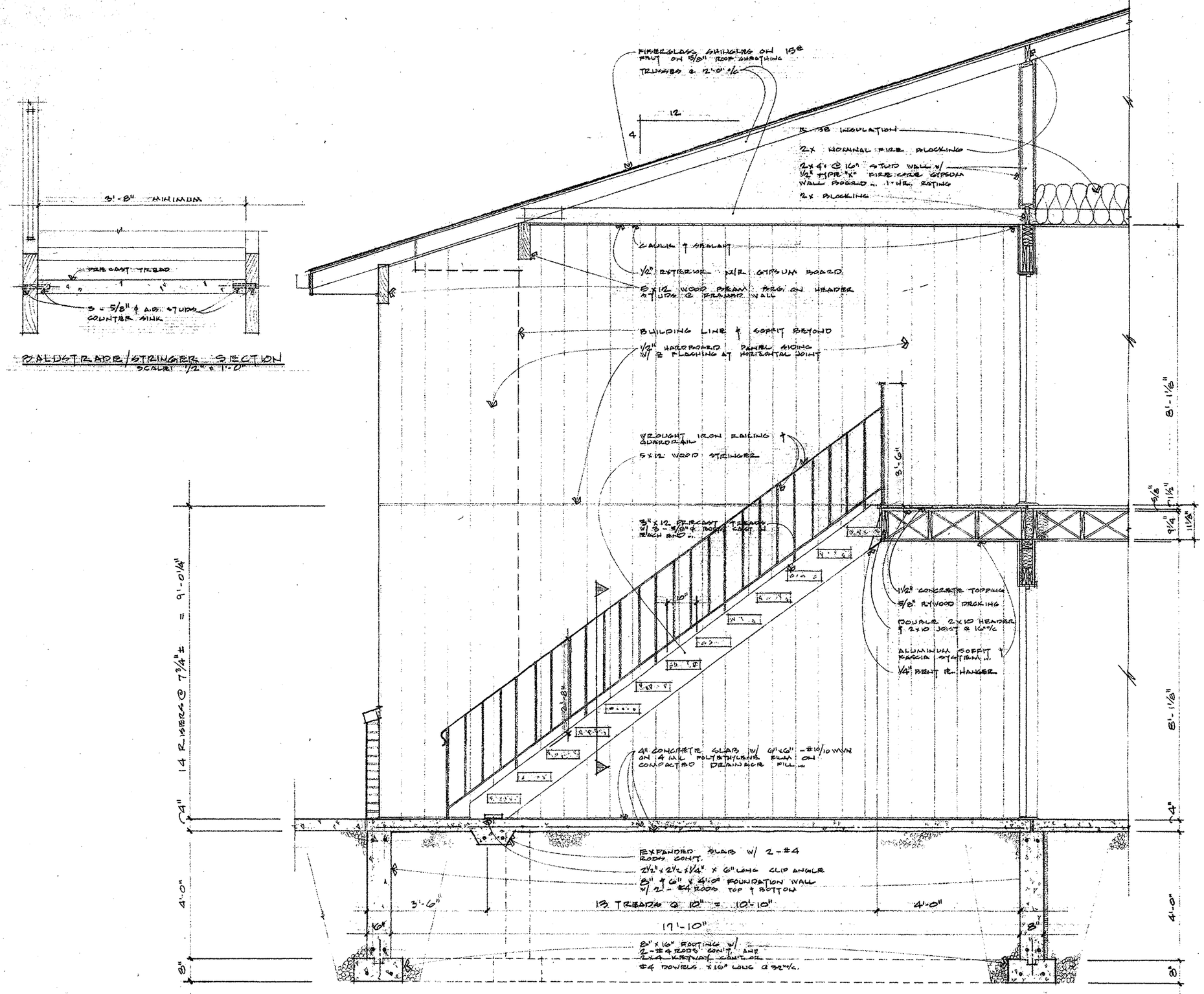
EIGHT UNIT APARTMENT / CONDOMINIUM — JACOBSON, PROMER & PROMER — KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/12/83

SHEET 9 OF 18

N23693



BALUSTRADE/STRINGER SECTION
SCALE: 1/2" = 1'-0"

A/10 STAIR SECTION
SCALE: 1/2" = 1'-0"

DRAWN BY S.K. & AB

APPROVED BY AB

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ARCHITECTURE
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KAUKAUNA, WISCONSIN 54130
414-766-4227

EIGHT UNIT APARTMENT/CONDOMINIUM BUILDING —
JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/22/83

SHEET 10 of 18

GENERAL NOTES & SPECIFICATIONS

1. GENERAL CONDITIONS

- o The Contractors are to furnish materials and labor to execute the work as shown on the drawings. Division of work shall be by separate contracts as requested by the Owner, or his representative.
- o All work shall be in compliance with all codes and laws which govern for location of the building site.
- o Reference to materials or systems herein by name, make or catalog number is intended to establish a standard of quality, and not to limit competition; and the words "or approved equal" are implied following each brand name.
- o Workmanship shall be of the best quality. Inasmuch as the specifications hereinafter are of a brief nature, it is the intent that each contractor provide workmanship that is neat, secure, with the best possible appearance and utility. The Architect will be judge of installed work, and may reject work which does not meet the standards established hereby. Such rejected work shall be repaired or replaced to the satisfaction of the Architect, without cost to the Owner.
- o All Contractors are responsible for the removal of their own refuse from the premises. Final cleaning and washing of glass is by the Owner.
- o Temporary electrical power will be provided by the owner, under the electrical contract.
- o The coordination and scheduling of work shall be by the Owner or the Owner's Expeditor/Representative.

2. SITE WORK

- o Site work shall be as described on sheet 2.

3. CONCRETE

- o Concrete work shall include wall and column footing, foundation walls, floor slabs, stoops, private walks, and aprons as shown on the drawings. This contractor shall stake out the buildings on the site and determine footings elevations.
- o All concrete shall be ready-mixed furnished by a reputable vendor in accordance with ASTM C94. Concrete shall be 3000 psi compressive strength at 28 days; maximum aggregate size 3/4" in all concrete; maximum water/ cement ration 5:1, minimum of 6 bags of cement per cu. yd.; 6% air entrainment (+ 1%), and water shall be potable. Maximum slump for walls shall be three inches; others four inches.
- o Contractor shall be responsible for adequacy of design and construction of forms, centering, shoring, and bracing. As a minimum, the Contractor shall follow ACI Standard Recommended Practice for Concrete Formwork (ACI 347-63). Supports for forms and centering shall be sufficiently strong to carry both dead and live loads to which they will be subjected. Shoring and supports shall be adjustable to permit tightening, bracing, leveling, and cambering as required.
- o Reinforcing steel shall conform to ASTM A615-40 fy = 40000 PSI. Reinforcing shall be suitably branded with rolled - in marks to visually establish the grade and size. Welded wire fabric reinforcement shall be electric welded, steel wire fabric conforming to ASTM A285, 6"x6" - #10/10. All reinforcing material shall be uncoated, unpainted, free from rust, scale, and dirt; and shall be placed in conformance with CRSI "Recommended Practice for Placing Bars", latest edition.
- o When the mean daily temperature of the atmosphere is less than 40°F., the temperature of the concrete shall be maintained between 50 and 70°F. for the required curing period. When necessary, arragnements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature and moisture conditions without injury due to concentration of heat. Cold weather requirements shall comply with ACT-306-66.
- o Slabs shall be placed on 4 mil (.004") polyethylene plastic film. Lap joints 6" minimum. Smooth dense steel trowel finish on all interior slabs. Skip resistant broom finish on walks and stoops.
- o This contractor is to provide and install the perimemter insulation shown on the drawings. Coordinate this work with the backfilling by the excavation contractor. Perimeter insulation shall be beaded styrofoam of R=5.9; or equal extending 4' vertical. Let vertical members dry prior to backfilling: butt joints snug. Keep area between concrete and insulation free of backfill and other debris.
- o Precast concrete patio slabs and stair treads shall be as manufactured and designed by a State approved firm normally engaged in precast concrete design and manufacture. Units shall be designed to carry a superimposed loading of 100 PSF. Provide all anchors and miscellaneous hardware as shown for erection. Any State of Wisconsin D.I.L.H.R. component approval shall be by the supplier.
- o The lighweight concrete underlayment shall be as manufactured by Gyp-crete, Elastizell, or equal. This contractor shall furnish all labor and materials for installation as shown on the drawings. Application shall be by an approved applicator according to the manufacturer's printed specifications. Plywood subflooring shall be primed, and underlayment layer a minimum of 1½" thick.

4. MASONRY

- o The masonry contractor shall furnish labor and materials for the brick veneer work shown on the floor plans and building elevations.
- o Brick veneer masonry units shall be ASTM-C652 hollow clay units of modular size and laid in running bond with 3/8" joint. Color and final selection of the brick shall be made by the Architect/ Owner. Allow $280. per thousands in preparing bid.
- O Mortar shall be Type N, 1,1,6 mix of reputable vendor with ASTM C144 sand and potable water.
  Mortar color shall be added according to the requirements of BIA. Color as selected by the Architect/Owner.
  No air entraining admixtures or anti-freeze compounds may be added to the mortar.
- o Cold weather construction shall be according to B.I.A. recommendation. A copy of which is available from the office of the Architect. Provide veneer ties of 22 gage galvanized metal at 16" o/c each way; 6" long and 7/8" wide.
- o Lay brick plumb and true to lines. Lay with completely filled mortar joints. Tool joints concave. Provide weep holes in head joints in first course immediately above all flashing by placing and leaving a sash cord in joint.
- o Masonry shall be left clean, free of stains, and acceptable by the Architect and Owner. Do no use cleaning agents other than water without approval of the Architect.
- o Veneer lintels shall be ASTM A-36 angle, shop primed - L3½"x4x¼".

5. METALS

- o Metal work shall include providing and installing the miscellaneous structural steel as shown on the drawings.
- o Structural steel framing shall be of ASTM A-36 steel. Shop prime one coat of manufacturers standard rust inhibitiing primer. Provide holes, anchor bolts, bearing plates, as required for complete job. Verify exact length of beam and columns at the job site.
- o All steel work shall conform to the American Institute of Steel Construction, Code of Standard Practice.

6. CARPENTRY

- o The carpentry contract shall include all work under this division, and also supplying material and labor to install work under, Division 7 except insulation; Division 8 doors; windows and hardware; and Division 10, specialties.
- o Roof truss design and State of Wisconsin D.I.L.H.R. approval shall be the responsibility of the supplier prior to fabrication. Design for a superimposed roof load of 50 PSF. Provide shop drawings and State approved drawings.
- o Rough framing materials shall be as follows: 2x4's and 2x6's Southern Yellow Pine, or White Fir, No. 2 construction grade or better; 2x10's joint framing Douglas fir-larch #2 construction grade or better; with a moisture content not to exceed 20% and shall be kiln dried. Each piece of lumber shall bear the grade and trademark of its producer. Structural and framing lumber shall be S4S unless noted otherwise.
- o Plywood roof and wall sheathing shall be of size shown on the drawings of standard INT-APA grade "CDX" (with exterior glue) fir with ply clips if required. Plywood sheathing at all corners of ½"x½" thermax over balance of walls 1" insulating sheathing thermax foil backed, R=8.
- o Sub-flooring shall be 5/8" INT-APA grade "CDX" plywood (with exterior glue).
- o Siding shall be Prefinished Hardboard Panel Siding (PS 60 Standard) as selected by the Owner/Architect. Material shall be a minimum 7/16" thick, channel grooved (grooves 4" to 8" o.c., wood textured hardboard, 48"x96". Fasteners shall be 10d Aluminum or hot-dipped zinc-coated siding or box nails to color match materials. Install per manufacturer's printed specifications. Install so that all edges are backed by solid lumber framing or blocking, nailing at 6" intervals at panel perimeter and 12" at intermediate supports; leave 1/16" space between adjacent panels. Caulk butt joints at inside and outside corners and at trim locations; install continous color matched galvanized or aluminum "Z" flashing at horizontal panel joints.
- o Framing lumber and other rough work shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Studs shall be sized to give true surfaces receiving finish materials. Partitions shall be framed with 2x4 studs spaced 16" on centers, unless detailed otherwise. Plates of partitions resting on concrete floors shall be anchored in place with ½" bolts spaced not more than 6' apart. Studs shall be doubled at openings. Headers for openings shall be made of 2 pieces of material set on edge; depth to suit size of opening per applicable code. Corners shall be thoroughly spiked and made solid. End studs of partitions abutting concrete walls shall be securely anchored, using ½" bolts not over 4' on centers. Partitions shall be provided with blocking for trim, recessed cabinets, plumbing, and other work to be concealed. Nailing strips shall be cut-in as required for support of fixtures of all kinds.
- o Finish carpentry shall be select oak as shown on the drawings with a moisture content not less than 6% or more than 15%. In no instance shall any woodwork be stored or installed in any area unless the entire area is broom clean, closed in , and possessing a realtive humidity below 50% at 70°F. All species shall contain only minor inherent natural defects, except that defects covered by adjoining members, concealed when the stock is installed, or not visible after pigmented finishing (as stain) may be admitted. Lengths shall be in the proportion available in the species and grade specified. Trim members shall be "backed-out" when 1-5/8" wide or wider, and for application on flat surfaces. Exposed surfaces shall be machine sanded on top face surfaces only, machine run otherwise. Working defects, as torn grain, machine marks, cross sanding, tool marks, will not be permitted. Edges shall be milled straight and true, and then exposed corners shall be slightly rounded. Scribing and joining shall be done accurately and neatly, so as to produce concealed and permanently tight joints, in a uniform plane for best appearance. Unless detailed otherwise, corners shall be mitered, except the inside corners shall be scribed; horizontal running trim shall butt vertical standing trim. Joints in horizontal running trim shall be scarfed glued and nailed. Where nailing is exposed, use finishing nails, counter-sunk.
- o Miscellaneous fasteners and rough carpentry hardware where not called out on the drawings shall be of a size and spacing which will develop the full strength of the members being fastened.
- o Cabinets will be furnished by the Owner. Bid shall include installation and 3-cove plastic laminate countertops. Colors as selected by the Architect/ Owner.
- o This contractor shall provide closet shelving, rods, and stair handrails.

7A. THERMAL & MOISTURE PROTECTION - Insulation

- o Building wall insulation shall be standard fiberglass, 3½" full thick, friction fit and unfaced batt with an R=13 value as shown on the drawings. Cover with 4 mil. (.004") thick polyethylene film. Ceiling insulation shall be standard fiberglass blanket insulation with craft paper backing to be stapled between truss chords and 9" blown fiberglass cover to provide a total R=38. Apply friction fit batt insulation and blankets to fit snugly between framing members at corners, wall intersections etc., between framing members and window frames, door frames, air sleeves, mechanical piping etc., to provide a completely insulated with a 3½" and 6"x4'0 sound attenuation batt respectively as shown on the drawings -- see wall section A/9.

7B. THERMAL & MOISTURE PROTECTION - By Carpentry Contractor

- o Roofing shall be a 225 pound fiberglass shingle, Class "A" similar to Johns-Mansville "Fire-Glass III, Seal-O-Matic," or equal. Color as selected by the Architect/Owner. Submit samples for approval. Apply one layer of #15 felt underlayment over plywood sheathing, lapping 2" at horizontal and 6" at vertical joints. At eaves provide a double layer two feet into interior space. Secure to hold in place. Install Type "D" galvanized room edge and starter strip; project over edge of sheathing 3/8" to form a drip. Use fasteners of hot galvanized steel or aluminum (10½ to 12 gauge) roofing nails having heads of at least 3/8" in diameter. Use nails of sufficient length to penetrate sheathing. Seal perimeter edges of shingle with a roofing cement. Install shingles per manufacturers standard specifications for the shingles used.
- o Flashing and sheet metal shall be a 26 ga. galvanized iron of best commerical grade fabricated to the size and contour as shown on the drawings. Provide poly vinyl ethylene sheet flashing as noted on the drawings of 6 mil thickness.
- o Soffit, and fascia system shall be preformed aluminum similar to Rollex-3. Provide trim pieces and accessories for complete job. Color as selected by the Architect. Seamless gutters and downspouts shall be color matched of .032" and .024" aluminum respectively.

8. WINDOWS, DOORS, & HARDWARE

- o Materials specified herein are to be furnished by the carpentry contractor.
- o Windows are to be Kolbe & Kolbe Clad Casement as shown on the drawings #KCW24 & #KCX13 with pre-finished painted interior. Glaze with manufacturer's standard double pane insulating glass, provide insect screen and extension jambs for a (2x4) stud wall with ½" interior finish board and exterior sheathing.
- o Patio door units shall be Andersen Corporation Perma-Shield PSII 6; as shown on the drawings. Glaze with manufacturer's standard 5/8" safety insulating glass, provide insect screen and jamb extensions for 5" wall ½"x½" thermax over system.
- o Exterior doors shall be Pease "Every-Strait" models #E-1, 3'0"x6'-8". See Door Schedule, Sheet 4. Frames are to be wood. Door swings to be verified at the site by Architect before ordering. Jamb width to be 5". Provide brick moulding.
- oInterior apartment-room doors shall be 6'8"x1-3/8" width shown on the plans, hollow standard "K" core, with rotary-cut Lauan Mahogany veneers, AWI "Custom" Grade. Door jambs and casings shall be oak or oak veneer. Hardware shall be hinges, and passage or privacy locksets. (Door units may be pre-hung.)
- o Bi-fold closet doors shall be "The Louver II" full louver by Slimfold Manufacturing Company, Inc. or approved equal pre-finished 24 gauge steel folding doors. Doors shall be factory assembled and supplied with all mounting hardware. Prefinished enameled paint color shall be Navajo White.
- o Each carpentry contractor shall include in his proposal an allowance of $2,000. per building for hardware. The successful bidder shall submit a hardware schedule for approval.

9. FINISHES

- o Carpeting, sheet vinyl, and ceramic tile work shall be by the Owner.

9A. FINISHES - Gypsum Board

- o Gypsum wall board shall be ½", regular 4'-0"xlength as required. Fastener shall be power driven, type S bugle head, 1" long. Joint treatment shall be a dura bond compound and Pert-A-Type. Joint compound for embedding and topping compound for fill and finishing per gypsum board manufacturer specification.

9B. PAINTING

- o Painting and staining shall be by an established firm
- o The painting contractor shall furnish labor and materials to stain and varnish with a three coat system (stain, sealer, varnish) all exposed wood surfaces. In general, this includes doors, frames, windows, casings, handrails, baseboard, and shelving, (cabinets are prefinished). Verify with Owner other materials pre-finished and the extent of work regarding this section.
- o Paint all gypsum board surfaces, except ceilings with two coats (plus primer if required for good coverage) system of flat latex except kitchen and bathroom, which shall have final coat of semi-gloss latex. See room finish schedule. Exterior doors and frames shall be painted with two coats of exterior oil base flat enamel. Colors for all coats as selected by the architect/owner. Submit to his office a color chart from the proposed manufacturer's of materials to be used. Each container shall be labeled by manufacturer stating type of paint, color or paint, and instructions for reducing. Brush, roll, or spray on materials smoothly in solid, even colors without drops, runs, lumps, defective brushing, discoloration or clogging of lines and angles. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping. Apply per manufacturer printed recommendations.

CON'T. SHEET # 7.

N23693

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BY	DATE

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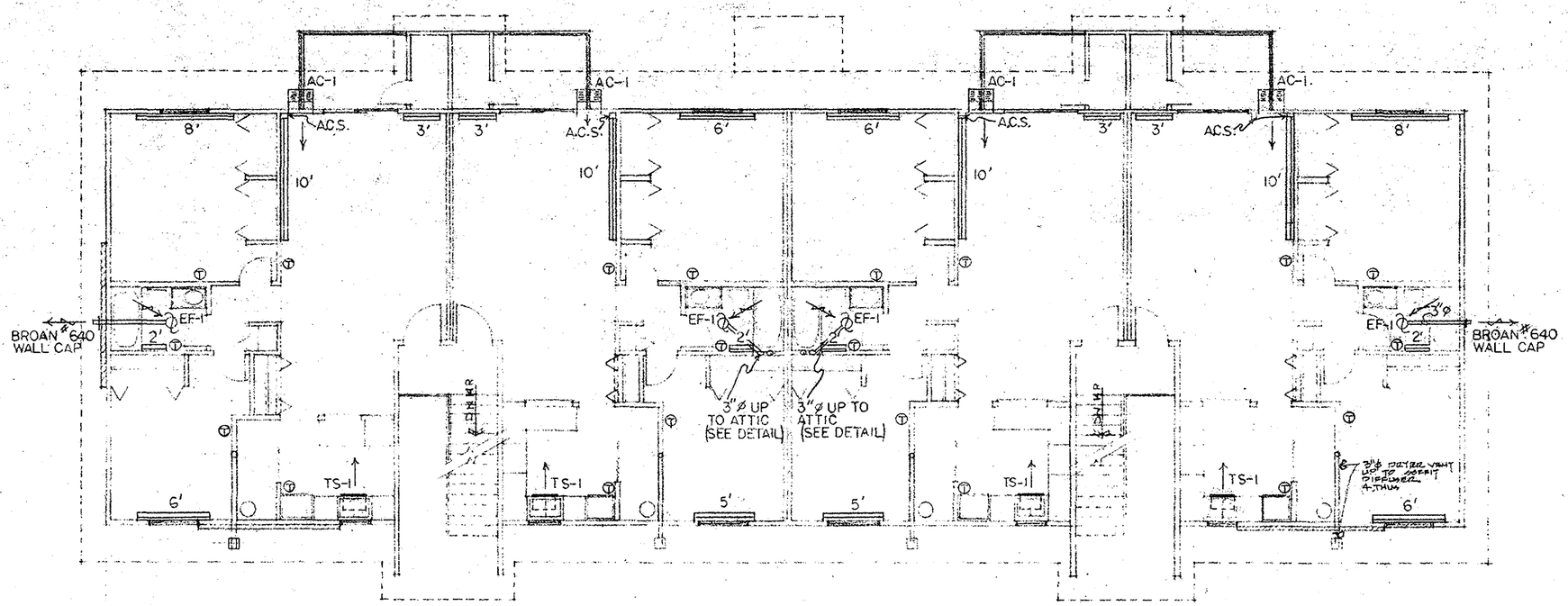
EIGHT UNIT APARTMENT/ CONDOMINIUM — JACOBSON, PROWER & PROWER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

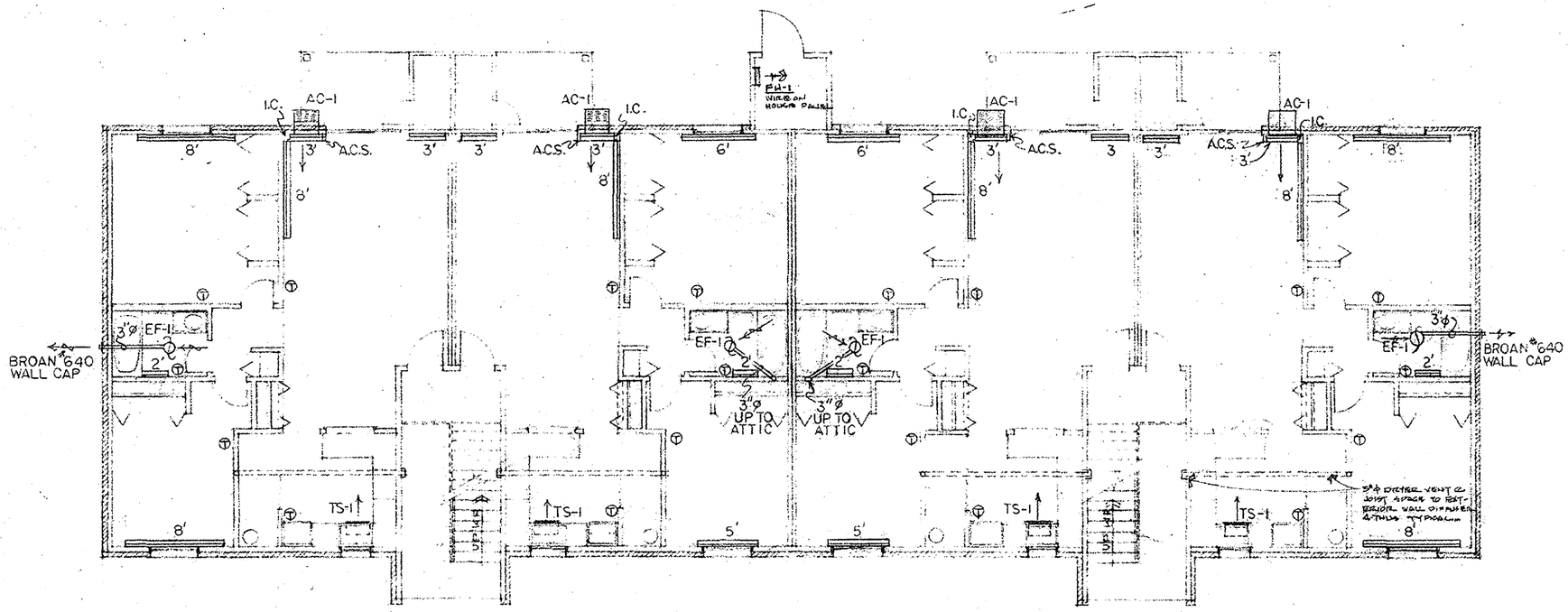
DATE 4/22/83

SHEET 11 OF 18



SECOND FLOOR PLAN — HEATING, VENTILATION, AND AIR CONDITIONING

SCALE: 1/8" = 1'-0"



GROUND FLOOR PLAN — HEATING, VENTILATION, AND AIR CONDITIONING

SCALE: 1/8" = 1'-0"

DRAWN BY: R.V. / P.A.

APPROVED BY:

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PB	6/3/83

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8 UNIT APARTMENT / CONDOMINIUM BUILDING — JACOBSON, PROMER & PROMER — KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4-22-83

SHEET HV-1 12 OF 12

ELECTRIC BASEBOARD SCHEDULE							
Unit No.	Length	BTUH	Watts	Watts/Ft.	Voltage	Amp.	Model * No.
2'	2'	1280	375	187	208/60/1	1.81	XLD-2375B
3'	3'	1911	560	187	208/60/1	2.69	XLD-3560B
5'	5'	3190	935	187	208/60/1	4.50	XLD-5935B
6'	6'	3839	1125	187	208/60/1	5.41	XLD-6112B
8'	8'	5118	1500	187	208/60/1	7.22	XLD-8150B
10'	10'	6398	1875	187	208/60/1	9.02	XLD-0187B
TS-1	-	5120	1500	-	208/60/1	7.21	AD-2450
FH-1	-	5120	1500	-	208/60/1	7.21	AO-2433 w/ AO417 & AO146

*BASED ON ARGO INDUSTRIES, INC.

AIR CONDITIONING SCHEDULE								
Unit No.	Cooling Capacity	EER	CFM	Motor RPM	Voltage	Amps	Fuse	Model* No.
AC-1	12,400	8.8	390/335	1070/850	208/60/1	7.0	15	WR-123 HE

*Based on Heat Controller Inc.

EXHAUST FAN SCHEDULE							
Unit No.	CFM	Sones	RPM	Amp.	Backdraft Damper	Voltage	Model* No.
EF-1	60	4.0	2200	.56	3" ø	115/60/1	689

*Based on Broan Mfg.

LEGEND:

A.C.S.	Air Conditioner Switch
I.C.	Inside Corner
A.C.	Air Conditioner
E.F.	Exhaust Fan
T.S.	Toe Space Heater
(T)	Thermostat
F.H.	FORCED FAN HEATER

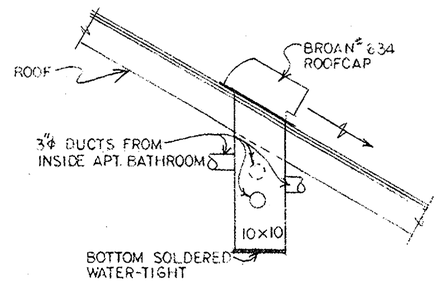
EQUIPMENT SPECIFICATIONS

Electric Baseboard

All electric baseboard heaters shall be of highest quality construction, UL rated, and be completely silent in operation. A built in wireway shall allow wiring two or more units together without additional accessories. Finish shall be neutral tan baked enamel on zinc coated heavy gauge steel. The safety cutout shall run the full length of the heating element. A typical 4' section rated at 187 watts per lineal foot must have a reflectance rating in excess of 73. Elements shall be constructed of aluminum sheath enclosing a long-life element wire encapsuled in magnesium oxide. The aluminum sheath is .600" in diameter. the aluminum fins over the sheath are 2 1/8" by 2 3/8" and there are 62 fins per active foot of element, giving a total heating surface of 316.09 square inches per foot insuring the lowest heating element temperature. Units shall have fully enclosed wireway that will accommodate 60°C or TW wire. The baseboard heater element shall be warranted against burnout in the building in which it is originally installed. The contractor shall meet the provisions of the warranty or shall be liabel for any burnout. Heaters shall be of voltage, size, density, and with accessories shown on drawings and shall be Series X as manufactured by Orbit Manufacturing, Perkasie, Pennsylvania, or approved equal.

Air Conditioner

All air conditioners shall be Power-Aire manufactured by Heat Controller Inc. of Jackson, Mich. The unit shall have a zinc clad steel cabinet with a slide out chassis, fresh air control, thermostat, 2 speed fan, and have adjustable air deflection. It shall be warranted to be free from defects in material and workmanship under normal use for a period of one year from date of installation. In addition, the refrigeration system, consisting of the compressor, evaporator, condenser, and factory connected tubing, shall be warranted for a period of 4 additional years following the standard one year warranty. The unit shall be of sizes and capacities shown on plan.



EXHAUST DUCT DETAIL

NO SCALE

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BY	DATE
PR	5-3-83

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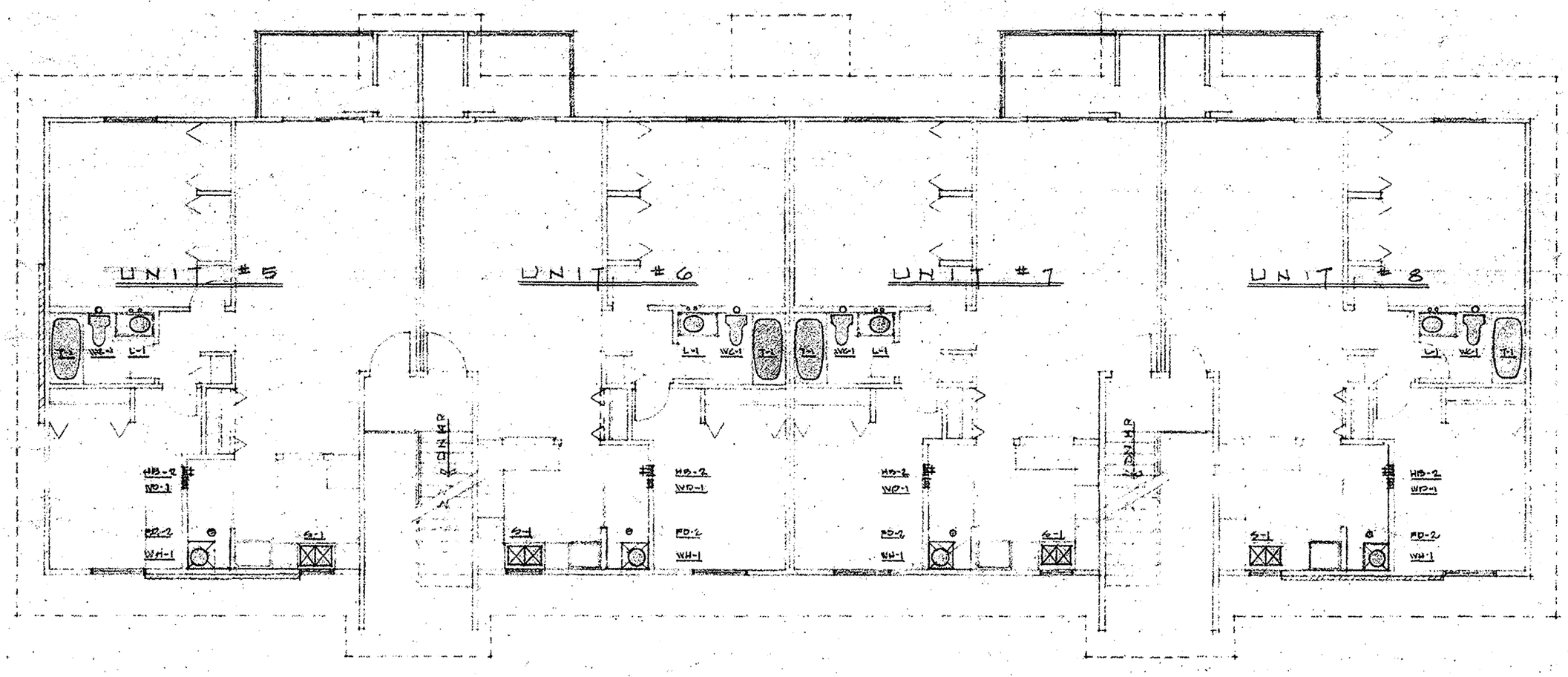
EIGHT UNIT APARTMENT/CONDOMINIUM — JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4/22/83

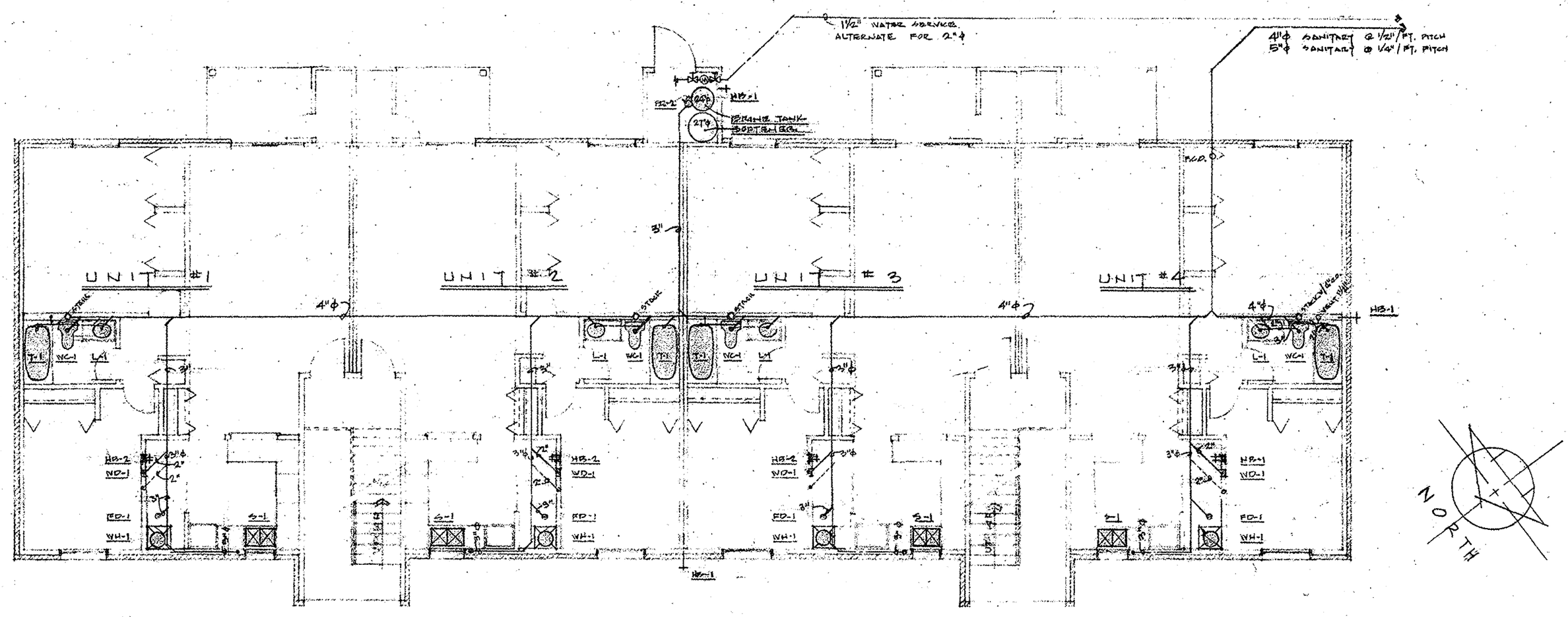
SHEET HV-2

13 OF 18



SECOND FLOOR — PLUMBING PLAN

SCALE: 1/8" = 1'-0"



GROUND FLOOR — PLUMBING PLAN

SCALE: 1/8" = 1'-0"

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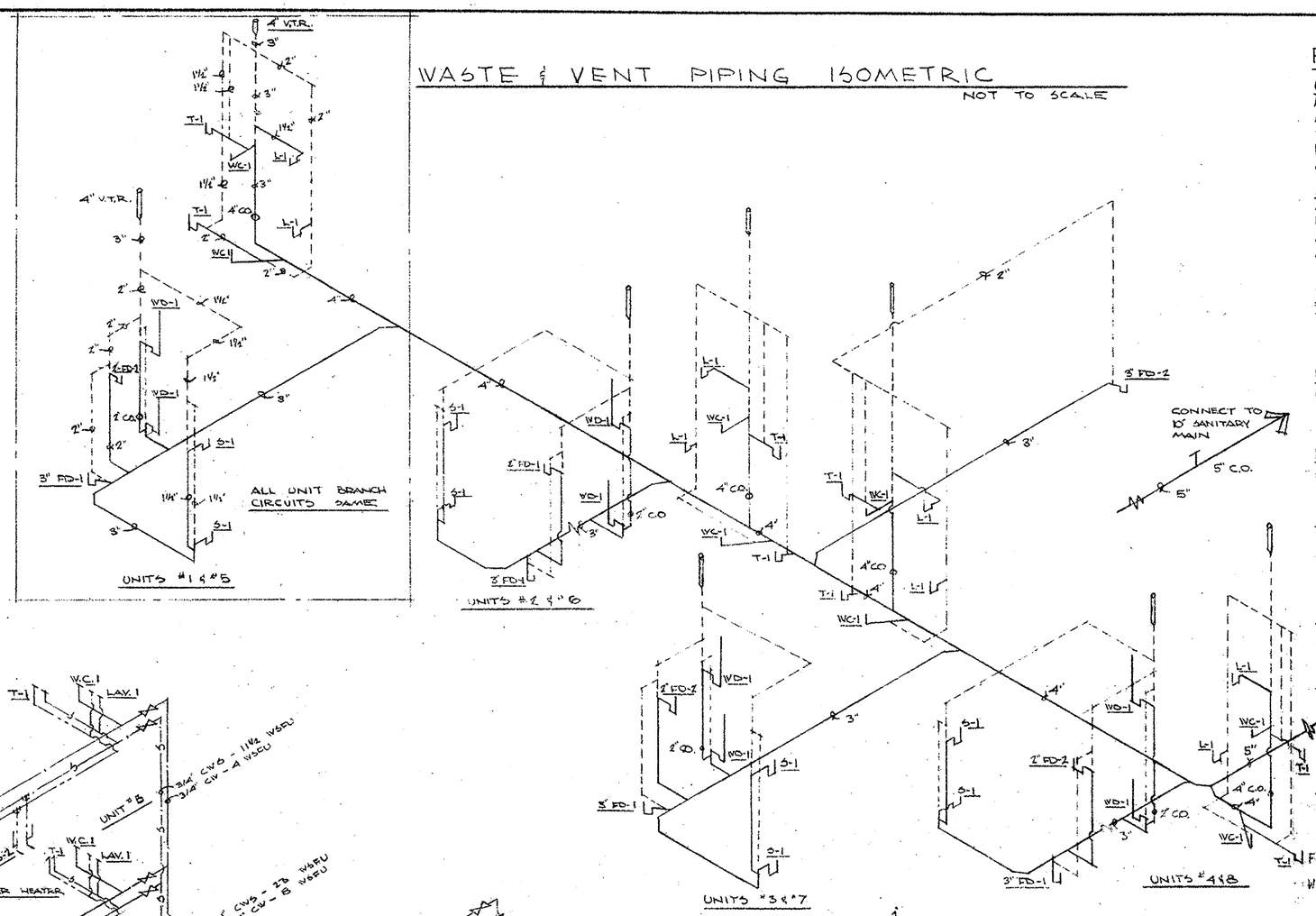
8 UNIT APARTMENT / CONDOMINIUM BUILDING —
JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

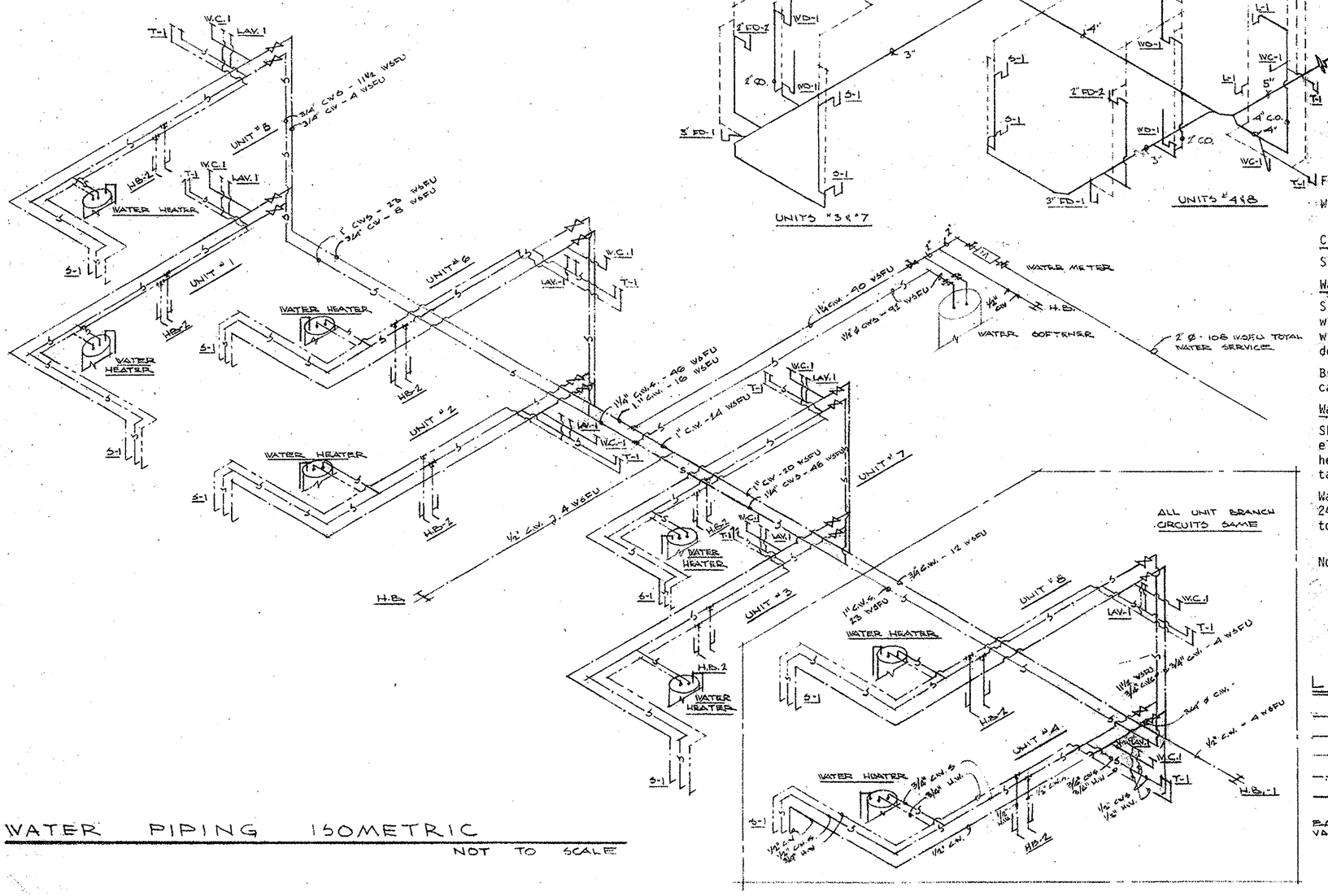
PROJECT NO. 8317

DATE 4-22-82

SHEET P-1

14 OF 18


WASTE & VENT PIPING ISOMETRIC
NOT TO SCALE


WATER PIPING ISOMETRIC
NOT TO SCALE

PLUMBING MATERIALS & SPECIFICATIONS

General
All materials shall conform to section H62.19 of the Wisconsin Administrative Code and shall be installed in accordance with the approved plans and in accordance with Chapter H62 of the Wisconsin Administrative Code. Fixtures for each apartment are to be color matched as chosen by the Owner or Architect.

Piping
All drain and vent piping shall be Schedule 40 ABS or PVC. Underground water distribution piping shall be Type "K" copper. Above ground water distribution shall be Type "L" copper. Waste and vent piping which penetrates the onephour party walls shall be metal or in a metal sleeve per code.

Tub/Shower
T-1 LASCO Industries "Model #2603-SG", fiberglass tub and shower module with Delta #636 shower/faucet, and Kohler #K-11660 TRIP WASTE, all in chrome finish; or equal.

Waterclosets
WC-1 Mansfield "Mohican #126-35", vitreous china, jet flush watersaving, regular bowl, colored, with solid plastic, colored seat w/cover; or equal.

Lavatories
L-1 Mansfield "Starlet 19" x 16" oval self-rimming, colored, vitreous china, with Delex #2522 faucet, chrome; or equal

Sinks
S-1 Dayton #D-23321-4, 33" x 21" stainless steel, 2-compartment sink, with Delex faucet #2402 w/spray for conditioned water, and Elkay faucet #LK-2085-13 gooseneck for drinking water; or equal.

Disposal
Shall be an Elkay #LKD 50, waste disposal, 1/2 hp., 120 volts, 1 phase, 7.2 amps; or equal.

Hose Bibbs
HB-1 Shall be freezeproof Woodford #14C with backflow preventers; or equal (Sillcock)
HB-2 Shall be laundry hose connections Nibco, Inc. #61; or equal.

Floor Drains
FD-1 Shall be Schier #N-104-3, 3" diameter pipe capacity; or equal.
FD-2 Shall be a 2" ABS or PVC with shower strainer.
WD-1 Shall be a 2" ABS or PVC wall drain for laundry washer drain, with open site top.

Clean Outs
Shall be 4" diameter Schier Model #106RS; or equal.

Water Conditioner / Softener
Shall be a Dick'nson Model # MGT-210-1½ water conditioning unit with 21" diameter x 62" filter with 7 cubic feet capacity tank, with 1½" diameter Hayes Automatic Reset flow meter with time delay. Tank to be fiberglass.

Brine tank shall be 24" diameter x 54" high, 900 lb. salt storage capacity of polyethylene.

Water Heaters
Shall be Rheem "Rheemglas Standard" Model #668HS-30D, 30 gal. electric unit for 208 volt, single phase, with 2-4500 watt heating elements, one year limited warranty, 5-year warranty tank.

Water heaters shall be set in a 24" x 24" square x 2" high 24 gauge galvanized iron pan with ½" diameter copper outlet to drain.

Note: See site plan for additional site work under separate contract.

Work under this contract shall extend to the building line. Final connections to utilites shall be by this contractor.

LEGEND OF SYMBOLS

- COLD WATER ... HARD (C.W.)
- COLD WATER ... SOFTENED (C.W.S.)
- HOT WATER SOFTENED (H.W.)
- VENT PIPING
- WASTE PIPING

EACH FIXTURE VALVED SEPARATELY
VALVE BRANCH CIRCUIT AS REQUIRED BY CODE.

DRAWN BY TG HB
APPROVED BY AB
REVISIONS
BY | DATE

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EIGHT UNIT APARTMENT / CONDOMINIUM
JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317
DATE 4-22-83
SHEET P-2
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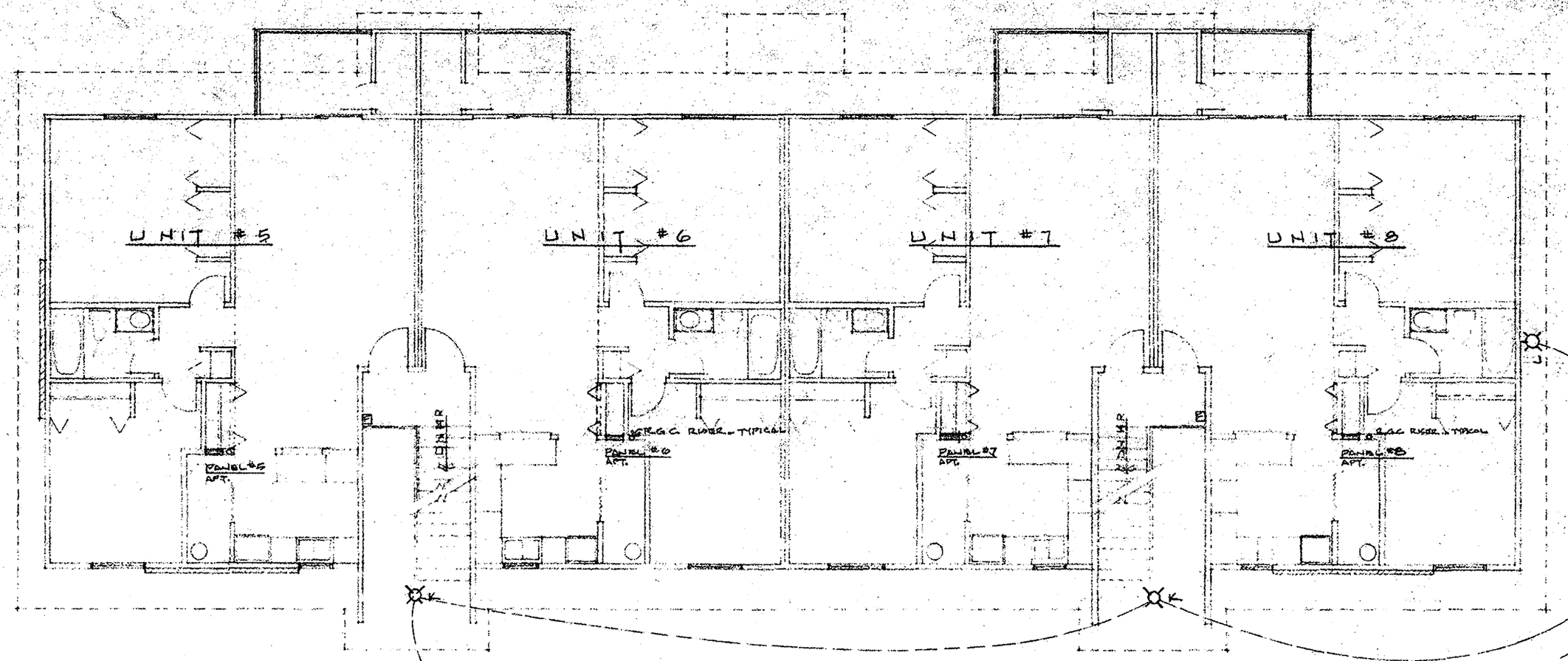
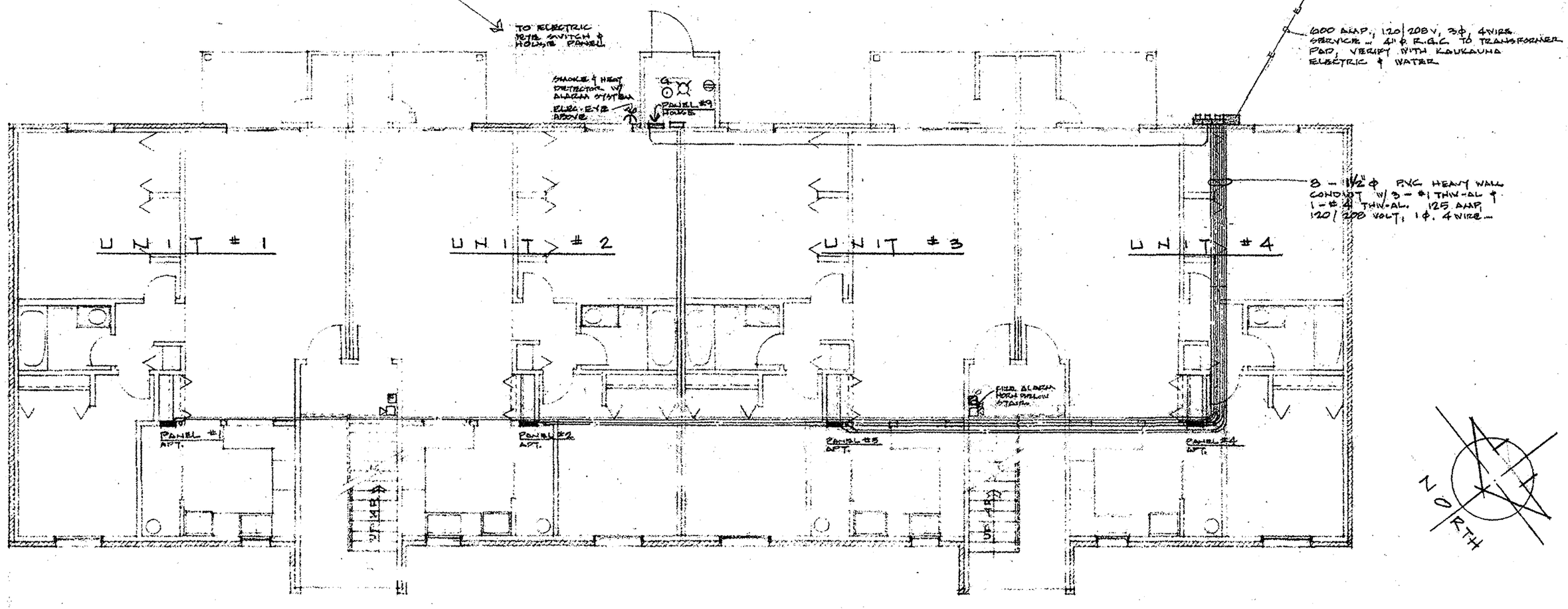


SECOND FLOOR PLAN — ELECTRICAL

SCALE: 1/8" = 1'-0"

NOTE! SEE HVAC PLANS FOR ELECTRICAL REQUIREMENTS



GROUND FLOOR PLAN — ELECTRICAL

SCALE: 1/8" = 1'-0"

DRAWN BY: FB

APPROVED BY:

REVISIONS

BY	DATE

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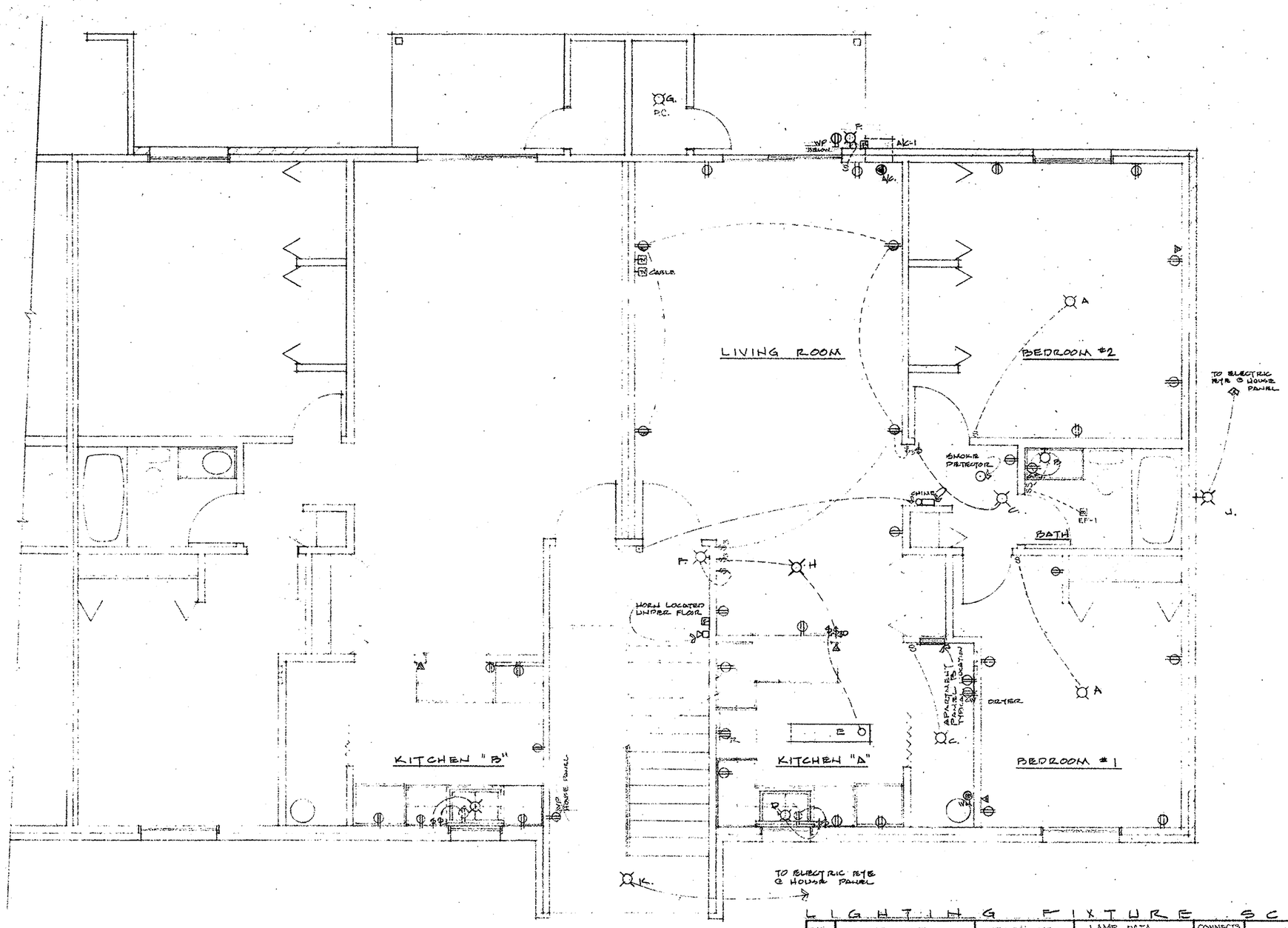
8 UNIT APARTMENT / CONDOMINIUM BUILDING — JACOBSON, PROMER & PROMER — KAUKAUNA, WISCONSIN

PROJECT NO. 8317

DATE 4-22-83

SHEET E-1

16 OF 18



UNIT FLOOR PLAN ELECTRICAL

SCALE: 1/4" = 1'-0"

NOTE! SEE HEATING PLAN FOR ELECTRICAL REQUIREMENTS

SYMBOL SCHEDULE

TYPE	DESCRIPTION	LOAD AMP	LOAD VOLT	LOAD PHASE	CIRCUIT PANEL	CIRCUIT CKT NO.	REMARKS
R	RANGE	40	208	1φ	APT.	—	CW - CLOTHES DRYER
CAB	TELEVISION CABLE						
TV	TELEVISION ANTENNA						
▲	TELEPHONE JACKS						
	SPECIAL PURPOSE OUTLET						
EF-1	BATHROOM EXHAUST	.56	120	1φ	APT.		BY HVAC CONTRACTOR
	FIRE ALARM HORN	15	120	1φ	HOUSE	—	TO FIRE ALARM
F	PULL STATION						TO FIRE ALARM
⊙	SMOKE DETECTOR						BY CARPENTER CONTRACTOR
A/C	A/C OUTLET - SPECIAL	20	208	1φ	APT.	—	WITH HEATING CIRCUIT
WH	WATER HEATER	4500W	208	1φ	APT.	—	HIGH RECOVERY
	DUPLEX OUTLET						
$ $3	SWITCHES						

LIGHTING FIXTURE SCHEDULE

TYPE	MANUFACTURER	CATALOG NO:	LAMP DATA NO:	LAMP DATA TYPE	CONNECTS WATTAGE	MOUNTING	REMARKS
A	STARLITE/THOMAS	#SL-120	2	60W	120	SURFACE	
B	STARLITE/THOMAS	#SL-286	4	75W	300	SURFACE/WALL	
C	STARLITE/THOMAS	#SL-8436-8	1	75W	75	SURFACE	OR EQUAL
D	STARLITE/THOMAS	#M-1523	2	60W	120	SURFACE	BOX IN PLYWOOD SOFFIT
E	PROGRESS	#P-7186	2	F40/WW	80	SURFACE	
F	LIGHTOLIER	#4845	1	100W	100	SURFACE/WALL	
G	PAULDING	#1625-4 P.C.	1	75W	75	SURFACE	W/ PULL CHAIN
H	STARLIGHT/THOMAS	#SL-8214-12	2	60W	120	SURFACE	
J	McPHILBEN	#22B3143JB	1	100W E23½MV	100W	SURFACE/WALL MTD.	CONNECT TO PHOTO EYE
K	KENALL	#5701	1	100W E23½MV	100W	SURFACE/CEILING MTD.	CONNECT TO PHOTO EYE

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T.G.	7-7-83

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EIGHT UNIT APARTMENT / CONDOMINIUM
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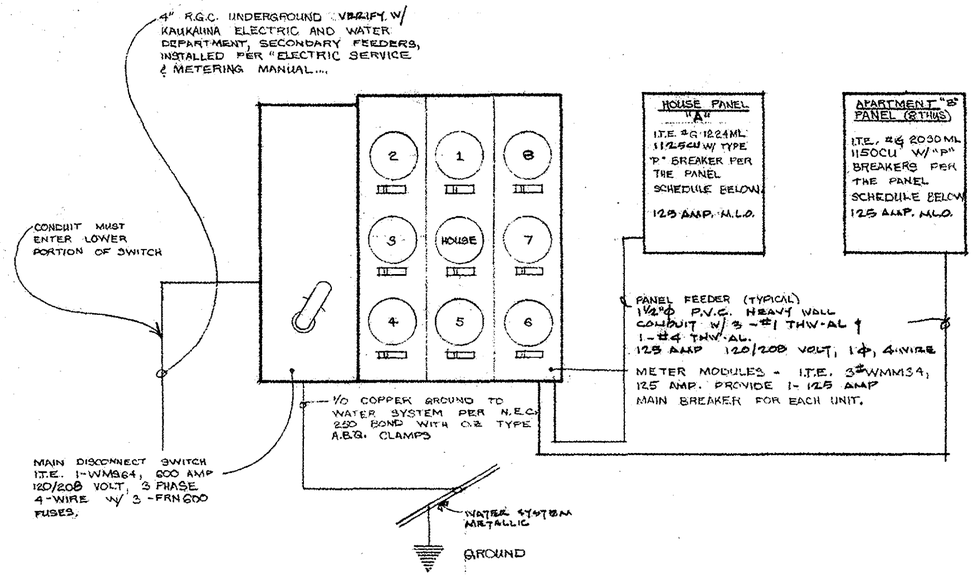
SHEET E-2

17 OF 18.



ELECTRICAL SERVICE ENTRANCE DIAGRAM

600 AMP 120/208 v. 3 PH. 4 WIRE SERVICE

HOUSE PANEL "A" (1) I.T.E. #G 1224 ML 1125 CU

125 AMP M.L.O. 120/208 v. 1 ø 4-WIRE SURFACE MOUNTED

BREAKER SIZE	LOAD	CIRCUIT WATTS	CIRCUIT Nº	PHASE A	LOADS B	CIRCUIT Nº	CIRCUIT WATTS	LOAD	BREAKER SIZE
1 P 15	OUTSIDE LITES		1			2		WATER CONTENT	1 P 20
1 P 15	FIRE ALARM		3			4		HEATER	2 P 15
1 P 15	SPARE		5			6		⊥	⊥
			7			8			
			9			10			
			11			12			

APARTMENT PANEL "B" (8) I.T.E. #G 2030 ML 1150 CU

125 AMP M.L.O. 120/208 v. 1 ø . 4-WIRE FLUSH MOUNTED

BREAKER SIZE	LOAD	CIRCUIT WATTS	CIRCUIT Nº	PHASE A	LOADS B	CIRCUIT Nº	CIRCUIT WATTS	LOAD	BREAKER SIZE
2 P 40	RANGE		1			2		DRYER	2 P 30
⊥	⊥		3			4		⊥	⊥
2 P 30	WATER HTR.		5			6		HEATING/AC	2 P 20
⊥	⊥		7			8		⊥	⊥
1 P 20	KITCHEN		9			10		HEATING	2 P 20
1 P 20	KITCHEN		11			12		⊥	⊥
1 P 15	DISPOSAL		13			14		LIGHTS/OUTLETS	1 P 15
1 P 15	LIGHTS/OUTLETS		15			16		LIGHTS/OUTLETS	1 P 15
			17			18			
			19			20			

ELECTRICAL NOTES & SPECIFICATIONS

- o All work shall be done in stricte accordance with all national, state and local codes. The Electrical contractor shall obtain and pay for all licenses, permits, and taxes necessary to perform work under this division.
- o The intent and object of these notes, plans, and specifications is for the Electrical contractor to include a complete, operable electrical system connecting all electrical devices and/or equipment furnished by other contractors. All 110 volt wiring by the electrical contractor. Low voltage wiring by others, with necessary conduit by Electrical contractor. The drawings are diagrammatic and all outlet locations must be verified at the time of installation.
- o The electrical contractor shall provide temporary electrical service for lighting and portable hand tools, and shall remove same when no longer required. (Includeing ground fault). Provide 120/208 volt, single phase service with minimum of 2-20 amp. circuits.
- o The electrical service shall conform to plans and specifications as well as utility requirements. The electrical contractor shall coordinate the service with the Kaukauna Electric and Water Company. Utility company costs will be paid by the Owner.
- o Motors and 208 volt controls furnished by mechanical trades, wired by electrical contractor, who shall also furnish the necessary disconnects. Contractor shall correlate closely with other trades for mounting requirements and conflicts, and include all costs for a complete workable installation.
- o Proposed circuiting shown on the panel schedules. Additional or alternate routing or circuits is left to the discretion of the contractor, however, any circuits judged by the Architect or his engineer to be overloaded or improperly derated shall be replaced by the contractor at his own expense.
- o The Electrical contractor shall provide materials as specified and shown on the drawings; or equal materials approved by the Architect.
- o All materials shall be U.L. listed and new. Switches shall be Sierra 5011/5013 or equal. Receptacles shall be Sierra 1910 or equal. Devices shall be ivory color unless directed otherwise.
- o Provide Electric-Eye Tork Model #3010, mounted a minimum of 12' high.
- o Fixture catalog numbers are general type numbers and along with description are intended to represent complete fixtures, including ballasts, sockets, back boxes, poles, mounting accessaries, and any other details required for a complete working installation. Use premium P ballasts for fluorescent fixtures.
- o Wire shall be new copper, and may be non-metallic cable system for general wiring per code. The Fire Alarm system shall be in a conduit system.
- o Install a complete non-coded Fire Alarm System as shown on the drawings, and described herein;
  - --Alarm panel shall be an Edwards #1520A, with #1522A-2 surface box for surface mounting. Uses 120/208 volt, 60 hz supply, or equal.
  - --Pull stations shall be Edwards #270-SPO; or equal.
  - --Horns shall be Edwards #884D-N5; or equal.
  - --Heat/Smoke Detectors shall be Edwards #281-A; or equal.
- o The telephone system shall be wired by the Wisconsin Telephone Company. The electrical contractor shall provide where shown on the electrical plan outlet boxes (3 per apartment), a 2' x 4' sheet of 5/8" plywood fastened to the utility room wall for telephone equipment, a 1½" conduit for telephone service entrance through the utility room floor and foundation wall, and a 120 volt, 15 amp. receptacle at the plywood sheet.
- o The electrial contractor shall provide outlet boxes for cable-TV installation where shown on the plans. Wiring for cable-TV shall be by Cablevision of the Fox Cities.
- o The television antenna system shall be by the Owner. Provide outlet boxes where shown on the plans.
- o The electrical contractor shall examine the heating drawings to determine the extent of work required for the electric heating system. The electrical contractor may bid the heating equipment as a separate bid, but must include all the HVAC work.
- o The electrical contractor shall remove his rubbish from the site as it accumulates.
- o The Contractor shall guarantee in writing all labor and materials for one year after final acceptance of the work hereunder.

DRAWN BY S.K. & HB

APPROVED BY HB

REVISIONS

BY	DATE

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KAUKAUNA, WISCONSIN 54130
414 · 766 · 4227

EIGHT UNIT APARTMENT / CONDOMINIUM — JACOBSON, PROMER & PROMER — KAUKAUNA, WISCONSIN

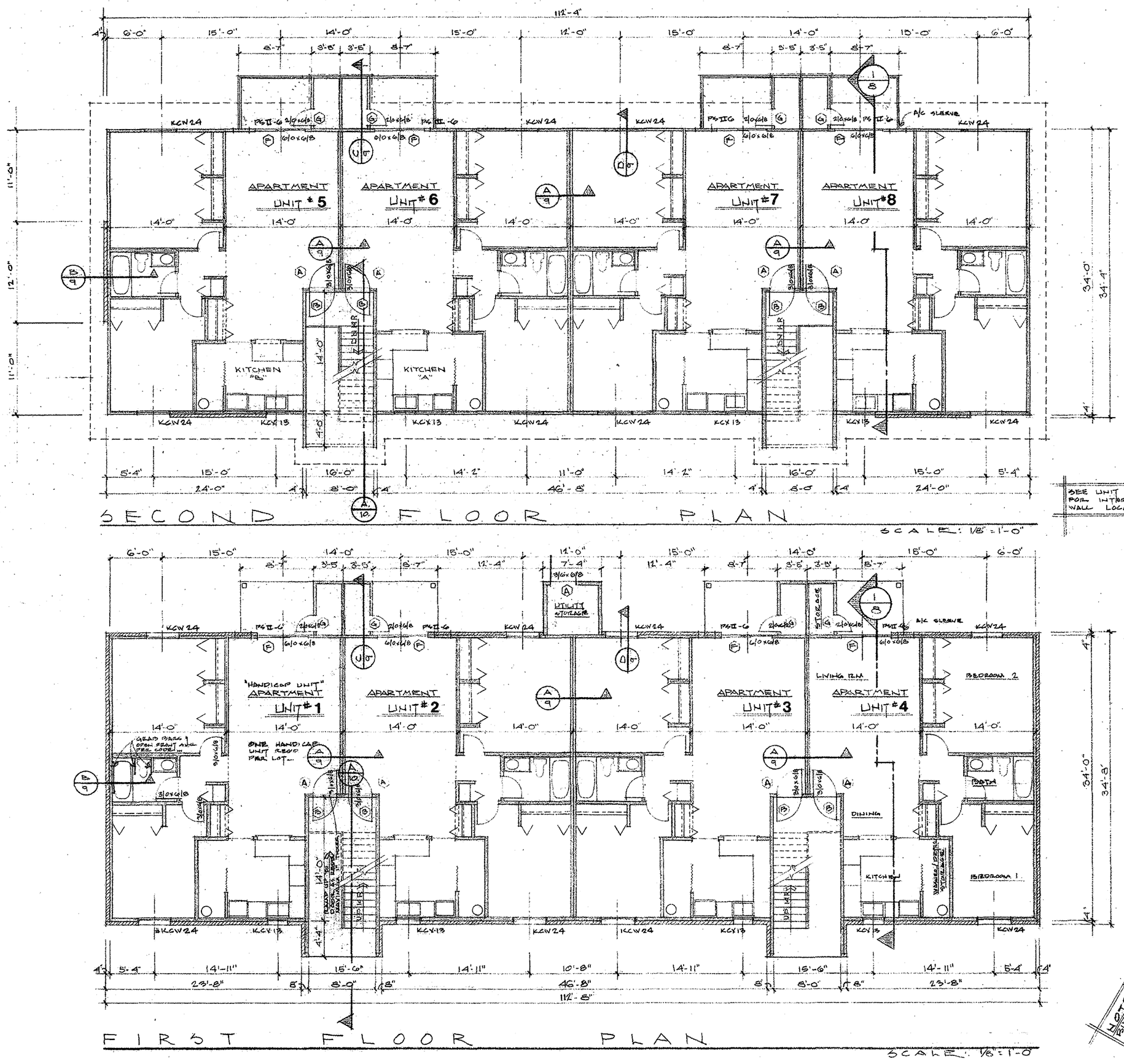
PROJECT NO. 8317

DATE 4/12/83

SHEET E-3

18 OF 18

N23003



SECOND FLOOR PLAN

SCALE: 1/8" = 1'-0"

FIRST FLOOR PLAN

SCALE: 1/8" = 1'-0"

SEE UNIT PLAN SHEET #5 FOR INTERIOR PARTITION WALL LOCATION.

- WINDOW NUMBERS SHOWN ARE FOR KOLBE & KOLBE CLAD WOOD CASEMENT W/ INTERIOR PREFINISHED ...
- PATIO UNIT DOOR BY ANDERSON CORPORATION DOOR F.
- VERIFY ROUGH OPENING SIZES FOR ACTUAL WINDOW & DOOR UNITS USED.

NORTH

NOTE: BUILDING "B" - LOT #2, & BUILDING "A" - LOT #1 ARE AS SHOWN. LOT #1 ARE REVERSED/OPPOSITE

DRAWN BY TG. & AB

APPROVED BY AB

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BY	DATE

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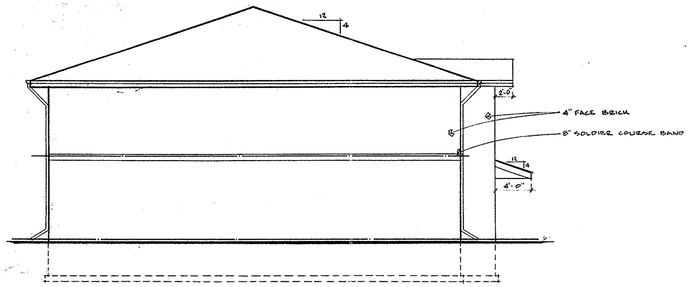
8 UNIT APARTMENT / CONDOMINIUM BUILDING —
JACOBSON, PROMER & PROMER
KAUKAUNA, WISCONSIN

PROJECT NO. 8317

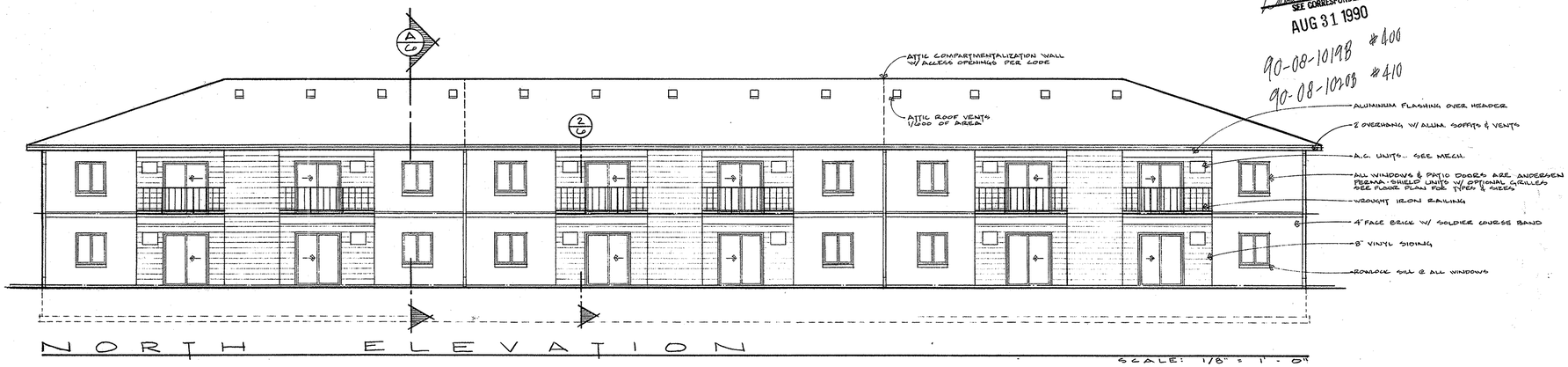
DATE 4-22-83

SHEET 3 OF 18



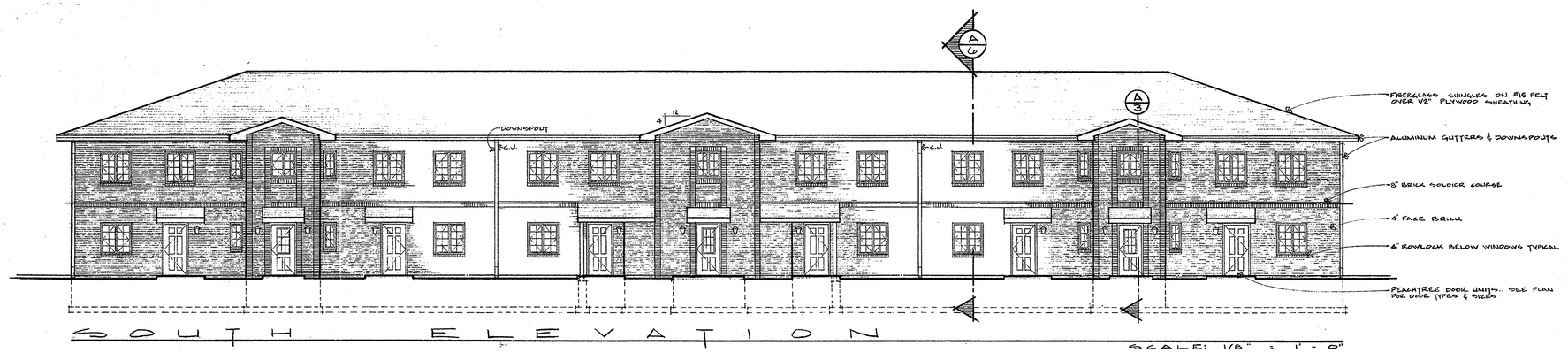
WEST ELEVATION EAST SIMILAR

SCALES: 1/8" = 1'-0"



NORTH ELEVATION

SCALE: 1/8" = 1'-0"



SOUTH ELEVATION

SCALE: 1/8" = 1'-0"

THREE 12 UNIT BUILDINGS FOR --

FOXSHORES APARTMENTS / CONDOMINIUMS

390, 400 & 410 FOXSHORES COURT, KAUKAUNA, WISCONSIN

A GORDON O. JACOBSON DEVELOPMENT

HEATING AND VENTILATING
BUILDING PLANS
Conditionally
APPROVED
DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS
SEE CORRESPONDENCE
AUG 31 1990
90-08-10198 #400
90-08-10208 #410

GENERAL NOTES & SPECIFICATIONS

1. GENERAL CONDITIONS (pertains to all contractors & subcontractors)

- o The contractors are to furnish materials and labor to execute the work as shown on the drawings, as described herein, and/or as directed by the Architect or Construction Manager.
- o Workmanship shall be of the best quality. In as much as the specifications hereinafter are of a brief nature, it is the intent that each contractor provide workmanship that is neat, secure, with the best possible appearance and utility. The Architect will be judge of installed work and may reject work which does not meet the standards established hereby. Such rejected work shall be repaired or replaced to the satisfaction of the Architect without cost to the Owner.
- o Reference to materials or systems herein by name, make or catalog number is intended to establish a standard of quality, and not to limit competition; and the words "or approved equal" are implied following each brand name. "Or approved equal" materials shall be approved by the Architect prior to acceptance for use.
- o All contractors are responsible for the removal of their own refuse from the premises. The Construction Manager shall provide a dumpster on the site for the use of all trades and shall broom clean the job site at least every Friday. Final cleaning and washing of glass is by Others.
- o Temporary electrical power, temporary water service, a portable chemical toilet, and temporary heat as required will be provided for contractors and subcontractors by the Owner and/or CM.

DESIGN LOADINGS & GENERAL REQUIREMENTS

Design Data:	Roof Live Load -- Snow		30 psf
	Snow Drift Loads per ILHR 53.11		--
	Roof Service Load		3 psf
	Floor Live Load -- Living Areas		40 psf
	-- Corridors		80 psf
	-- Balconies		40 psf
	Wind Load		20 psf
Criteria:	Soil Bearing Capacity (Presumptive)		3,000 psf
	Concrete: Footings, slabs, etc.		3,000 psi
	Reinforcing Steel #3 Bars A615-40	fy =	40,000 psi
	#4 & Larger A615-60	fy =	60,000 psi
	Structural Steel - ASTM A36	fy =	36,000 psi
	Wood Framing - 2x4 bearing studs shall Douglas Fir Construction grade	fb =	1,450 psi
		fv =	95 psi
		E =	1,500 ksi
	Wood Framing:		
	MICRO-LAMS	Fbr =	2,800 psi
	2x8's, 2x10, 2x12's Joists & Headers	Fbr =	1,450 psi
	2x4, 2x6 Studs	Fbr =	1,150 psi

- o Contractors to cross check dimensions and elevations between architectural, mechanical, and structural drawings. Architect to be notified of any variance before contractor begins work. All equipment supports and anchorages to be cross checked with manufacturer's drawings. Contractor to verify all profiles, heights and dimensions at project, prior to fabrication of any materials / components and inform the architect of any discrepancies for framing interferences.
- o Shop Drawings: Submit a minimum of 6 copies for approval of shop drawing clearly showing details for accurate placing of reinforcing steel, structural steel, precast planking, timber members, steel joist, steel decking, etc. Separate material lists will not be accepted. Architect's approval does not relieve contractor of any responsibility for correctness, fit, or strength of details.

GENERAL NOTES continued on Sheet #3

INDEX OF DRAWINGS --

1. ELEVATIONS, CONTENT, NOTES
2. SITE PLAN
3. FOUNDATION PLAN, FOOTING DETAILS, STAIR SECTION, GENERAL NOTES
4. FIRST & SECOND FLOOR PLANS, GENERAL NOTES
5. UNIT PLANS @ 1/4" SCALE, DOOR SCHEDULE, ROOM FINISH SCHED., GEN. NOTES & SPECS.
6. BUILDING CROSS SECTION, SECTION, DETAILS

HVAC-1. FIRST & SECOND FLOOR PLANS
HVAC-2. SCHEDULES, NOTES
P-1. FLOOR PLANS, NOTES
P-2. PIPING ISOMETRICS
E-1. BUILDING FLOOR PLANS, SYMBOL SCHEDULE
E-2. 1/4" SCALE UNIT PLANS, RISER DIAGRAM, LIGHTING & FIXTURE SCHEDULE, NOTES

BUILDING CONTENT --

o LOCATION	o AREA	sf	o VOLUME	cf
o FIRST FLOOR:	o 7,595	sf	o 72,114	cf
o SECOND FLOOR:	o 7,287	sf	o 59,510	cf
o ATTIC SPACE	o	sf	o 30,375	cf
o TOTALS	o 14,882	sf	o 162,000	cf

WISCONSIN ALLAN R. BIRSCHBACH A-4501 APPLETON, WISCONSIN ARCHITECT

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Registered Architect under the Statutes of the State of Wisconsin.

Date: July 25, 1990 Reg. No. A-4501

BIRSCHBACH & ASSOCIATES, LTD. ARCHITECTURE
P.O. BOX 318 KAUKAUNA, WISCONSIN 54130-0318
1801 CROOKS AVENUE 414-766-4227

DRAWN BY

APPROVED BY

REVISIONS	
BY	DATE

APPROVED

THREE 12 UNIT BUILDINGS FOR -- FOXSHORES APARTMENTS / CONDOMINIUMS
390, 400 & 410 FOXSHORES COURT, KAUKAUNA, WISCONSIN
A GORDON O. JACOBSON DEVELOPMENT

PROJECT NO. 8957.01

DATE 7-25-90

SHEET 1 OF 12.

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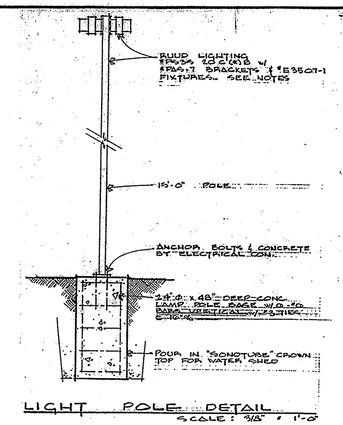
SCALE 1"=20'



LIGHT POLE DETAIL
SCALE: 3/8" = 1'-0"

SITE PLAN

SCALE : 1" = 20'-0"

KEY TO SYMBOLS

- 2"-4" ASPHALT PAVING (NEW)
- CONCRETE
- 658.3 NEW GRADES IN BOXES
- EXISTING GRADES
- E ELECTRICAL LINE

DRAWN BY: T. Wood
APPROVED BY: RB

REVISIONS

BY	DATE
D.D.	5-29-90
TO	8-21-90

BIRSCHBACH & ASSOCIATES, LTD.
ARCHITECTURE
1801 CROOKS AVENUE
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THREE 12 UNIT BUILDINGS FOR --
FOXSHORES APARTMENTS / CONDOMINIUMS
390, 400 & 410 FOXSHORES COURT, KAUKAUNA, WISCONSIN
A GORDON O. JACOBSON DEVELOPMENT

PROJECT NO. 8937.01
DATE 7-25-90
SHEET 2 OF 12

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G E N E R A L   N O T E S   continued from Sheet #1

2. DIVISION 2 -- SITE WORK

General:
- o The buildings on the site shall be staked out and footing elevations set by the Construction Manager and shall be approved by the Architect before excavation is begun.
- o The location of utilities where shown on the drawings are based on available records and are not guaranteed to be complete or correct. The intention is to assist the contractors in making a determination of exact locations.
- o Soil bearing, samples, and testing was not done. Soil bearing capacity is assumed at 3,000 psf; sandy clay silt, firm inorganic silt per ILHR 53.12, Table 53-II. The contractor shall notify the Architect immediately if soils other than those indicated are encountered.
- o The electrical, telephone, and gas services shown shall be by the utility companies supplying service.

2A. Excavation:
- o Excavate to grade lines for footings, floor slabs, parking lot base, as shown on the drawings. Provide compacted granular fill to bring the grade under paved areas to within 6" of the required contours shown on the drawings or finished grades as determined in the field. Miscellaneous debris shall be hauled from the site and disposed of by the excavation contractor. Include all disposal costs in the bid. Stockpile at site material needed for backfilling and rough grading.
- o Footings shall bear on undisturbed soil. Backfill the interior of the building with sand fill placed in 6" to 8" lifts and compacted to 95% compaction as measured by a Standard Proctor test. Provide copies of the test result to the office of the architect for review. Backfilling around the exterior of the building may be with excavated earth at foundation walls with slabs on grade floors, if compacted uniformly. Excess excavated material if any shall be hauled from the site to a point within five miles (round trip) as designated by the Owner, or in the absents thereof, shall be hauled from the site and disposed of at the contractor's expense and option. Coordinate backfilling with the concrete contractor for placement of perimeter insulation.
- o At proposed parking lots and drives provide grades required for a minimum of 8" compacted gravel subbase. Areas below parking and drives shall be filled with compacted sand/pit run fill, compacted to 96% as measured by Standard Proctor test. Provide test results to the office of the Architect for review. Fill material shall be placed in maximum lifts of 8". Top 8" of subbase material shall be breaker run. Four (4") inch base for asphalt shall be furnished by the Asphalt Contractor.
- o After backfilling, rough grade the site to grade lines shown or to obtain the gradual slope from the buildings, drives, walks, etc. as shown to obtain the best possible drainage from the building site. Coordinate rough grading work with the landscape contractor. Spread top soil if any over the areas to be lawn, and fill all planting areas.
- o Trenching for utilities and backfilling of that work shall be by the utility contractor doing the work.

2B. Asphalt Paving:
- o The asphalt contractor is to provide the finished grading of the parking/paved areas and the top 4" of base material. Provide 4" compacted base material of crushed limestone. Provide asphalt concrete paving of 2" thickness. This contractor to layout work to provide drainage to the drainage ditches and/or catch basins shown. Include parking striping as shown on the site plan.

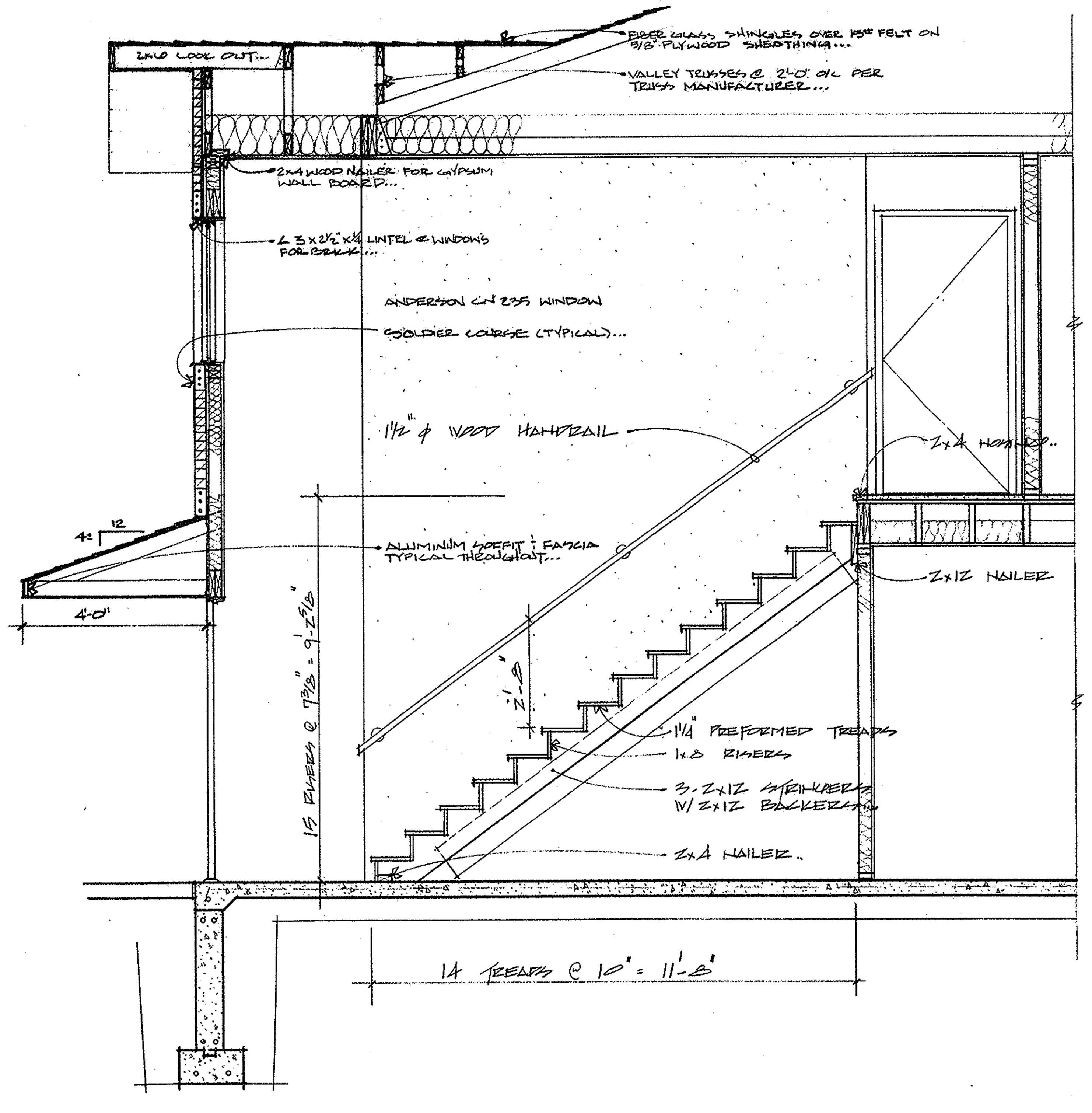
2C. Utilities:
- o This contractor is to furnish labor and materials to install the water service, sanitary laterals, and storm sewer systems as shown on the site plan required for each building. This contractor is to include in his bid all licenses, permits, and fees necessary to perform work, ready for final connection to the building by others.
- o All work shall conform to state and local codes, and shall meet the requirements of the utility and/or municipality providing the service.
- o All materials shall be approved and new. The storm laterals and sanitary laterals shall be Schedule 30 ABS or PVC. The water service shall be type "K" copper. All trench excavations shall be back filled in 8" to 12" layers lifts with compacted (to 96% by Proctor) sand or gravel fill. Unless noted otherwise on the plans, the catch basins shall be 36" in diameter x the depth shown on the site plan. The rim and grate shall be a Neenah Foundry #R-1660 w/Type "A" grate; or equal.

2D. Landscaping & Miscellaneous:
- o Landscape work and miscellaneous site work, such as fences, timber work, etc. shall be by separate proposal submitted to the Architect/Construction Manager. Proposals shall include plant lists with caliber or proposed stock. When requested, provide a landscape design proposal for approval.

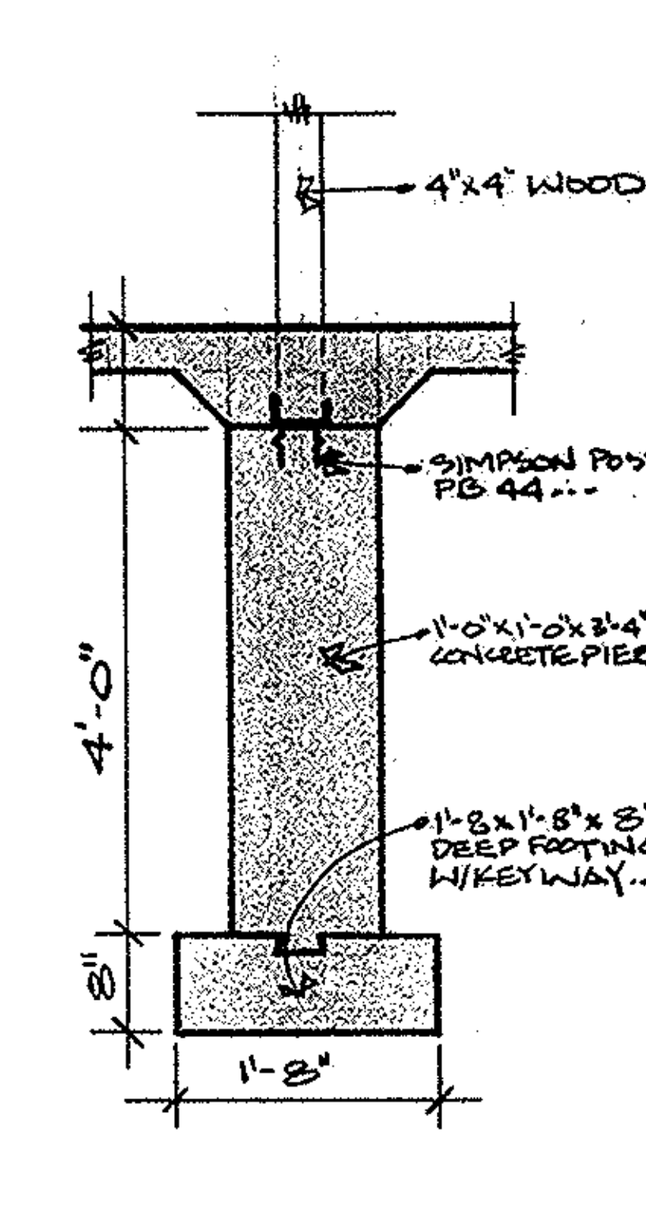
3. DIVISION 3 -- CONCRETE

3A. Cast in Place:
- o Concrete work shall include all footings, walls, floor slabs, stoops, private walks, aprons, city walks, etc. shown on the drawings. This contractor shall stake out the buildings on the site and determine footing elevations.
- o All concrete shall be ready-mixed furnished by a reputable vendor in accordance with ASTM C94. Concrete shall be 3,000 psi compressive strength at 28 days; maximum aggregate size 3/4" in all concrete; maximum water/cement ratio 5:1, minimum 6 bag of cement per cu. yd.; 6% air entrainment (+/- 1%), and water shall be potable. Maximum slump for walls shall be not over 3" and for others 4".
- o Contractor shall be responsible for adequacy of design and construction of forms, centering, shoring, and bracing. As a minimum, the Contractor shall follow ACI Standard Recommended Practice for Concrete Formwork (ACI 347-63). Supports for forms and centering shall be sufficiently strong to carry both dead and live loads to which they will be subjected. Shoring and supports shall be adjustable to permit tightening, bracing, leveling, and cambering as required.
- o Reinforcing steel shall conform to ASTM-A615-40, fy = 40,000 psi. Reinforcing shall be suitably branded with rolled -in marks to visually establish the grade and size. Welded wire fabric reinforcement shall be electric welded, steel wire fabric conforming to ASTM-A285, 6" x 6" - 10/10. All reinforcing material shall be uncoated, unpainted, free from rust, scale, and dirt; and shall be placed in conformance with CRSI "Recommended Practice for Placing Bars", latest edition.
- o When the mean daily temperature of the atmosphere is less than 40 degrees F., the temperature of the concrete shall be maintained between 50 degrees and 70 degrees F. for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature and moisture conditions without injury due to concentration of heat. Cold weather requirements shall comply with ACT 306-66.
- o Slabs shall be placed on 4 mil (.004") polyethylene plastic film. Lap joints 6" minimum. Smooth dense steel trowel finish on all interior slabs. Slip resistant broom finish on walks and stoops.
- o This contractor is to provide and install the perimeter insulation shown on the drawings. Coordinate this work with the backfilling by the excavation contractor. Perimeter insulation shall be beaded styrofoam of R = 5.9; or equal, extending vertical to footings. Insulation shall be applied to wall with mastic approved by the insulation manufacturer. Let vertical members dry prior to backfilling; butt joints snug. Keep area between concrete and insulation free of backfill and other debris. Insulation exposed above grade shall be protected with fiberglass insulation guard applied with mastic and flashed into the wall structure (masonry or siding). All concrete form ties shall be removed prior to adhering insulation.
- o The lightweight concrete underlayment shall be as manufactured by Gyp-crete, Elastizell, or equal. This contractor shall furnish all labor and materials for installation as shown on the drawings. Application shall be by an approved applicator according to the manufacturer's printed specification. Plywood subflooring shall be primed, and underlayment layer a minimum of 1-1/2" thick.

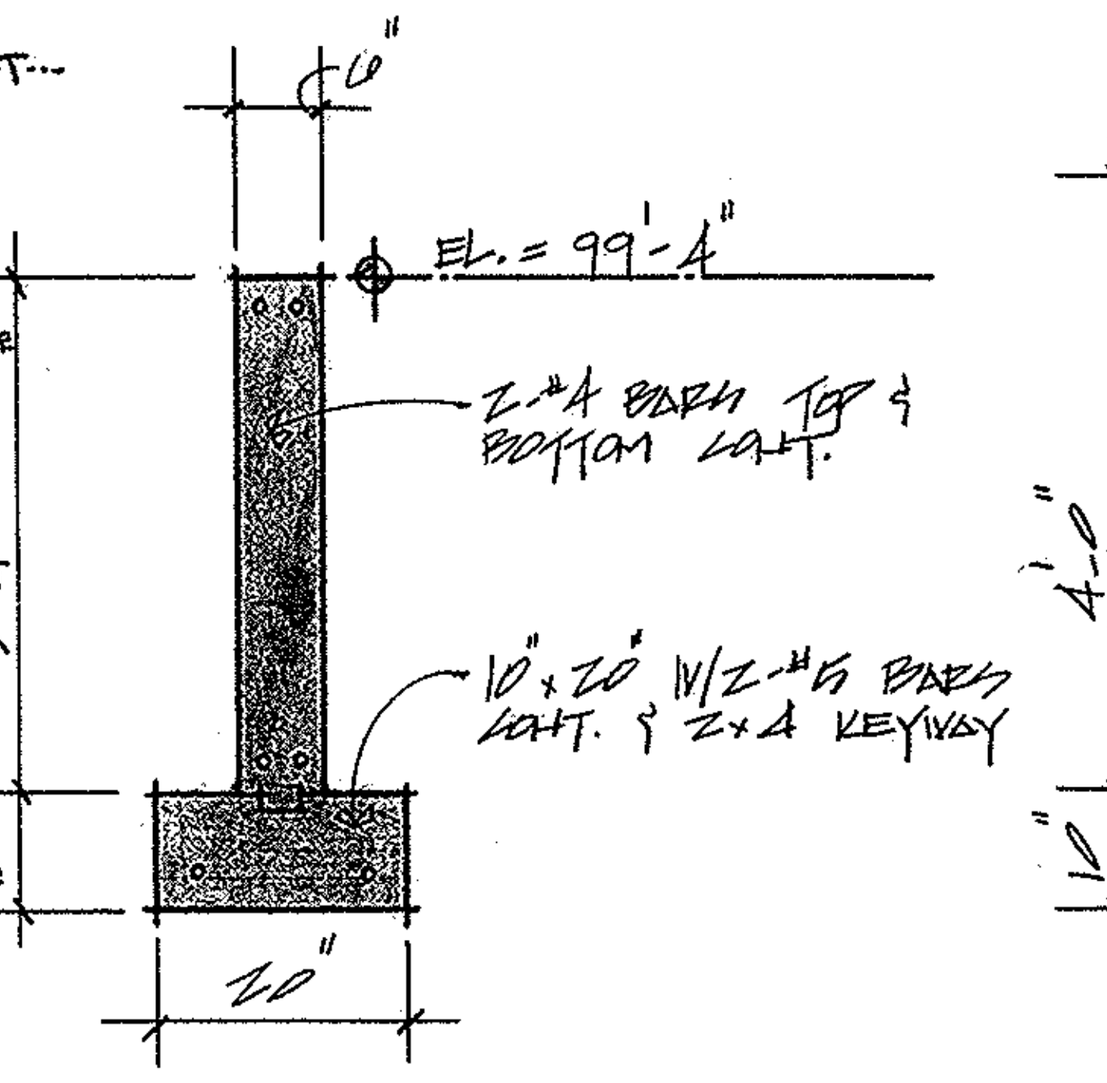
GENERAL NOTES continued on Sheet #4



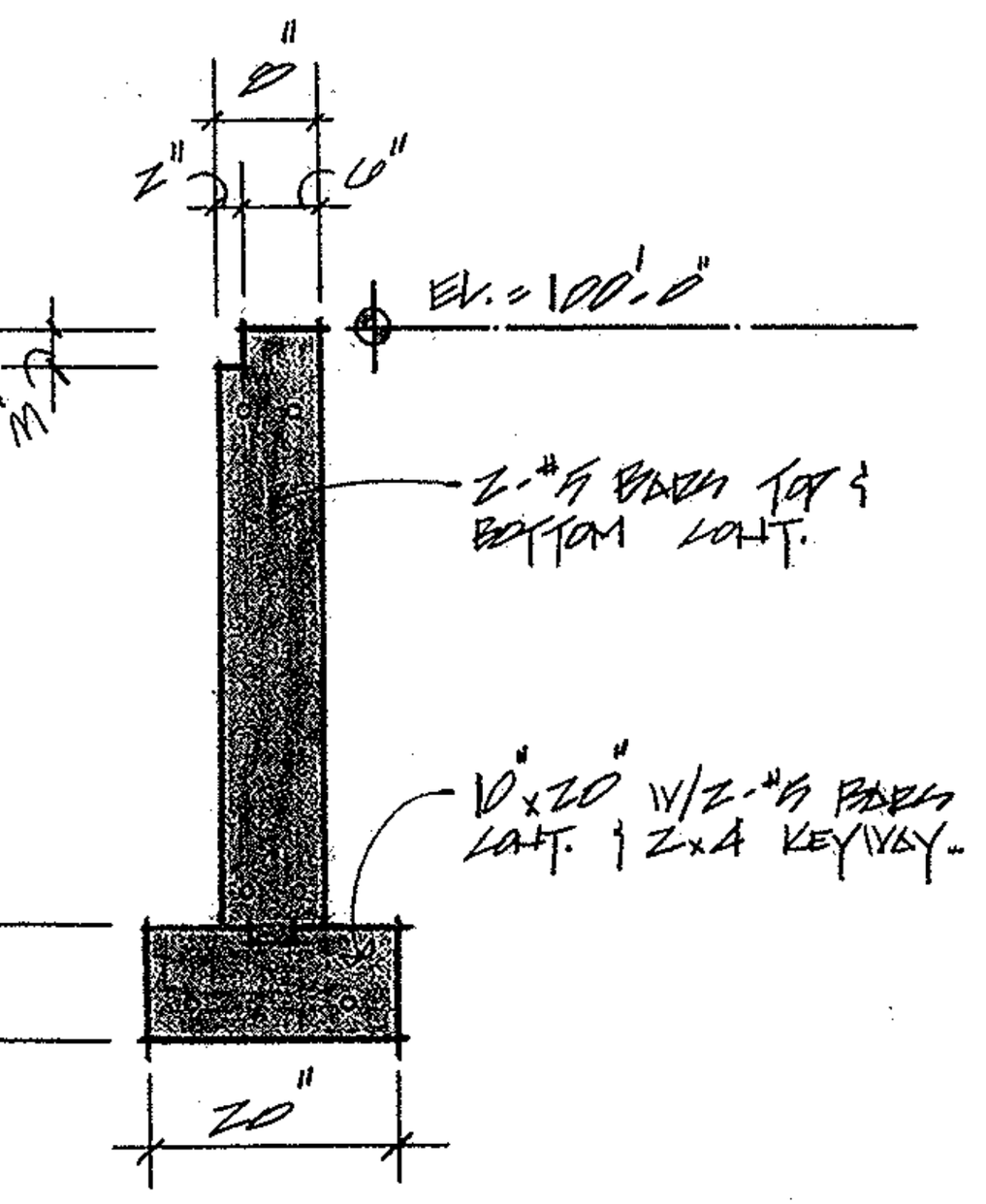
(A/3) SECTION THRU STAIRS



(7/3) WOOD POST PIER



(1/3) WALL DETAIL



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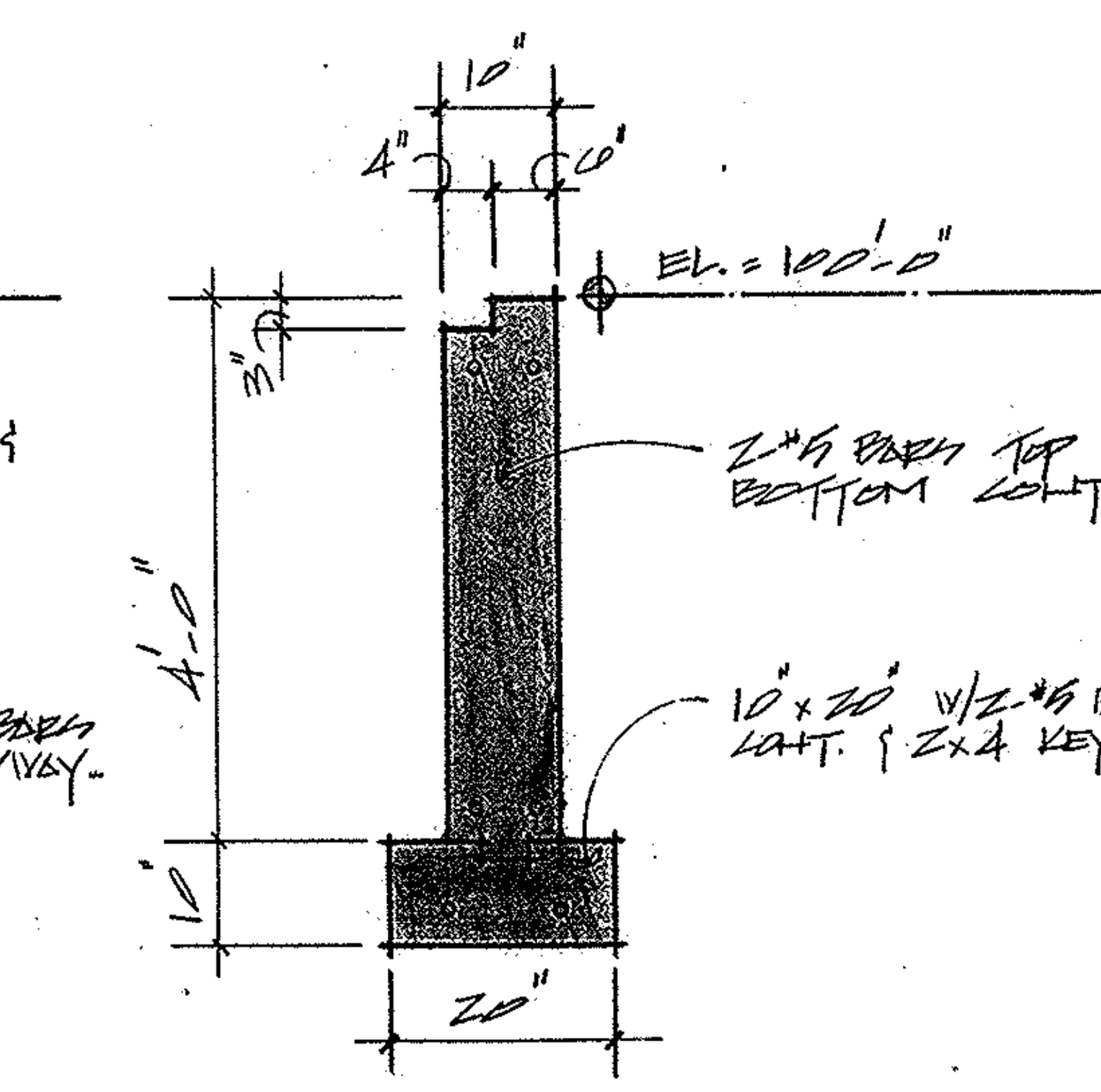

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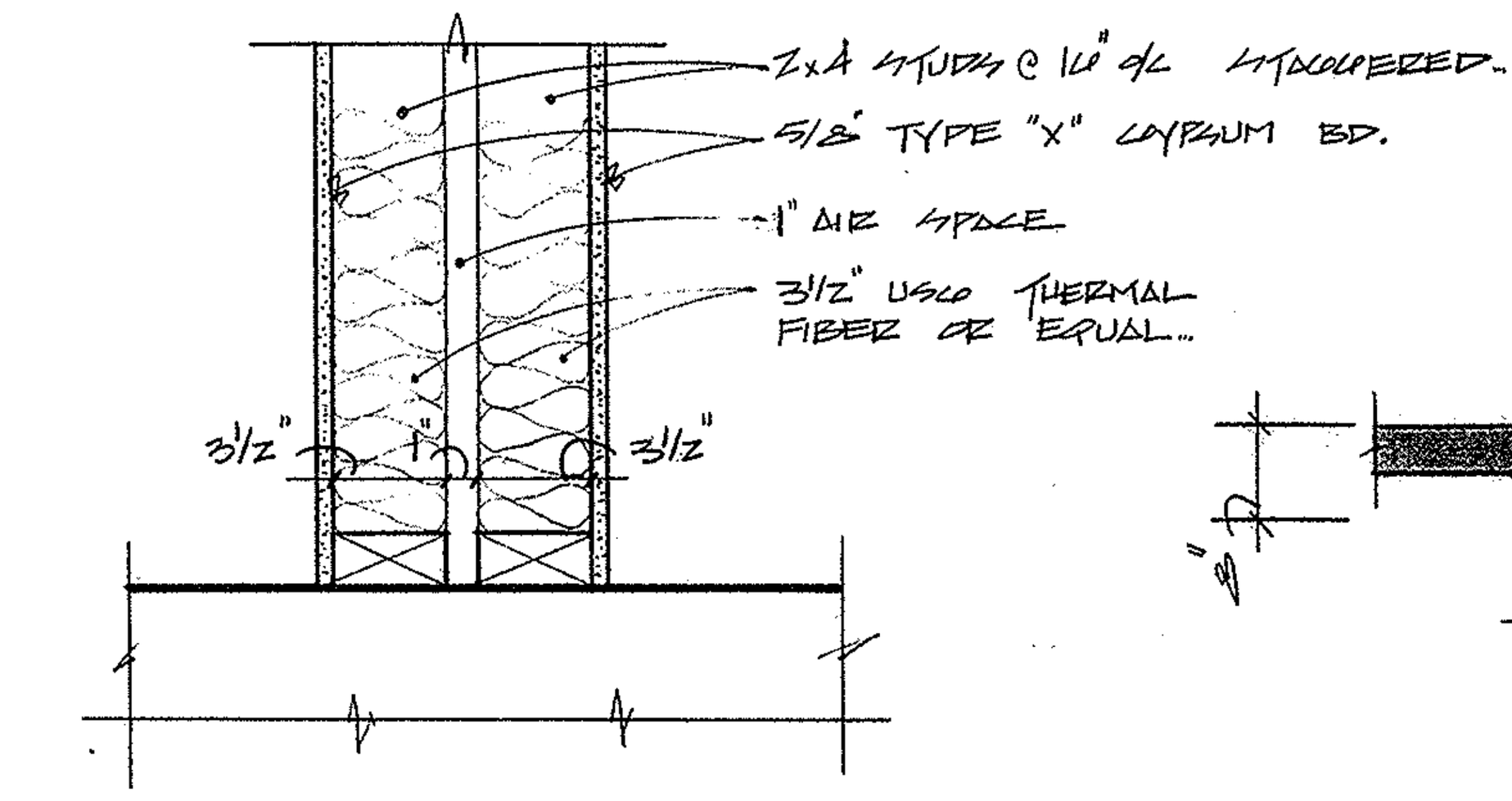
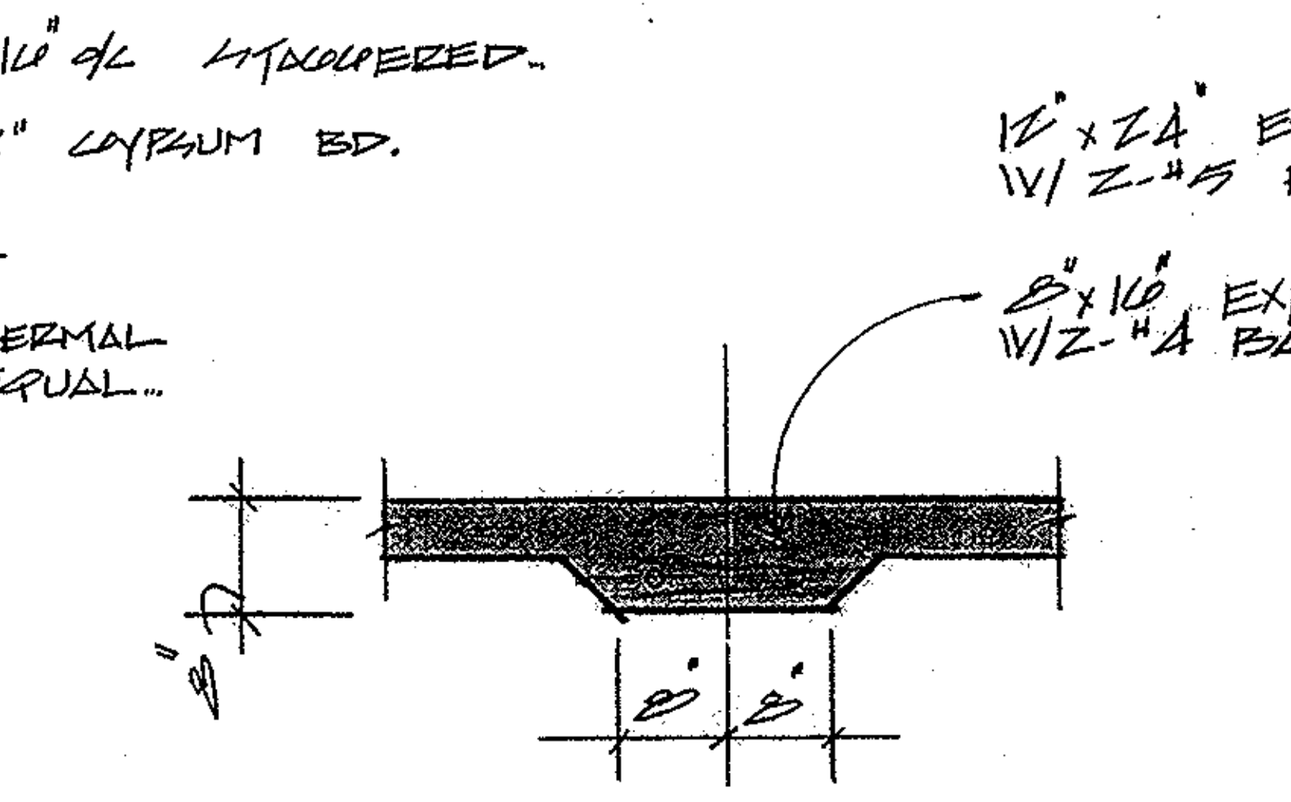
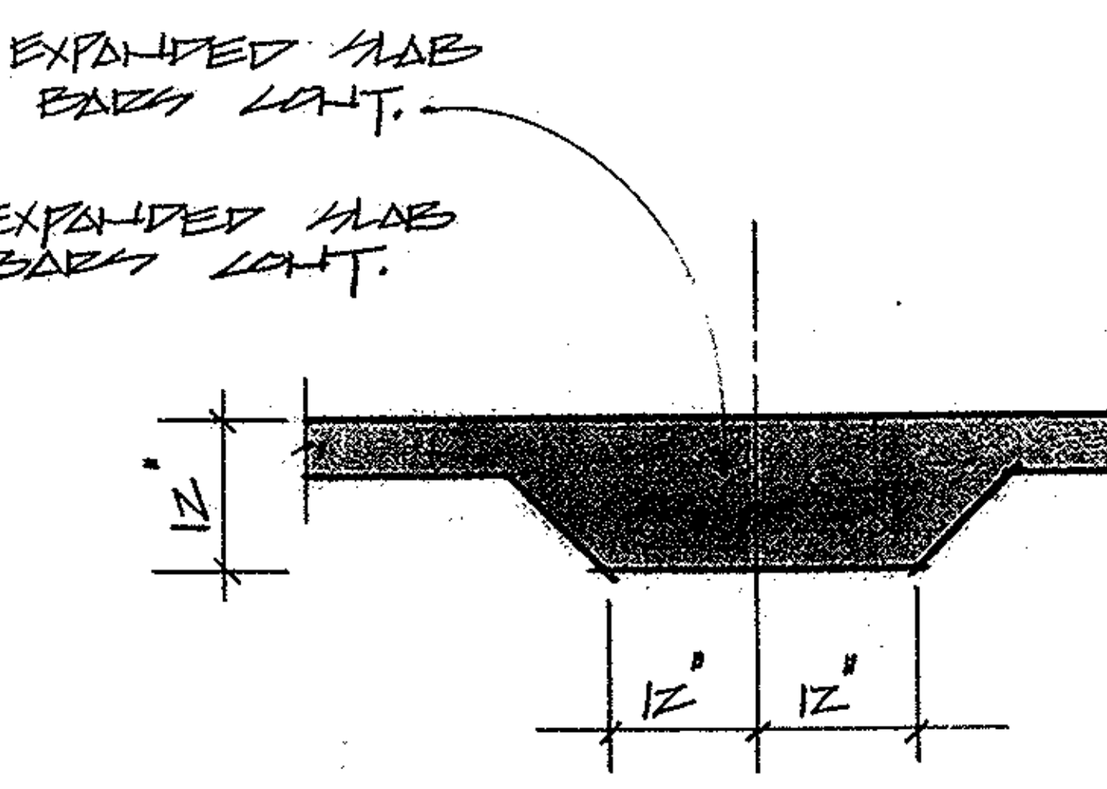


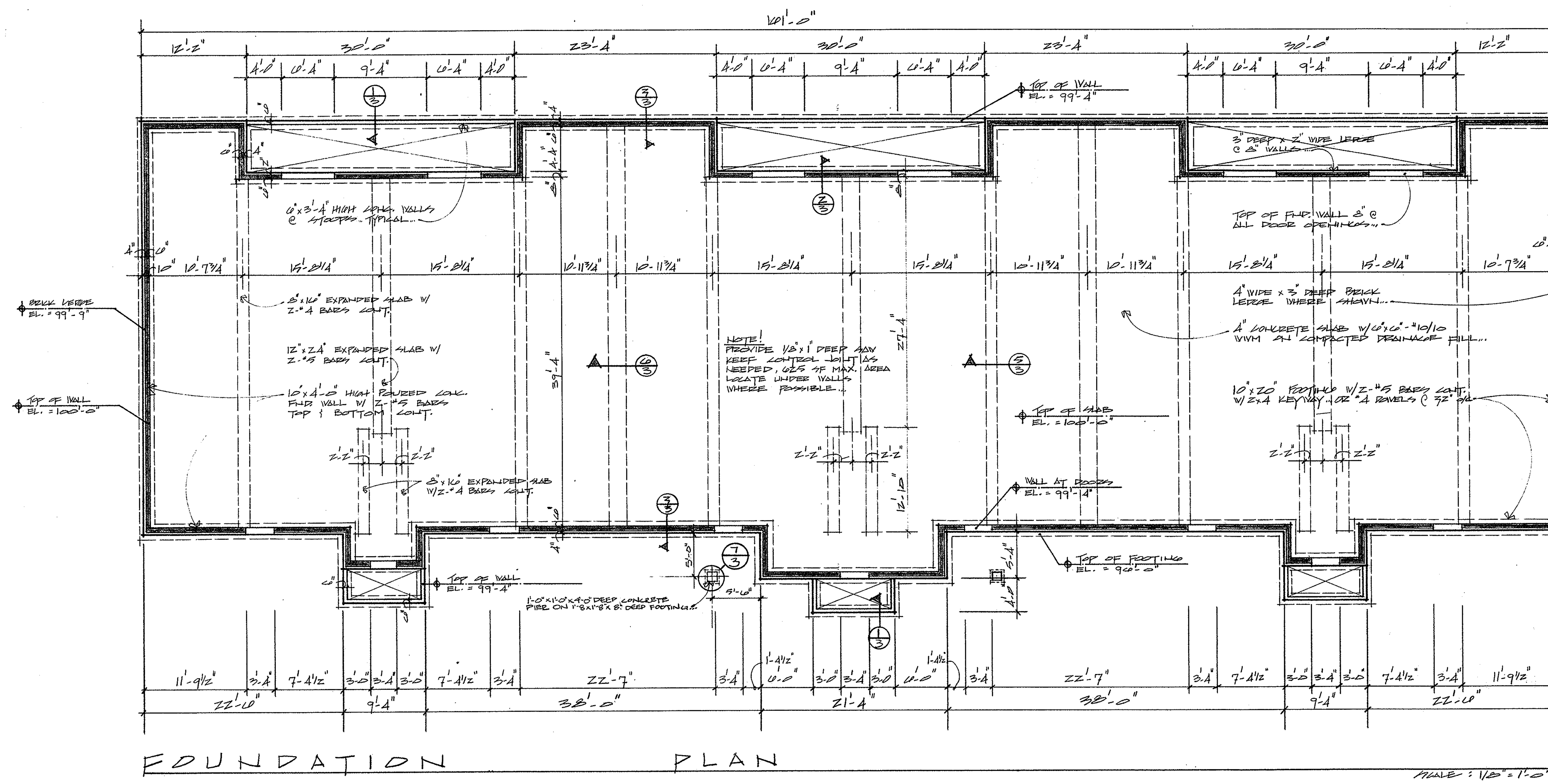
(4/3) DETAIL @ PARTY WALL



(5/3) EXPANDED SLAB



(6/3) EXPANDED SLAB



FOUNDATION PLAN

SCALE: 1/8" = 1'-0"

DRAWN BY
APPROVED BY
REVISIONS
BY / DATE

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THREE 12 UNIT BUILDINGS FOR --
FOXSHORES APARTMENTS / CONDOMINIUMS
KAUKAUNA, WISCONSIN
390, 400 & 410 FOXSHORES COURT.
A G O R D O N D. J A C O B S O N D E V E L O P M E N T

PROJECT NO. 8957.01

DATE 7-25-90

SHEET 3 OF 12

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GENERAL NOTES continued from Sheet #3

4. DIVISION 4 -- MASONRY

- o The general contractor shall furnish labor and materials for the masonry brick veneer work shown on the floor plans and building elevations.
- o Brick veneer masonry units shall be ASTM-C652 hollow clay units of modular size and laid in running bond with 3/8" joints. Color and final selection of brick shall be made by the Architect. The intent is to match the existing. Mortar shall be Type N, 1:1:6 mix of ruputable vendor with ASTM C144 sand and potable water. Mortar color shall be added according to the requirements of BIA. No air entraining admixtures or anti-freeze compounds may be added to the mortar. Provide 22 gage x 7/8" galvanized veneer ties at 16" o.c. each way.
- o Lay C.M.U. plumb and true to lines. Lay with completely filled mortar joints. Provide weep holes in head joints in first course immediately above all flashings by placing and leaving a sash cord in joint.
- o Masonry shall be left clean, free of stains, and acceptable by the Architect/Owner. Do not use cleaning agents other than water without approval of the Architect.
- o The contractor shall provide openings for ductwork as required by the HVAC drawings, and shall review the electrical drawings for outlet box and switch boxes required to be placed in masonry.
- o Cold weather construction shall be according to B.I.A. recommendations; a copy of which is available from the office of the Architect. When the mean daily temperature of the atmosphere is less than 40 degrees F or expected to be within 3 days, the masonry work shall be protected by temporary enclosure with temporary heat provided by the masonry contractor. The masonry contractor shall include in his bid the net cost per day for temporary heat. Temporary heat when required is to be approved in advance by the Architect.

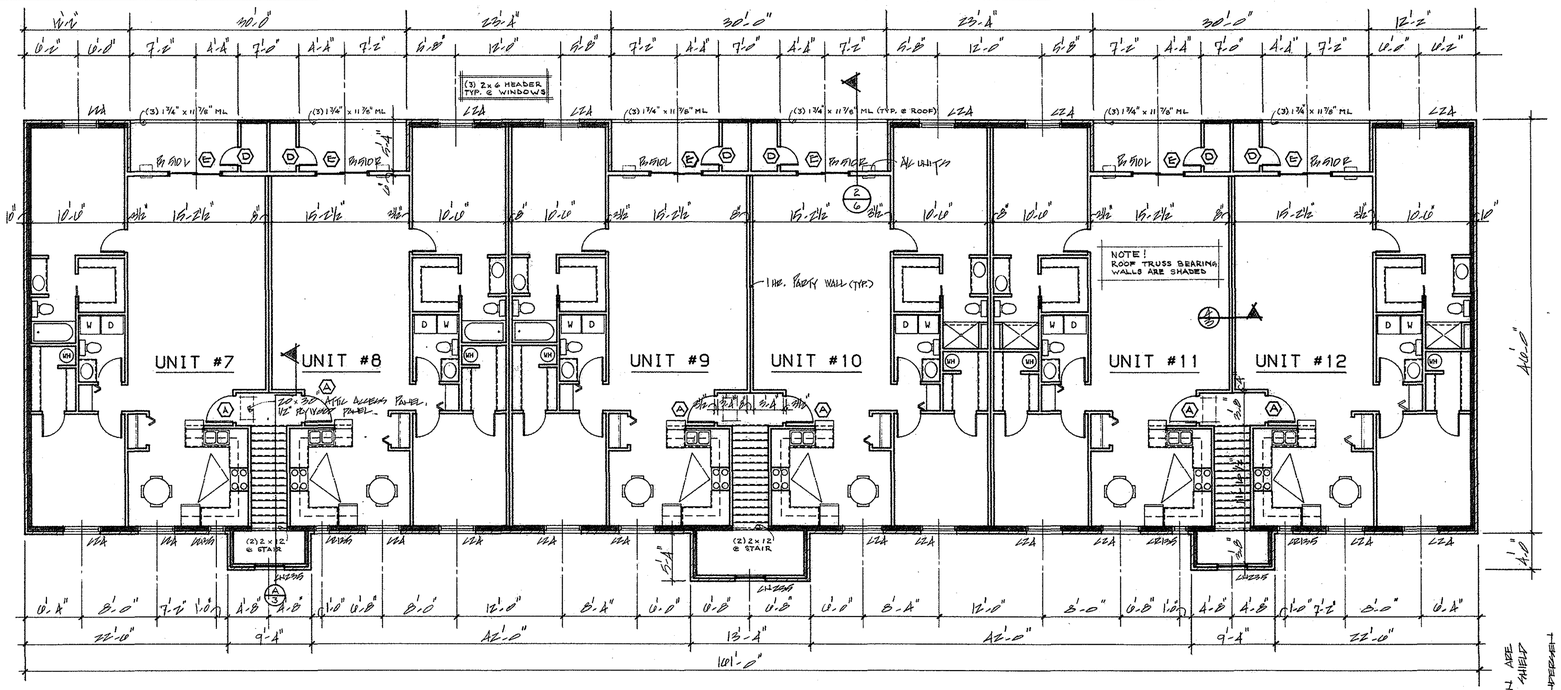
5. DIVISION 5 -- STRUCTURAL STEEL & METALS

- o This contractor shall provide and erect all steel beams, columns, and lintels as shown on the drawings. Structural steel framing shall conform to ASTM A36 except structural tubes which shall comply with ASTM A500, grade B. All field connections for members to be made with high strength bolts ASTM A325N unless noted otherwise. Field welding in lieu of bolts to be used only with approval of the Architect. Field welds where shown shall be performed by a State of Wisconsin certified welder, in accordance with American Welding Society.
- o Structural steel framing shall be shop primed with one coat of the manufacturer's standard rust inhibiting primer. Provide holes, anchor bolts, bearing plates, as required for a complete job. All fabrication and erection shall be in accordance with the "Specification for Design, Fabrication, and Erection of Structural Steel for Buildings" by the American Institute of Steel Construction and in accordance with the Wisconsin Administrative Code, ILHR53.50.
- o Provide and maintain cross bracing of all structural steel erection until structural work is securely incorporated into construction to insure plumb and square alignment. Provide masonry anchor straps on columns where masonry abuts. Provide miscellaneous support angles as required for HVAC openings as required.
- o Provide shop drawings for approval to the office of the Architect.

6. DIVISION 6 -- CARPENTRY

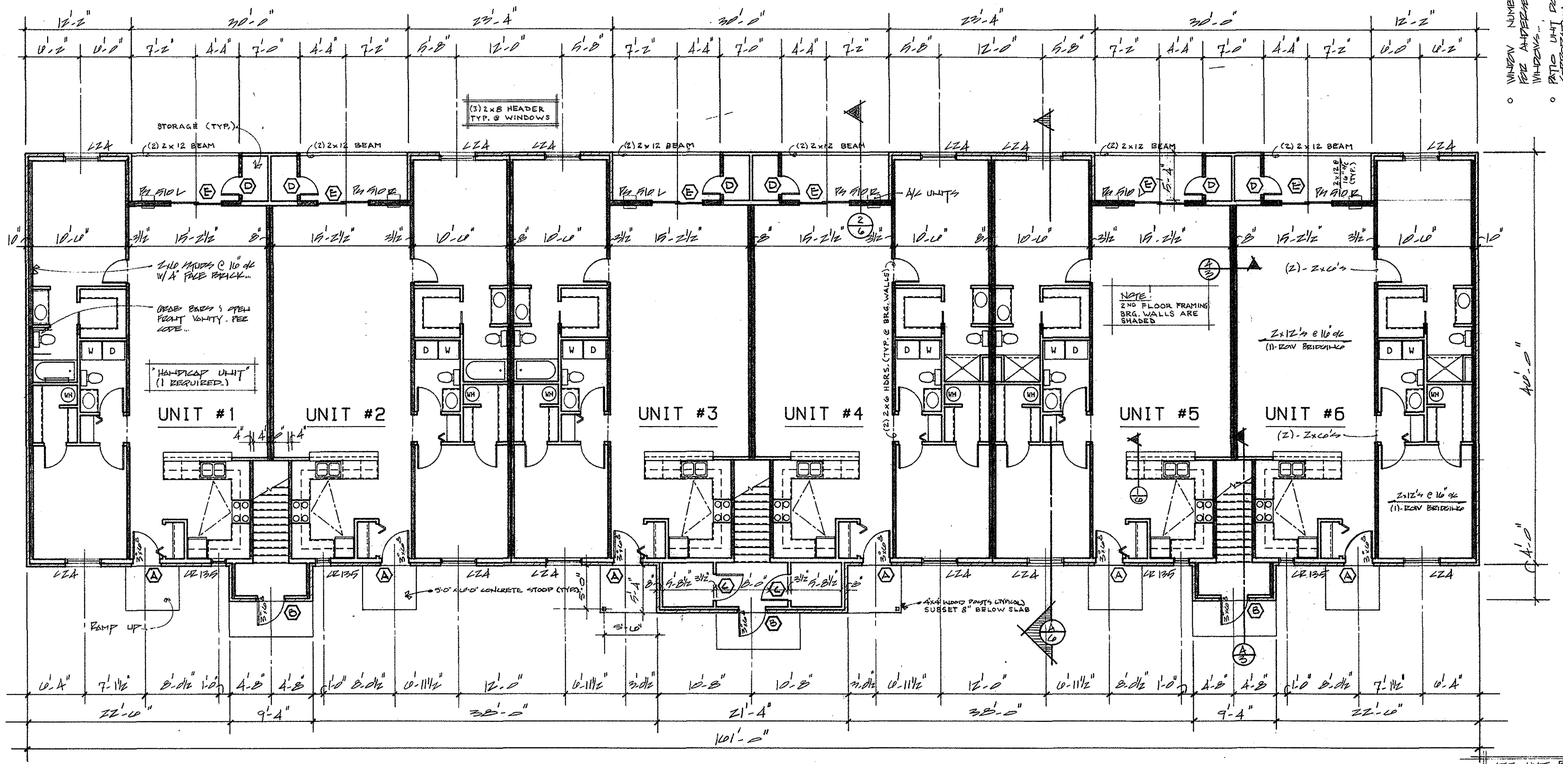
- o The carpentry contract shall include all work under this division, and also supplying labor to install work under Division 7, except insulation; Division 8; (doors, windows, & hardware): and Division 10 (specialties).
- o Roof truss design and State of Wisconsin DILHR approval shall be the responsibility of the supplier prior to fabrication. Design for a superimposed roof load of 30 psf LL, 10 psf DL/TC, and 10 psf DL/BC. Provide shop drawings and State approved drawings.
- o **Structural bearing wall studs and miscellaneous floor joists shall be Douglas Fir Construction grade and Douglas Fir No. 2 as specified above.** Miscellaneous rough framing materials shall be as follows: 2 x 4's and 2 x 6's Southern Yellow Pine, or White Fir, No. 2 construction grade or better; 2 x 10's joist framing Douglas Fir-Larch #2 construction grade or better; with a moisture content not to exceed 20% and shall be kiln dried. Each piece of lumber shall bear the grade and trademark of its producers. Structural and framing lumber shall be S4S unless noted otherwise.
- o Floor joist shall be TJI-35 series joist as manufactured by The Truss Joist Corporation. The TJI joists shall be sized and detailed to fit the dimensions and loads indicated on the plans. All designs shall be in accordance with allowable values and section properties assigned and approved by the building code. Verification of design of the TJI joist by complete calculations is to be available upon request. The TJI joists are to be erected and installed in accordance with the plans, any Trus Joist drawings, and installation suggestions.
- o Plywood roof and wall sheathing shall be of size shown on the drawings of standard INT-APA grade "CDX" (with exterior glue) fir with ply clips if required. "Oxboard" sheathing may be substituted for plywood.
- o Subflooring shall be 5/8" INT-APA grade "CDX" plywood (with exterior glue).
- o Framing lumber and other rough work shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Studs shall be sized to give true surfaces receiving finished materials. Partitions shall be framed with 2 x 4 studs spaced 16" on center, unless detailed otherwise. Plates of partitions resting on concrete floors shall be anchored in place with 1/2" bolts spaced not more than 6' apart. Studs shall be doubled at openings. Headers for openings shall be made of 2 pieces of material set on edge; depth to suit size of opening per applicable code. Corners shall be thoroughly spiked and made solid. End studs of partitions abutting concrete/masonry walls shall be securely anchored, using 1/2" bolts not over 4' o.c. Partitions shall be provided with blocking for trim, recessed cabinets, plumbing, and other work to be concealed. Nailing strips shall be cut-in as required for support of fixtures of all kind.
- o MICRO=LAM beams shall be as manufactured by the Trus Joist Corporation. MICRO=LAM lumber beams shall be designed to meet the dimensions and loads indicated on the plans. All designs shall be in accordance with standard engineering practice. Complete design calculation showing member forces and stresses and allowable load shall be available upon request for each MICRO=LAM lumber beams is to be under the supervision of a registered professional engineer and in accordance with the NRB acceptance, and provisions of The National Design Specification For Wood, 1984.
- o Finished carpentry shall be select oak as shown on the drawings with a moisture content not less than 6% or more than 15%. In no instance shall any woodwork be stored or installed in any area unless the entire area is broom clean, closed in, and possessing a relative humidity below 50% at 70 degrees F. All species shall contain only minor inherent natural defects, except that defects covered by adjoining members, concealed when the stock is installed, or not visible after pigmented finishing (as stain) may be admitted. Lengths shall be in the proportion available in the species and grade specified. Trim members shall be "backed-out" when 1-5/8" wide or wider, and for application on flat surfaces. Exposed surfaces shall be machine sanded on top face surfaces only, matching run otherwise. Working defects, as torn grain, machine marks, cross sanding, tool marks, etc. will not be permitted. Edges shall be milled straight and true, and then exposed corners shall be slightly rounded. Scribing and jointing shall be done accurately and neatly, so as to produce concealed and permanently tight joints, in a uniform plane for best appearance. Unless detailed otherwise, corners shall be mitered, except the inside corners shall be scribed; horizontal running trim shall butt vertical standing trim. Joints in horizontal running trim shall be scarfed, glued, and nailed. Where nailing is exposed, use finishing nails, counter-sunk.
- o Miscellaneous fasteners and rough carpentry hardware where not called out on the drawings shall be of a size and spacing which will develop the full strength of the members being fastened.
- o Cabinets shall be furnished and installed by others. Bid shall include the installation of backing materials as required.
- o This contractor shall provide closet shelving, rods, and miscellaneous trim work implied for a complete job.

GENERAL NOTES continued on Sheet #5



SECOND FLOOR PLAN

SCALE : 1/8" = 1'-0"



FIRST FLOOR PLAN

SCALE : 1/8" = 1'-0"

SEE UNIT PLAN SHT. #5 FOR INTERIOR PARTITION WALL LOCATIONS

- o WINDOW NUMBERS SHOWN ARE FOR APPROVAL PURPOSES ONLY. REFER TO ELEVATIONS FOR ACTUAL WINDOWS.
- o REFER TO UNIT PLANS FOR CABINET LOCATIONS.
- o VERIFY ROUGH OPENINGS FOR ALL APPLIANCES WITH ACTUAL APPLIANCES TO BE USED.

DRAWN BY: [illegible]
APPROVED BY:

REVISIONS	
BY	DATE

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THREE 12 UNIT BUILDINGS FOR --
FOXSHORES APARTMENTS / CONDOMINIUMS
390, 400 & 410 FOXSHORES COURT. KAUKAUNA, WISCONSIN
A GORDON O. JACOBSON DEVELOPMENT

PROJECT NO: 8957.01
DATE: 7-25-90
SHEET: 4 OF 12.

G E N E R A L   N O T E S   continued from Sheet #4

7. DIVISION 7 -- THERMAL & MOISTURE PROTECTION

7A. Insulation:

- o Building wall insulation shall be standard fiberglass, 3-1/2" full thick, friction fits and unfaced batt insulation with an R = 19 value as shown on the drawings. Ceiling insulation shall be standard fiberglass or mineral fiber (rockwool) blown insulation to provide a total R-value = 46. Special care shall be taken to fill all voids between members, window frames, door frames, sleeves, mechanical piping, etc. to provide a completely insulated system. Framed areas are to be provided with a 4 mil (.004") polyethylene film vapor barrier.

7B. Thermal & Moisture Protection (by Carpentry Contractor)

- o Roofing shall be a 225 pound fiberglass shingle, Class "A" similar to Johns-Mansville "Fire-Glass III, Seal-o-Matic," or equal. Color as selected by the Architect/Owner. Submit samples for approval. Apply one layer of #15 felt underlayment over plywood sheathing, lapping 2" at horizontal and 6" at vertical joints. At eaves provide a double layer two feet into interior space. Secure to hold in place. Install Type "D" galvanized or bronze P.V.S. roof edge and starter strip; project over edge of sheathing 3/8" to form a drip. Use fasteners of hot galvanized steel or aluminum (10-1/2 to 12 gauge) roofing nails having heads of at least 3/8" diameter. Use nails of sufficient length to penetrate sheathing. Seal perimeter edges of shingle with a roofing cement. Install shingles per manufacturer's standard specifications for the shingles used.
- o Flashing and sheet metal shall be of a 26 ga. galvanized iron of best commercial grade, fabricated to the size and contour as shown on the drawings. Use galvanized where not exposed to view. For sheet metal flashings exposed to view, use 26 ga. polyvinyl steel similar to Color Klad as manufactured by Vincent Brass Co. Provide polyvinyl ethylene sheet flashing as noted on the drawings of 6 mil. thickness.
- o Soffits and fascia system shall be of preformed aluminum similar to Rollex-3. Provide trim pieces and accessories for complete job. Color as selected by the Architect. Seamless gutters and downspouts shall be color matched of .032" and .024" aluminum respectively.
- o All wood framing areas shall be covered /wrapped with Tyvek infiltration paper per the manufacturer's printed recommendations.

8. DIVISION 8 -- WINDOWS, DOORS & HARDWARE

- o Windows numbers shown are Andersen Perma-Shield by the Andersen Corp. Final selection of the windows units to be used shall be made by the Owner/CM. Units shall be vinyl clad w/ the manufacturer's standard material. Glaze with the manufacturer's standard double pane insulating glass, provide insect screen, and extension jambs as required per the window details shown.
- o Apartment door units shall be cored for locksets, dead bolts, "peep hole", and prepared for a knocker.
- o Wood doors shall be as shown on the door schedule sheet #A-7. Doors shall be solid core (standard "K" core) with Red Oak face veneer; or hollow core with Red Oak face veneer as scheduled. Doors shall be AWI "Premium" grade or better. Door jambs and casings shall be solid oak milled material.
- o Bi-fold closet doors shall be the same as above or as scheduled, with bi-fold hardware.
- o Hollow metal doors shall be 1-3/4" thick with skin sheeting of 18 gauge steel with fiber core fill. Shop prime. Frame assemblies shall be 14 gauge and shall be provided with anchorage devices as required. Shop prime and prepare for hardware. Submit shop drawings for approval. Doors and frames shall be reinforced to accept finish hardware per the manufacturer's recommendations.
- o All doors and frames shall be hung and set true and with uniform clearance along the edges. Prepare doors for grilles if any, and glazing as shown on the door schedule. Grilles to be furnished by the door supplier (see HVAC drawings).
- o Finish hardware bids shall be submitted with a proposed hardware schedule prepared by the supplier. In general, apartment hardware shall be Schlage residential series Light Duty F series "Georgian style". Apartment doors shall be furnished with lockset, dead bolts, view holes, and knockers. Other hardware shall be Schlage "D" series, with LCN closers, Hager hinges, etc.; or approved equals.
- o Apartment and garage interior door units shall be Peachtree "Avanti" model #A100, #A300, A31C; or equal. Doors shall be constructed of 24 ga. galvanized steel faces over a foamed-in-place polyurethane core. Unit shall be 1-3/4" thick, have an R-value=14.1 and be fire rated per ASTM E-152 of 3/4 hour (C-label). Doors shall be weather stripped and have the standard threshold.
- o Overhead doors shall be steel sectional upward acting Raynor "Decade R/S" Series Residential garage doors; or equal. Door shall be constructed of 24 gauge galvanized steel and shall be a four panel, four section prefinished acrylic baked on enamel. Door shall be insulated with 1-3/8" expanded polystyrene with fire retardant additive. Track shall be 2" regular head room, with torsion spring operation. Provide weather stripping four (4) sides perimeter of doors. Doors shall be warranted for one year against defective materials and workmanship. Install per the manufacturer'e written specifications.

9. DIVISION 9 -- FINISHES

- o Carpeting, sheet vinyl, and ceramic tile work shall be as directed by the Owner and / or Construction Manager.

9A. Gypsum Wall Board:

- o Gypsum base board (drywall) shall be 1/2" and 5/8" as shown, of regular and fire core (type X), 4'-0" x lengths as required. Use 5/8" for 24" centers and 1/2" all others. Fasteners shall be power driven, type "S" bugle head, 1" long. Provide all accessories necessary for an installation per the manufacturer's printed specifications. See Room finish schedule sheet #4.
- o Gypsum board shall be finished with a three coat system, with a fourth/final spray coating with sand textured finish.

9B. Painting & Staining:

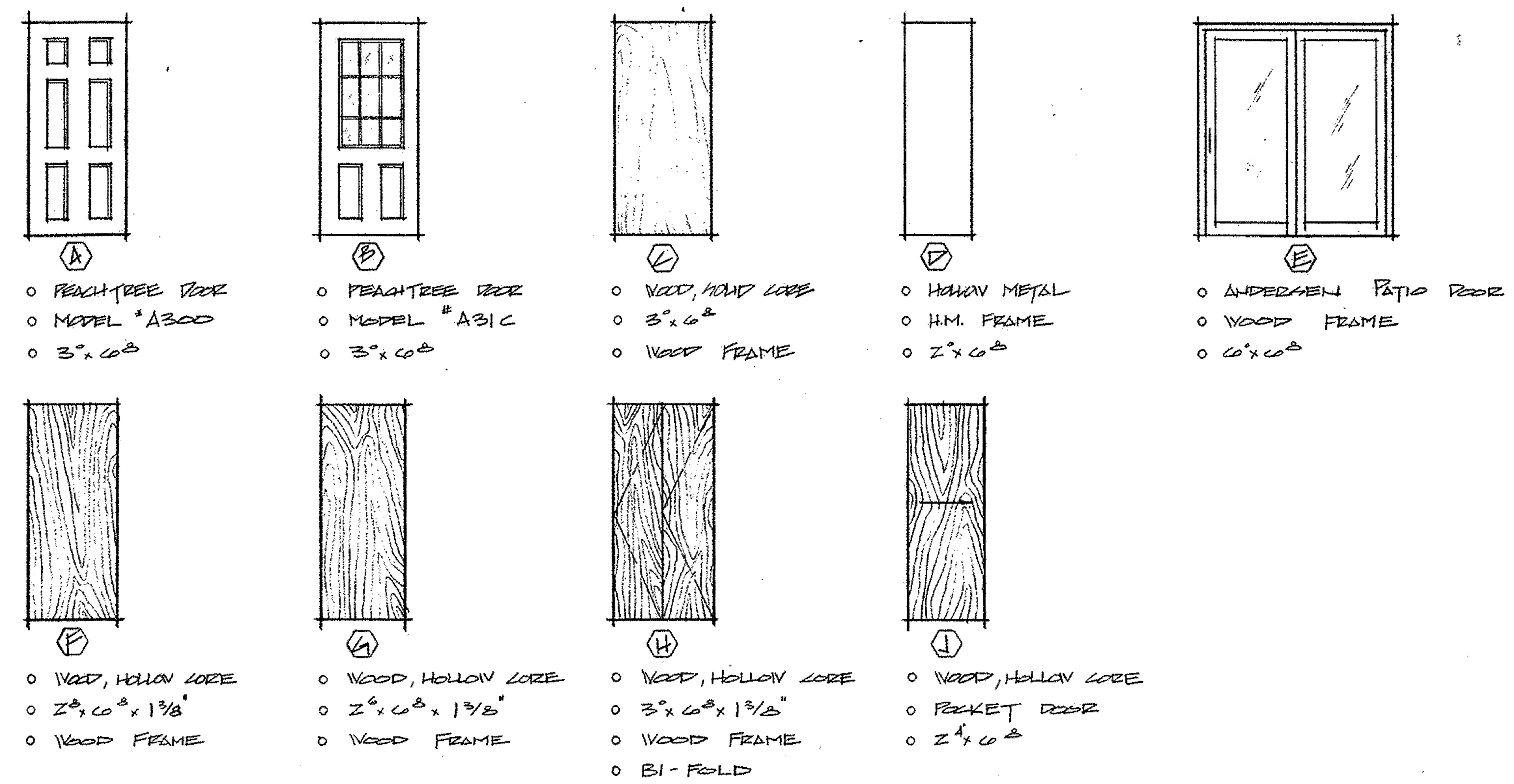
- o Painting and staining shall be by an established firm.
- o The painting contractor shall furnish labor and materials to stain and varnish with a three coat system (stain, sealer, varnish) all exposed wood surfaces, including tops and bottoms of all doors. In general, this includes doors, frames, windows, casings, handrails, baseboard, and shelving, (cabinets are prefinished). Verify with CM other materials prefinished and the extent of work regarding this section.
- o Paint all gypsum surfaces with two coats (plus primer if required for good coverage) system of flat latex except kitchen and bathrooms, which shall have a final coat of semi-gloss latex. Colors for all coats as selected by the Owner. Submit to this office a color chart from the proposed manufacturer.
- o Each container shall be labeled by the manufacturer stating type of paint, color of paint, and instructions for reducing. Brush roll, or spray materials smoothly in solid, even colors without drops, runs, lumps, defective brushing, discoloration or clogging of lines and angles. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping. Apply per manufacturer's printed recommendations.
- o Hollow metal doors & frames shall be coated with two coats of an oil base flat enamel. Colors as selected by the Owner.

10. DIVISION 10 -- SPECIALTIES

- o Provide an allowance for shower rod, bathroom towel bar (30") and paper holder for installation in all each bathroom. Final selection of hardware to be made by the Owner.
- o Fire extinguishes shall be "Kidde" model #6TPS; 2A-40BC, 6 lb./gal. extinguishes, or approved equal. Provide recessed cabinets for installation by others. Submit shop drawings & installation instructions. Units shall be red, with break glass entrance.
- o Smoke detectors shall be provided where shown on the electrical plan. Detectors shall be ionization units, with test button, solid state, white polymer housing, powered by a 9-volt alkaline battery, similar to First Alert, or equal. (25 required thus).
- o Appliances by Owner/CM per building; Ranges (12), Refrigerators (12), Ductless Range Hoods (12), Dishwashers (12).

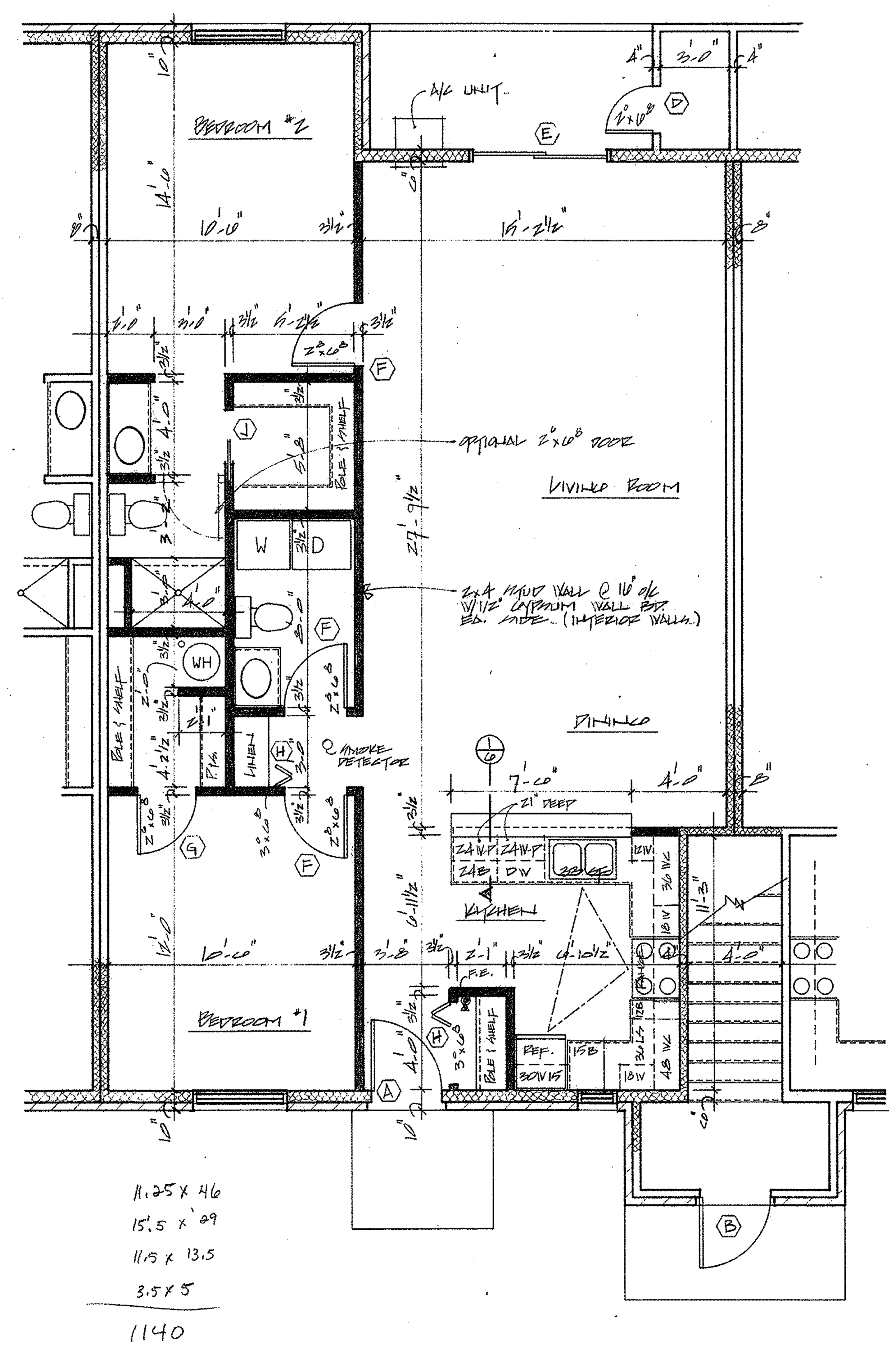
15. & 16. DIVISIONS 15A, 15B, & 16.

- o Mechanical & Electrical System specifications and notes are found on the mechanical plans. Bids shall be submitted separately as base bids.



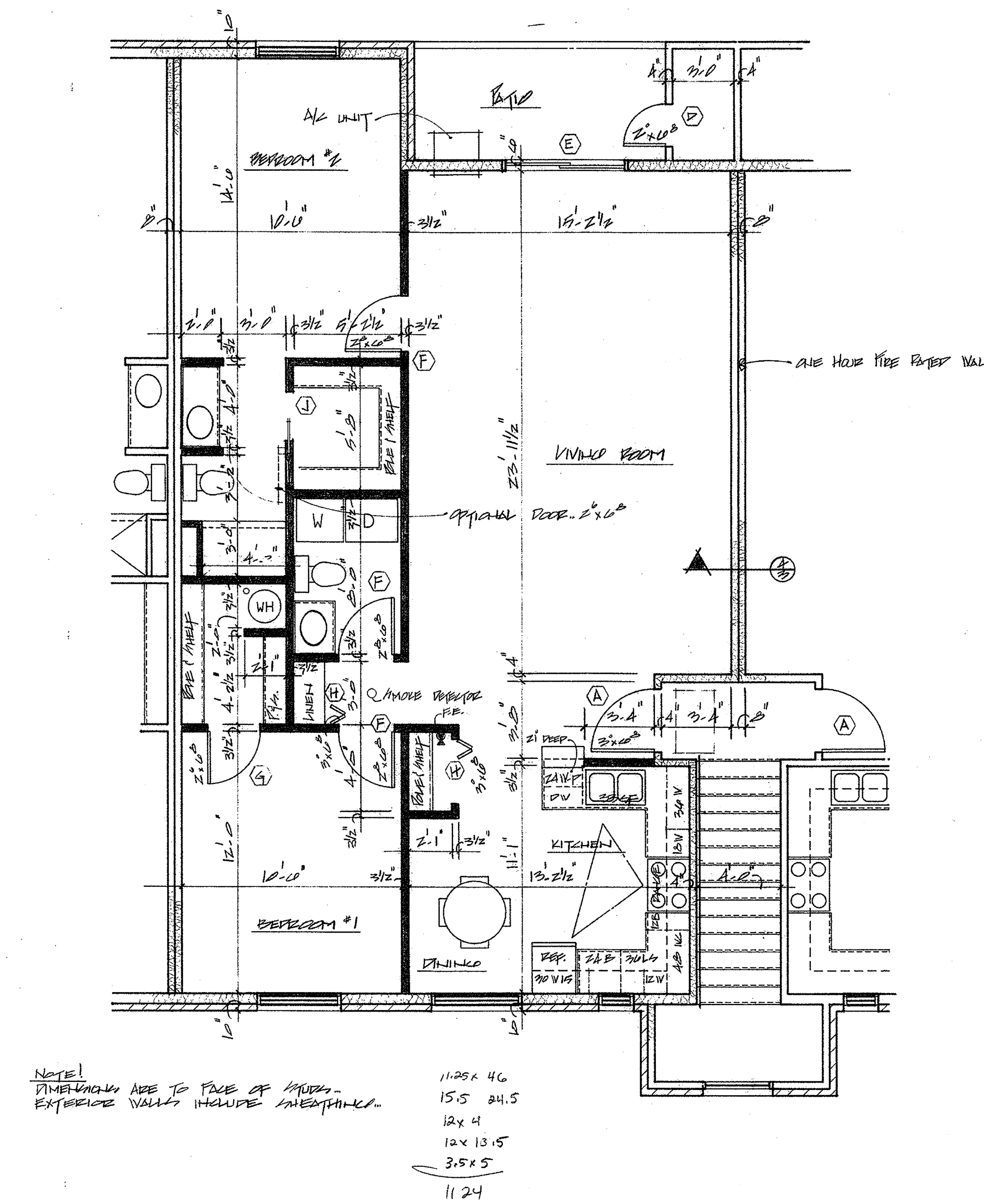
R O O M   F I N I S H   S C H E D U L E

ROOM NAME	FLOOR	BASE	WALLS NORTH	WALLS WEST	WALLS SOUTH	WALLS EAST	CEILING	CEILING HEIGHT	REMARKS
FOYER	VINYL	2 1/4" OAK	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYPSUM BOARD	8'-0"	
STAIRWAY	CARPET	VINYL						VARIES	
STORAGE	CONCRETE	—	↓	↓	↓	↓	↓	8'-0"	
TYPICAL APARTMENT:									
LIVING ROOM	CARPET	2 1/4" OAK	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYPSUM BOARD	8'-0"	
DINING RM. 1ST FLOOR	CARPET	2 1/4" OAK						8'-0"	
DINING RM. 2ND FLOOR	VINYL	2 1/4" OAK						8'-0"	
KITCHEN	VINYL	2 1/4" OAK						8'-0"	
BATHROOMS	VINYL	2 1/4" OAK						8'-0"	
BEDROOM #1	CARPET	2 1/4" OAK						8'-0"	
BEDROOM #2	CARPET	2 1/4" OAK	↓	↓	↓	↓	↓	8'-0"	
CLOSETS	CARPET	2 1/4" OAK	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYP. WALL BOARD	PAINTED GYPSUM BOARD	8'-0"	



TYPICAL UNIT PLAN —— FIRST FLOOR

SCALE : 1/4" = 1'- 0"



TYPICAL UNIT PLAN —— SECOND FLOOR

SCALE : 1/4" = 1"- 0"

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TG/AT
APPROVED BY
REVISIONS
BY / DATE

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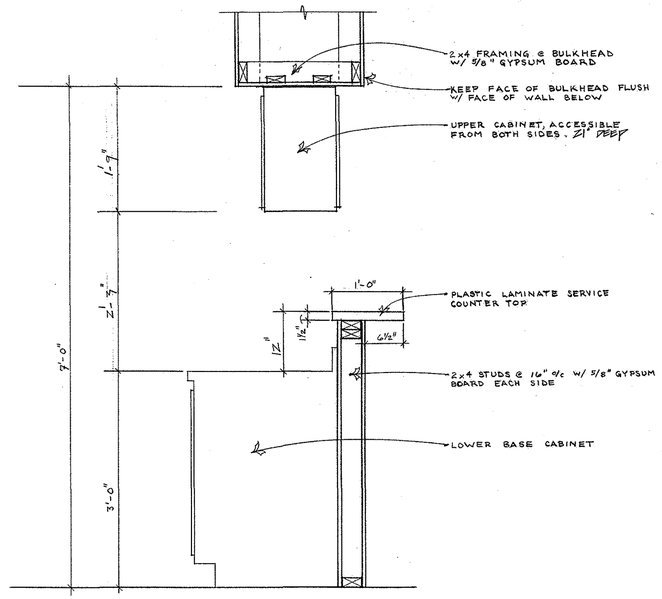
THREE 12 UNIT BUILDINGS FOR --

FOXSHORES APARTMENTS / CONDOMINIUMS

390, 400 & 410 FOXSHORES COURT. KAUKAUNA, WISCONSIN

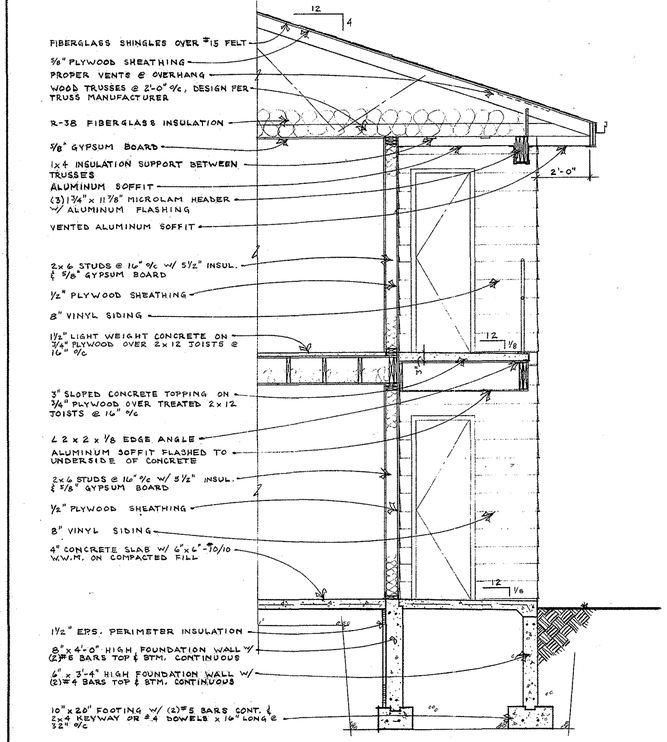
A G O R D O N D. J A C O B S O N D E V E L O P M E N T

PROJECT NO
8957.01
DATE
7-25-90
SHEET
5 of 12.



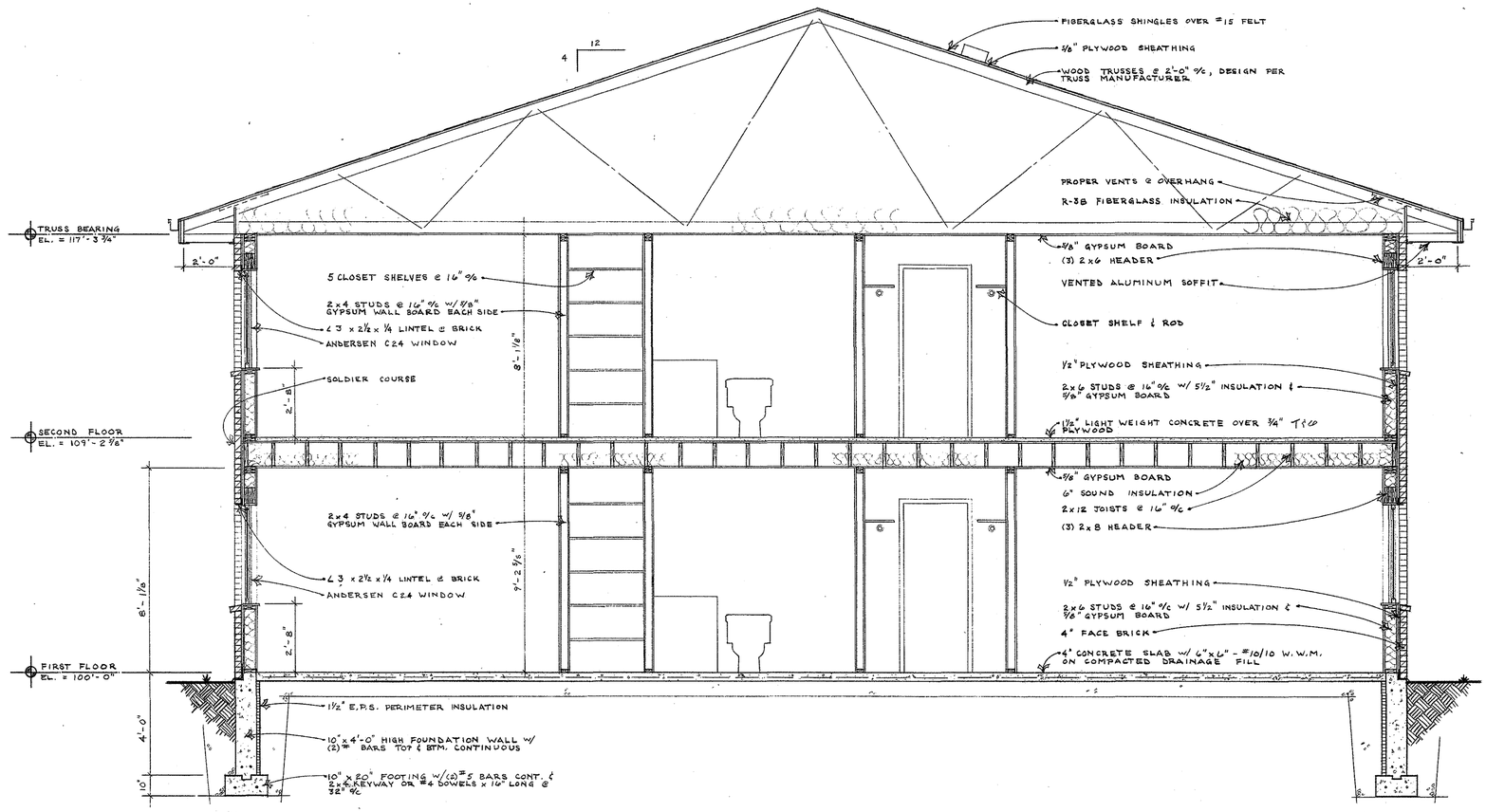
1/6 SECTION @ COUNTER/CABINETS

SCALE: 1" = 1'-0"



2/6 SECTION @ BALCONIES

SCALE: 3/8" = 1'-0"



A/6 BUILDING CROSS SECTION

SCALE: 3/8" = 1'-0"

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APPROVED BY

REVISIONS

BY	DATE

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THREE 12 UNIT BUILDINGS FOR --
FOXSHORES APARTMENTS / CONDOMINIUMS
390, 400 & 410 FOXSHORES COURT, KAUKAUNA, WISCONSIN
A GORDON O. JACOBSON DEVELOPMENT

PROJECT NO. 9197.01

DATE 7.25.90

SHEET 6 OF 10

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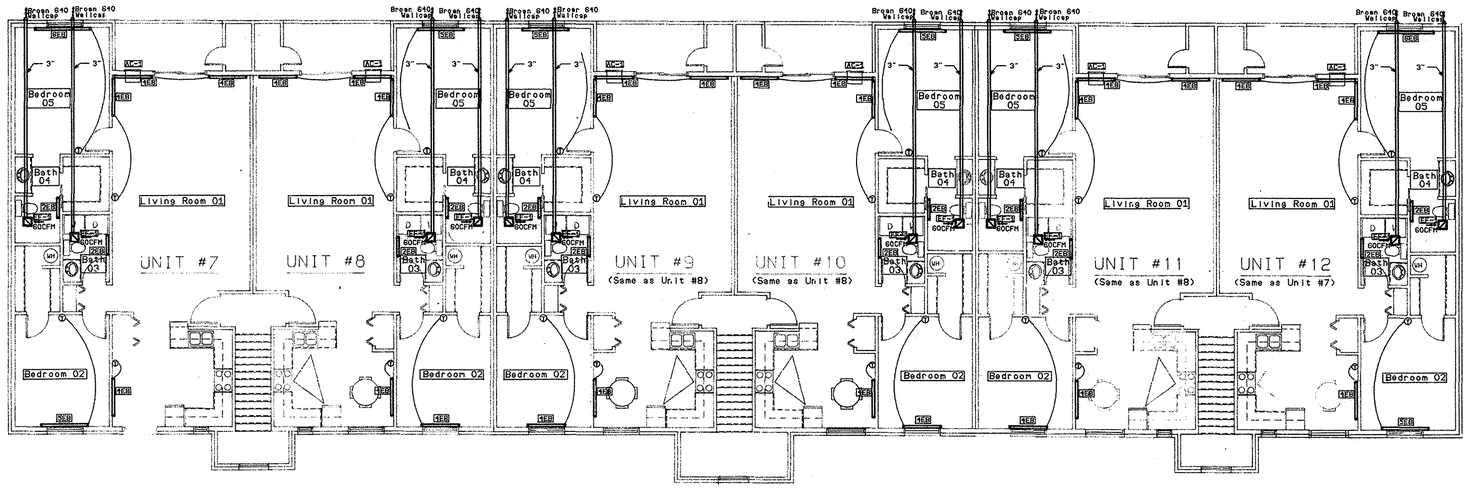
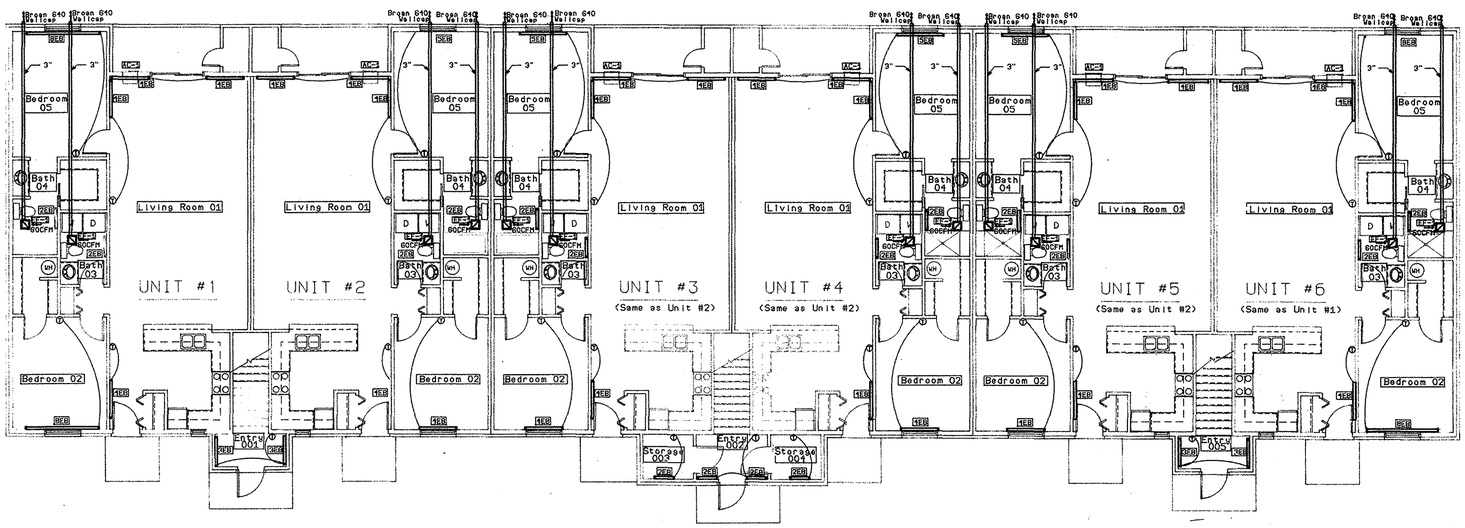


SECOND FLOOR PLAN

SCALE : 1/8" = 1'-0"



FIRST FLOOR PLAN

SCALE : 1/8" = 1'-0"

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APPROVED BY

REVISIONS

BY	DATE

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THREE 12 UNIT BUILDINGS FOR --
FOXSHORES APARTMENTS / CONDOMINIUMS
390, 400 & 410 FOXSHORES COURT, KAUKAUNA, WISCONSIN
A. GORDON JACOBSON DEVELOPMENT

PROJECT NO
8957.01

DATE
7-25-90

SHEET
HVAC -1
7 of 12

1. SCOPE
   A. THE WORK COVERED BY THIS DIVISION OF THE SPECIFICATIONS WILL BE AWARDED AS A SEPARATE CONTRACT AND INCLUDES THE FURNISHING OF ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, TRANSPORTATION, PERMITS, CERTIFICATES AND TEMPORARY PROTECTION NECESSARY FOR OR INCIDENTAL TO EXECUTING AND COMPLETING THE RELATED WORK AS HEREIN SPECIFIED OR AS INDICATED ON THE DRAWINGS.

   B. WORK EXCLUDED FROM THIS CONTRACT INCLUDES: LINE VOLTAGE, ELECTRICAL WIRING AND CONNECTIONS TO EQUIPMENT.

2. GENERAL REQUIREMENTS
   A. THE CONTRACTOR SHALL LAY OUT HIS WORK AND SHALL BE RESPONSIBLE FOR ITS CORRECTNESS. HE SHALL TAKE SUCH MEASUREMENTS AS MAY BE NECESSARY TO ASSURE APPROVED FITTING AND PROPER INSTALLATION OF HIS WORK, AND ALL OTHER WORK DEPENDING THERON

   B. HEATING CONTRACTOR SHALL COOPERATE WITH OTHER CONTRACTORS TO AVOID COMPLICATIONS BETWEEN INSTALLATION OF HEATING AND VENTILATING EQUIPMENT AND EQUIPMENT INSTALLED BY OTHERS.

   C. THE HEATING CONTRACTOR SHALL ESPECIALLY CONFER WITH THE ELECTRICAL CONTRACTOR TO AVOID INTERFERENCES; WHEN DIFFERENCES OF OPINION RESULT AS TO THE USE OF AVAILABLE SPACE, THE OPINION OF THE ARCHITECT SHALL GOVERN SUCH A CONTROVERSY.

   D. THIS CONTRACTOR SHALL VISIT THE SITE AND VERIFY EXISTING CONDITIONS, LOCATIONS AND REQUIREMENTS. IT IS THE CONTRACTORS RESPONSIBILITY TO BE FAMILIAR WITH ALL REQUIREMENTS OF EXISTING AND REQUIRED ADDITIONS TO COMPLETE THE INSTALLATION IN COMPLETE COMPLIANCE WITH THE INTENT OF THE PLANS AND SPECIFICATIONS. NO ADDITIONS WILL BE ALLOWED FOR ITEMS OVERLOOKED.

3. CODES AND PERMITS
   A. ALL WORK AND MATERIAL SHALL COMPLY WITH ALL FEDERAL, STATE AND LOCAL CODES AND ORDINANCES. CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS AS APPLICABLE TO WORK UNDER THIS CONTRACT.

4. GUARANTEE
   A. THE CONTRACTOR MUST GUARANTEE THAT ALL OF THE MATERIAL FURNISHED BY HIM IS OF A QUALITY AS SPECIFIED AND FREE FROM DEFECTS IN VERY RESPECT, AND IF SO ORDERED BY THE ARCHITECT, HE SHALL REMOVE ANY DEFECTIVE MATERIAL AND REPLACE THE SAME WITH MATERIAL OF PROPER QUALITY. ALL WORK SHALL BE QUARANTEED AGAINST ORIGINAL DEFECTS IN WORKMANSHIP AND MATERIAL FOR A PERIOD OF ONE YEAR FROM DATE OF FINAL ACCEPTANCE OR OCCUPANCY BY THE OWNER, WHICHEVER IS EARLIER. ANY DEFECTIVE WORKMANSHIP OR MATERIAL DEVELOPING WITHIN THAT TIME SHALL BE REPLACED FREE OF COST TO THE OWNER.

5. SHOP DRAWINGS
   A. SUBMIT FOUR (4) SETS OF DRAWINGS FOR ALL EQUIPMENT TO THE ARCHITECT FOR APPROVAL. SUBMITTALS SHALL INCLUDE AIR CONDITIONERS, FANS, ELECTRIC HEATERS AND TEMPERATURE CONTROLS.

6. CUTTING & REPAIRING
   A. CONTRACTOR SHALL DO ANY NECESSARY CUTTING OF WALLS, PARTITIONS AND FLOORS AND SHALL PATCH UP AROUND SUCH CUTTING IN SUCH MANNER AS TO LEAVE THE BUILDING IN GOOD CONDITION. ALL SUCH CUTTING AND RESTORATION IS TO BE PERFORMED UNDER THE DIRECTION OF AND TO THE SATISFACTION OF THE OWNER. THE CONTRACTOR SHALL COOPERATE WITH OTHER CONTRACTORS TO REDUCE CUTTING TO THE VERY MINIMUM.

7. PIPING
   A. FLEX DUCTS FROM EXHAUST FANS SHALL BE PIPED BY THIS CONTRACTOR. VERIFY LOCATION AND REQUIREMENTS.

8. CONTROL SEQUENCE
   A. THERMOSTAT SHALL CYCLE HEATING OR COOLING EQUIPMENT TO MAINTAIN SPACE TEMPERATURE.

9. EQUIPMENT
   A. AC-1 SHALL BE EQUAL TO WHITE-WESTINGHOUSE OF MODEL, SIZE, AND CAPACITY INDICATED ON PLAN. UNITS SHALL HAVE A WALL SLEEVE THAT ENABLES CHASSIS TO SLIDE INTO AND COME COMPLETE WITH TWO SPEED COOLING FAN, ADJUSTABLE AIR DEFLECTORS, BUILT IN THERMOSTAT, AND VENTILATION CONTROL.

   B. EXHAUST FANS SHALL BE BROAN OR EQUAL OF CAPACITIES AND EQUAL TO MANUFACTURERS AS SHOWN ON PLANS, ALL FANS SHALL BE FURNISHED COMPLETE WITH BACKDRAFT DAMPERS, DISCONNECTS AND BIRD GUARDS AS REQUIRED.

   C. ELECTRIC HEATERS SHALL BE EQUAL TO T.P.I. OF MODELS AND CAPACITIES AS SHOWN, ALL UNITS SHALL BE COMPLETE WITH UL LABELS AND BE INSTALLED IN COMPLIANCE WITH MANUFACTURER'S REQUIREMENTS AND ALL APPLICABLE CODES.

10. ELECTRICAL HEATERS
   A. ELECTRIC HEATERS SHALL BE T.P.I. OR EQUAL OF SIZES AND CAPACITIES INDICATED ON PLANS. UNIT SHALL BE U.L. LISTED AND HAVE ALL SAFETY AND OPERATING CONTROLS NECESSARY. PROVIDE HEATERS WITH ALL NECESSARY COMPONENTS REQUIRED FOR PROPER INSTALLATION.

11. CONCRETE PADS.
   A. ALL CONCRETE PADS FOR MECHANICAL EQUIPMENT WILL BE FURNISHED BY H.V.A.C. CONTRACTOR.

12. LUBRICATION
   LUBRICATE ALL EQUIPMENT PRIOR TO INITIAL START UP IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. ALL LUBRICATION POINTS SHALL BE CLEARLY MARKED.

   FURNISH A LUBRICATION SCHEDULE LISTING ALL POINTS OF LUBRICATION FOR EACH PIECE OF MECHANICAL EQUIPMENT, FREQUENCY OF LUBRICATION, AND TYPE OF LUBRICANT REQUIRED AT EACH POINT.

13. HOUSEKEEPING
   IT SHALL BE THE DUTY OF THIS CONTRACTOR TO KEEP THE BUILDING CLEAN AND FREE OF DEBRIS DURING THE INSTALLATION OF HIS WORK.

14. TESTING AND BALANCING
   THE FINAL PAYMENT TO THE HEATING CONTRACTOR WILL NOT BE MADE UNTIL THE SYSTEM HAS BEEN THOROUGHLY TESTED AND FOUND TO BE IN GOOD ORDER AND IN FIRST CLASS OPERATING CONDITION IN EVERY PARTICULAR.

15. INSTRUCTIONS

   OPERATIONAL INSTRUCTIONS: COPIES OF STANDARD OPERATIONAL INSTRUCTIONS SHALL BE FURNISHED TO THE OWNER FOR ITEMS OF EQUIPMENT INCLUDED IN THIS CONTRACT.

   MAINTENANCE INSTRUCTIONS: THE CONTRACTOR SHALL REVIEW WITH THE OWNER'S REPRESENTATIVE, COMPLETE MAINTENANCE PROCEDURES FOR EQUIPMENT INSTALLED UNDER THIS CONTRACT.

16. ELECTRICAL REQUIREMENTS

   THE HEATING AND VENTILATING CONTRACTOR SHALL FURNISH ALL STARTING EQUIPMENT AND CONTROLS NECESSRY FOR OPERATION OF EQUIPMENT FURNISHED UNDER THIS DIVISION THE ELECTRICAL CONTRACTOR SHALL DO ALL LINE VOLTAGE WIRING.

   THE HEATING AND VENTILATING CONTRACTOR SHALL FURNISH ALL NECESSARY WIRING DIAGRAMS, CONTROL SEQUENCE DRAWINGS, ETC., AS MAY BE REQUIRED FOR COORDINATION OF WORK BETWEEN CONTRACTORS.

   STARTERS SHALL BE ALL OF SAME MANUFACTURE AND SHALL BE MAGNETIC, ACROSS THE LINE TYPE OF SIZE NECESSARY TO OPERATE THE MOTOR OR SYSTEM IT CONTROLS. THE ELECTRICAL CONTRACTOR WILL FURNISH NECESSARY, ADEQUATE DISCONNECTS WITHIN SITE OF MOTOR LOCATION.

17. FINALLY
   THIS CONTRACT CONTEMPLATES AND COMPRISES A COMPLETE AND WORKMANLIKE INSTALLATION OF LHEATING AND VENTILATING SYSTEM AS HEREIN BEFORE SPECIFIED AND ANYTHING NECESSARY TO THAT RESULT IS HEREBY INCLUDED THE SAME AS IF PARTICULARLY MENTIONED.

   WHEN COMPLETED, THE CONTRACTOR SHALL REMOVE ALL DEBRIS, TOOLS, MACHINES, AND APPARTUS OF EVERY SORT BELONGING TO HIM, LEAVING THE PREMISES FREE FROM ANYTHING OF THE KIND.

EXHAUST FAN SCHEDULE

UNIT NO.	CFM	AMPS	RPM	SONES	VOLTAGE	MFG.'S NAME	MFG.'S NUMBER	REMARKS
EF-1	60	.75	2400	3.5	120/60/1	BROAN MFG.	• 689	INTERLOCK W/LIGHT SWITCH

THRU WALL AIR CONDITIONER SCHEDULE

UNIT NO.	BTUH	VOLTAGE	AMPS	EER	FAN CFM	MFG.'S NAME	MFG.'S NUMBER	REMARKS
AC-1	18,000	240/60/1	8.5	9.2	520	WHITE WESTINGHOUSE	AS189L2K	THRU WALL UNIT W/SLEEVE

ELECTRIC BASEBOARD SCHEDULE

UNIT NO.	BTUH	WATTS	AMPS	MFG.'S NAME	MFG.'S NUMBER	VOLTAGE	REMARKS
2-EB	1707	500	2.1	T.P.I.	CC2D05	230/60/1	1. ALL BASEBOARD IN BATHROOMS MUST BE 4' ABOVE FLOOR.
3-EB	2557	750	3.1	T.P.I.	CC2D07	230/60/1	2. PROVIDE 1D22-3 •WALL THERMOSTAT WHERE SHOWN.
4-EB	3413	1000	4.2	T.P.I.	CC2D10	230/60/1	3. WHERE WALL THERMOSTAT IS NOT SHOWN, TC-1• BUILT-IN THERMOSTAT.
5-EB	4266	1250	5.2	T.P.I.	CC2D12	230/60/1	
6-EB	5120	1500	6.3	T.P.I.	CC2D15	230/60/1	
8-EB	6826	2000	8.3	T.P.I.	CC2D20	230/60/1	
10-EB	8533	2500	10.4	T.P.I.	CC2D25	230/60/1	

•BASED ON T.P.I.

BIRSCHBACH & ASSOCIATES, LTD.
ARCHITECTURE
P.O. BOX 310 KAUKAUNA, WISCONSIN 54130-0310
1801 CROOKS AVENUE
414-766-4827
FAX# 766-9804

DRAWN BY

APPROVED BY

REVISIONS

BY	DATE

THREE 12 UNIT BUILDINGS FOR --
FOXSHORES APARTMENTS / CONDOMINIUMS
390, 400 & 410 FOXSHORES COURT. KAUKAUNA, WISCONSIN
A. GORDON O. JACOBSON DEVELOPMENT

PROJECT NO
8957.01

DATE
7-29-90

SHEET
HVAC-2

8 of 12

12/21/01
CC: Maint - Carp
Whse!
E. H.
S. B.

MATERIAL SAFETY DATA SHEET

Dow Chemical U.S.A.* Midland, MI 48674 Emergency Phone: 517-636-4400

Product Code: 81982 Page: 1

PRODUCT NAME: STYROFOAM (R) BRAND SCORE BOARD EXTRUDED POLYSTYRENE INSULATION (2 INCH)

Effective Date: 07/31/89 Date Printed: 12/13/89 MSDS:002462

1. INGREDIENTS: (% w/w, unless otherwise noted)

Polystyrene	CAS# 009003-53-6	Balance
Dichlorodifluoromethane	CAS# 000075-71-8	0-7.5%
Chlorodifluoroethane	CAS# 000075-68-3	0-9.5%
Ethyl chloride	CAS# 000075-00-3	0-4.0%
Polyethylene	CAS# 009002-88-4, or CAS# 026221-73-8	0-6.0%
Hexabromocyclododecane (HBCD)	CAS# 003194-55-6	0-2.0%
Pentabromomonochlorocyclohexane	CAS# 000087-84-3	0-2.0%

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

2. PHYSICAL DATA:

BOILING POINT: Not applicable
VAP. PRESS: Not applicable
VAP. DENSITY: Not applicable
SOL. IN WATER: None
SP. GRAVITY: .027 To .064
APPEARANCE: Rigid cellular foam board.
ODOR: No odor.

3. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT: 670F, 354C Flash ignition temperature.
METHOD USED: ASTM D1929 Proc. B.

FLAMMABLE LIMITS
LFL: Not applicable.
UFL: Not applicable.

(Continued on Page 2)
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3. FIRE AND EXPLOSION HAZARD DATA: (CONTINUED)

EXTINGUISHING MEDIA: Water fog.

FIRE & EXPLOSION HAZARDS: Emits dense, black smoke when burned.

Certain operations, such as grinding or cutting, may lead to a buildup of dust suspended in air which can cause a dust explosion if ignited. Provide adequate ventilation, and appropriate dust handling systems.

FIRE-FIGHTING EQUIPMENT: Wear positive-pressure, self-contained breathing apparatus.

Apply large volume of water directly on flame or burning surface.

4. REACTIVITY DATA:

STABILITY: (CONDITIONS TO AVOID) Avoid fire and high temperatures. Temperatures over 300C (572F) will release combustible gases.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Aromatic hydrocarbons, higher (>C5) aliphatic hydrocarbons, esters, amines, higher aldehydes.

HAZARDOUS DECOMPOSITION PRODUCTS: Does not normally decompose. In smoldering or flaming conditions, carbon monoxide, carbon dioxide, carbon are generated. Evolution of small amounts of hydrogen bromide, hydrogen chloride and hydrogen fluoride occurs when burned or heated over 250C (482F); under high heat, non-flaming conditions, small amounts of aromatic hydrocarbons such as styrene and ethylbenzene are generated.

Studies have found that the products of combustion of this

(Continued on Page 3)

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4. REACTIVITY DATA: (CONTINUED)

polystyrene foam insulation are no more acutely toxic than the products of combustion of other common building material such as wood.

HAZARDOUS POLYMERIZATION: Will not occur.

5. ENVIRONMENTAL AND DISPOSAL INFORMATION:

ACTION TO TAKE FOR SPILLS/LEAKS: Pick up, or if dust or in small pieces, sweep up and place in suitable container for disposal.

DISPOSAL METHOD: Bury in an approved landfill, or burn in an adequate incinerator with excess oxygen, in accordance with all local, state and federal regulations.

HEALTH HAZARD DATA:

EYE: Solid or dust may cause irritation or corneal injury due to mechanical action.

SKIN CONTACT: Mechanical injury only. Essentially nonirritating to skin.

SKIN ABSORPTION: Skin absorption is unlikely due to physical properties.

INGESTION: Ingestion is unlikely due to physical state. Physical injury only. May cause choking if swallowed.

INHALATION: Dust may cause irritation to upper respiratory tract. Excessive exposure to high concentrations of the ethyl chloride, dichlorodifluoromethane, and chlorodifluoroethane blowing agents may cause central nervous system depression, anesthetic effects and irregular heartbeats (cardiac sensitization). In animals, excessive exposure to chlorodifluoroethane has caused low blood

(Continued on Page 4)

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6. HEALTH HAZARD DATA: (CONTINUED)

pressure, respiratory stimulation and tightness in the chest (bronchoconstriction). Concentrations of the above blowing agents anticipated incidental to proper handling are expected to be well below those which cause the acute inhalation effects listed above, as well as below the OSHA PEL and Dow Industrial Hygiene Guide. (See Section 8 for Handling Precautions.)

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Repeated exposures to dusts of this material are not anticipated to result in systemic toxicity or permanent lung injury; however, excessive exposures may cause less severe respiratory effects. Pentabromomonochlorocyclohexane is essentially encapsulated in the polymer, but when tested separately, it caused liver and kidney effects; pentabromomonochlorocyclohexane and hexabromocyclododecane (HBCD) may increase tissue levels of bromine.

CANCER INFORMATION: Neither polystyrene foam dust, dichlorodifluoromethane nor chlorodifluoroethane caused cancer in long-term animal studies. An increase in uterine tumors has been reported in female mice exposed for their lifetimes to 15,000 ppm ethyl chloride. Such tumors did not occur in rats similarly exposed. These results are of unknown relevance to humans. Pentabromomonochlorocyclohexane is essentially encapsulated in the polymer, but when tested separately it has been shown to cause cancer in laboratory animals, but only at doses producing other toxic effects.

TERATOLOGY (BIRTH DEFECTS): No birth defects were seen in animal studies with dichlorodifluoromethane, ethyl chloride or chlorodifluoroethane.

REPRODUCTIVE EFFECTS: Dichlorodifluoromethane has been reported to have no adverse effects on reproduction in rats.

MUTAGENICITY (EFFECTS ON GENETIC MATERIAL): Results of tests for genetic effects with dichlorodifluoromethane, HBCD and pentabromomonochlorocyclohexane have been negative. Ethyl

(Continued on Page 5)

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6. HEALTH HAZARD DATA: (CONTINUED)

chloride and chlorodifluoroethane have been shown to be negative in some in vitro (test tube) mutagenicity tests and positive in others. Results of mutagenicity tests in animals on chlorodifluoroethane have been negative.

7. FIRST AID:

EYES: Irrigate immediately with water for at least 5 minutes; mechanical effects only.

SKIN: No adverse effects anticipated by this route of exposure.

INGESTION: No adverse effects anticipated by this route of exposure.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

8. HANDLING PRECAUTIONS:

EXPOSURE GUIDELINE(S): Ethyl chloride: Dow Industrial Hygiene Guide (IHG) is 150 ppm; ACGIH TLV and OSHA PEL are 1000 ppm. Dichlorodifluoromethane: ACGIH TLV and OSHA PEL are 1000 ppm. Pentabromomonochlorocyclohexane: Dow Industrial Hygiene Guide (IHG) is 3 mg/m3.

VENTILATION: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use an approved air-purifying respirator. In dusty atmospheres, use an approved dust respirator.

(Continued on Page 6)

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8. HANDLING PRECAUTIONS: (CONTINUED)

SKIN PROTECTION: No skin protection should be needed.

EYE PROTECTION: Safety glasses should be sufficient for most operations; however, for dusty operations wear chemical goggles.

9. ADDITIONAL INFORMATION:

REGULATORY REQUIREMENTS:

SARA HAZARD CATEGORY: This hazard category classification is listed solely to assist with federal laws under SARA Title III. This classification is not intended nor appropriate for evaluating safe handling and use of this product. Refer to the body of this material safety data sheet for health and safety information. According to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) this product is considered under applicable definitions to meet the following categories:

An immediate health hazard
A delayed health hazard

SPECIAL PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Limited industrial hygiene measurements of ethyl chloride in ventilated warehouses and production facilities indicate that ethyl chloride present in the air is below the current 150 ppm Industrial Hygiene Guide for ethyl chloride.

Gas fired recirculating air furnaces or heaters, gas water heaters, etc., drawing air from areas where there may be a

presence of ethyl chloride, dichlorodifluoromethane and chlorodifluoroethane gases from storage or fabrication of extruded polystyrene foam, can be subjected to rust and corrosion problems as a result of thermal decomposition of the blowing agents to hydrogen chloride.

(Continued on Page 7)
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9. ADDITIONAL INFORMATION: (CONTINUED)

This extruded polystyrene insulation will burn and should be handled and installed properly. Use only as directed by the specific instructions for this product. This insulation contains a flame retardant additive to inhibit accidental ignition from small fire sources. During shipping, storage, installation and use this material should not be exposed to flame or other ignition sources.

This foam product should not be stored or used in confined, virtually airtight spaces to prevent buildup of combustible vapors.

MSDS STATUS: Revised sections 1, 3, 4, 6, 7, 8, and 9.

SARA 313 INFORMATION:
This product contains the following substances subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME	CAS NUMBER	CONCENTRATION
CHLOROETHANE (ETHYL CHLORIDE)	000075-00-3	<4 %

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The Information Herein Is Given In Good Faith, But No Warranty,

Express Or Implied, Is Made. Consult The Dow Chemical Company For Further Information.

* An Operating Unit of The Dow Chemical Company

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Ronald W. Kazmierczak, Regional Director

Oshkosh Service Center
625 East County Road Y, STE. 700
Oshkosh, WI 54901-9731
TELEPHONE 920-424-3050
FAX 920-424-4404

October 9, 2006

Clay Eiting
Ghost Town Fitness Center, LLC
180 Fox Shores Drive
Kaukauna, WI 54130

SUBJECT: Final Case Closure with PAL Exemption by Closure Committee for **Ghost Town Fitness Center**, 180 Fox Shores Dr, Kaukauna, WI
WDNR BRRTS Activity #: 02-45-547911

Dear Mr. Eiting:

On October 3, 2006, the Northeast Regional Closure Committee reviewed the above referenced case for closure. This committee reviews environmental remediation cases for compliance with state laws and standards to maintain consistency in the closure of these cases.

On October 6, 2006, the Department received documentation for abandonment of the monitoring well, indicating that you have complied with the final requirements of closure. Based on the correspondence and data provided, it appears that your case has been remediated to Department standards in accordance with s. NR 726.05, Wis. Adm. Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time.

Recent groundwater monitoring data at this site indicates exceedances of the NR 140 preventive action limit (PAL) for arsenic and selenium at monitoring well, MW-1, but compliance with the NR 140 enforcement standard. The Department may grant an exemption to a PAL for a substance of public health concern, other than nitrate, pursuant to s. NR 140.28(2)(b), Wis. Adm. Code, if all of the following criteria are met:

1. The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically and economically feasible.

2. Compliance with the PAL is either not technically or economically feasible.

3. The enforcement standard for the substance will not be attained or exceeded at the point of standards application.

4. Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

Based on the information you provided, the Department believes that the above criteria have been or will be met. Therefore, pursuant to s. NR 140.28(2)(b), Wis. Adm. Code, an exemption to the PAL is granted for arsenic and selenium at MW-1. This letter serves as your exemption.

Please be aware that this case may be reopened pursuant to s. NR 726.09, Wis. Adm. Code, if additional information regarding site conditions indicates that contamination on or from the site poses a threat to public health, safety or welfare, or the environment.

If you have any questions regarding this letter, please contact me at the number below.

Sincerely,

Jennifer Borski
Hydrogeologist
Bureau for Remediation & Redevelopment
(920) 424-7887

Ecc: Terracon
Bill Phelps – DNR, Madison – DG/2

Borski, Jennifer - DNR

From: Lowery, Jason [jblowery@terracon.com]
Sent: Friday, October 06, 2006 11:00 AM
To: Borski, Jennifer - DNR
Cc: Schroyer, Blaine R.
Subject: Ghost-town Fitness Center
Attachments: 38067037.3300-005.pdf

43

Jennifer

Attached is the Borehole Abandonment Form for monitoring well MW-1 at Ghost-town Fitness Center. I understand that this is the final requirement to close the site. Please let me know if you have any questions. A hard copy will follow in the mail.

<<38067037.3300-005.pdf>>

No hard copy needed. Printout legible. AB 10/9/06

Jason B. Lowery, P.G.
Project Hydrogeologist I Appleton
Terracon
3011B East Capitol Drive I Appleton, Wisconsin 54911
P 920-993-9096 I F 920-993-9108
jblowery@terracon.com I www.terracon.com

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State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: _____

1. General Information

WI Unique Well No.: P J 4 2 5
DNR Well ID No.:
County: Outagamie
Common Well Name: MW-1
Gov't Lot # (if applicable):
¼ / ¼: NW
¼: NW
Section: 22
Township: 21 N
Range: 18 ☑ E ☐ W
Well Location ☐ ft / ☐ M (Local Grid ☐) Datum
_____ ☐ N / ☐ S _____ ☐ E / ☐ W _____ Zone
WTM ☐ UTM ☐ Latitude/Longitude ☐ State Plane ☐ ☐ S ☐ C ☐ N
Local Grid Origin ☐ ft / ☐ M Datum
_____ N, _____ ☐ E / ☐ W _____ Zone
WTM ☐ UTM ☐ Latitude/Longitude ☐ State Plane ☐ ☐ S ☐ C ☐ N
Reason For Abandonment: Site Closure
WI Unique Well No. of Replacement Well:

2. Facility / Owner Information

Facility Name: Ghost-town Fitness Center
Facility ID:
License/Permit/Monitoring No.:
Street Address of Well: 180 Fox Shores Drive
City, Village or Town: Kaukauna
Present Well Owner: Ghost-town Fitness Center
Original Well Owner:
Street Address or Route of Present Owner: 180 Fox Shores Drive
City: Kaukauna
State: WI
ZIP Code: 54130

3. Well / Drillhole / Borehole Information

☑ Monitoring Well ☐ Water Well ☐ Borehole / Drillhole
Original Construction Date: September 8, 2006
If a Well Construction Report is available, please attach.

Construction Type:
☑ Drilled ☐ Driven (Sandpoint) ☐ Dug ☐ Other (specify): _____

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 13.5
Casing Diameter (in.): 2
Lower Drillhole Diameter (in.): 8.0
Casing Depth (ft.): 1

Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet): Approximately 4.5

4. Pump, Liner, Screen, Casing & Sealing Material

	Yes	No	N/A
Pump and piping removed?	☐	☐	☑
Liner(s) removed?	☐	☐	☑
Screen removed?	☐	☑	☐
Casing left in place?	☑	☐	☐
Was casing cut off below surface?	☑	☐	☐
Did sealing material rise to surface?	☑	☐	☐
Did material settle after 24 hours?	☐	☑	☐
If yes, was hole retopped?	☐	☐	☑
If bentonite chips were used, were they hydrated with water from a known safe source?	☐	☐	☑

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☑ Screened & Poured (Bentonite Chips) ☐ Other (Explain): _____

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☑ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

Material	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite Chips	Surface	13.5	1 sack (50 pounds)	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Terracon Consultants, Inc.
Date of Abandonment: October 5, 2006
Street or Route: 3011B East Capitol Drive
Telephone Number: (920) 993-9096
City: Appleton
State: WI
ZIP Code: 54911
Signature of Person Doing Work: James B Lowey for Brett Losey
Date Signed: 10/5/06

DNR Use Only
Date Received:
Noted By:
Comments:

Borski, Jennifer - DNR

From: Lowery, Jason [jblowery@terracon.com]
Sent: Thursday, October 05, 2006 7:52 AM
To: Borski, Jennifer - DNR
Cc: Schroyer, Blaine R.
Subject: Ghost-town

Jennifer

We'll be abandoning the monitoring well at Ghost-town Fitness Center either today or tomorrow.

Jason B. Lowery, P.G.
Project Hydrogeologist I Appleton
Terracon
3011B East Capitol Drive I Appleton, Wisconsin 54911
P 920-993-9096 I F 920-993-9108
jblowery@terracon.com I www.terracon.com

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TO: Jenna Barski - Oshkosh

FROM: NER Closure Committee

DATE: 10-3-06

✓ Closure Approved – No Restrictions
_____ Closure Approved With Restrictions
_____ Closure Denied

84
48

Send Appropriate Letter

For BRRTS # 02-45-547911

Activity Name Ghost Town Fitness

The following information is needed or missing	The following information is in BRRTS
___ No acres indicated (100ac or less)	1 Acres recovered
	These fees have been entered
___ Not all fees paid	✓ Closure Fee
	___ Soil GIS
	___ GW GIS
___ Risk	___ Risk is N/A
___ Priority	___ Priority is Med

___ Please forward information to Diane Hansen

dek 9-29-06

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN DEPT. OF NATURAL RESOURCES

MEMO

RRFF-01

DATE: September 25, 2006

TO: Diane Hansen, Green Bay &
NER Closure Committee – Lauridsen, Chronert, Polczinski

FROM: Jennifer Borski, DNR, RR, Oshkosh AB

SUBJECT: Request for Closure with PAL Exemption

SITE NAME: Ghost Town Fitness Center

WDNR BRRTS #: 02-45-547911

FAST TRACK – Financing dependent upon committee determination.

The lending bank required a Phase I be performed for a property transfer. The Phase I identified several past land uses of concern. At the requirement of the bank, Terracon performed a limited site assessment and installed one soil boring for soil and groundwater sampling in a location common to all land uses of concern in July 2006, which is currently in a gravel parking lot. Soils and groundwater were analyzed for DRO, VOCs and RCRA metals. DRO and VOCs were not detected in soil. Metals were not detected above standards in soil. The groundwater was collected from a 1" diameter, two-foot screen with water at 4 ft and identified three PAL exceedances (arsenic, lead and selenium). The temp well was replaced with a NR 141 well in September 2006, screened 3.5 to 13.5 ft bgs, and sampled. Two of the three PAL exceedances were confirmed (arsenic and selenium).

Groundwater Results (ppb)

Compound	1" diam geoprobe well	NR 141 MW-1	PAL	ES
Sample Date	7/26/06	9/12/06		
Arsenic	*7.8*	*3.0*	1	10
Lead	*5.8*	<0.7	1.5	15
Selenium	*32*	*14.7*	10	~~100~~

Italics = PAL exceedance

So KBL

I recommend closure with a PAL exemption for arsenic and selenium at MW-1.

WDNR BRRTS CASE # 02 - 45 - 547911 WDNR SITE NAME : Ghost Town Fitness

FOR DEPARTMENT USE ONLY

PROJECT MANAGER: Borski Date Reviewed: 9/25/06

( ) Approved ( ) Denied (✓) Sent to Committee

CLOSURE COMMITTEE DECISION ON CLOSURE:

FIRST COMMITTEE REVIEW DATE: _____ **(X) Approved ( ) Denied**

(Signature) (Signature) (Signature) (Signature)

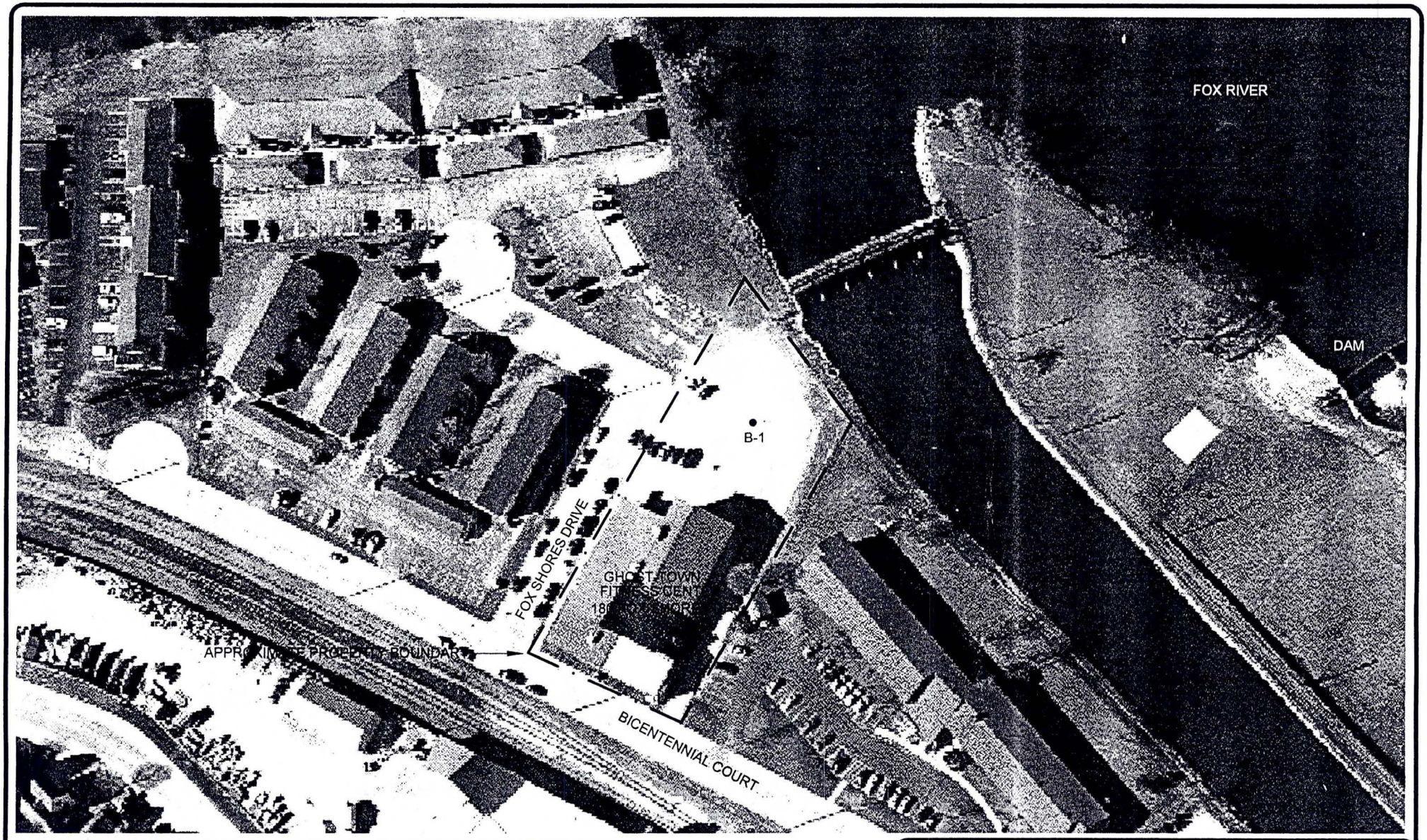
COMMITTEE RECOMMENDATION:

X **Closure Approved With:**

- X No Restrictions
- _____ Listing on GIS Registry due to Groundwater impacts
- _____ Listing on GIS Registry due to Soil impacts
- _____ Zoning Verification
- _____ Deed Restriction
- _____ Deed Notice
- _____ Site Specific Close Out Letter
- X Well Abandonment Documentation
- _____ Soil Disposal Documentation
- X NR 140 Exemption For: arsenic & selenium at MW1
- _____ VPLE Insurance needed
- _____ Other Conditions/Comments: _____

_____ **Closure Denied, Needs More:**

- _____ Investigation
- _____ Groundwater Monitoring
- _____ Soil Remediation
- _____ Groundwater Remediation
- _____ Documentation of Soil Landspreading or Biopile Destiny
- _____ Specific Comments: _____



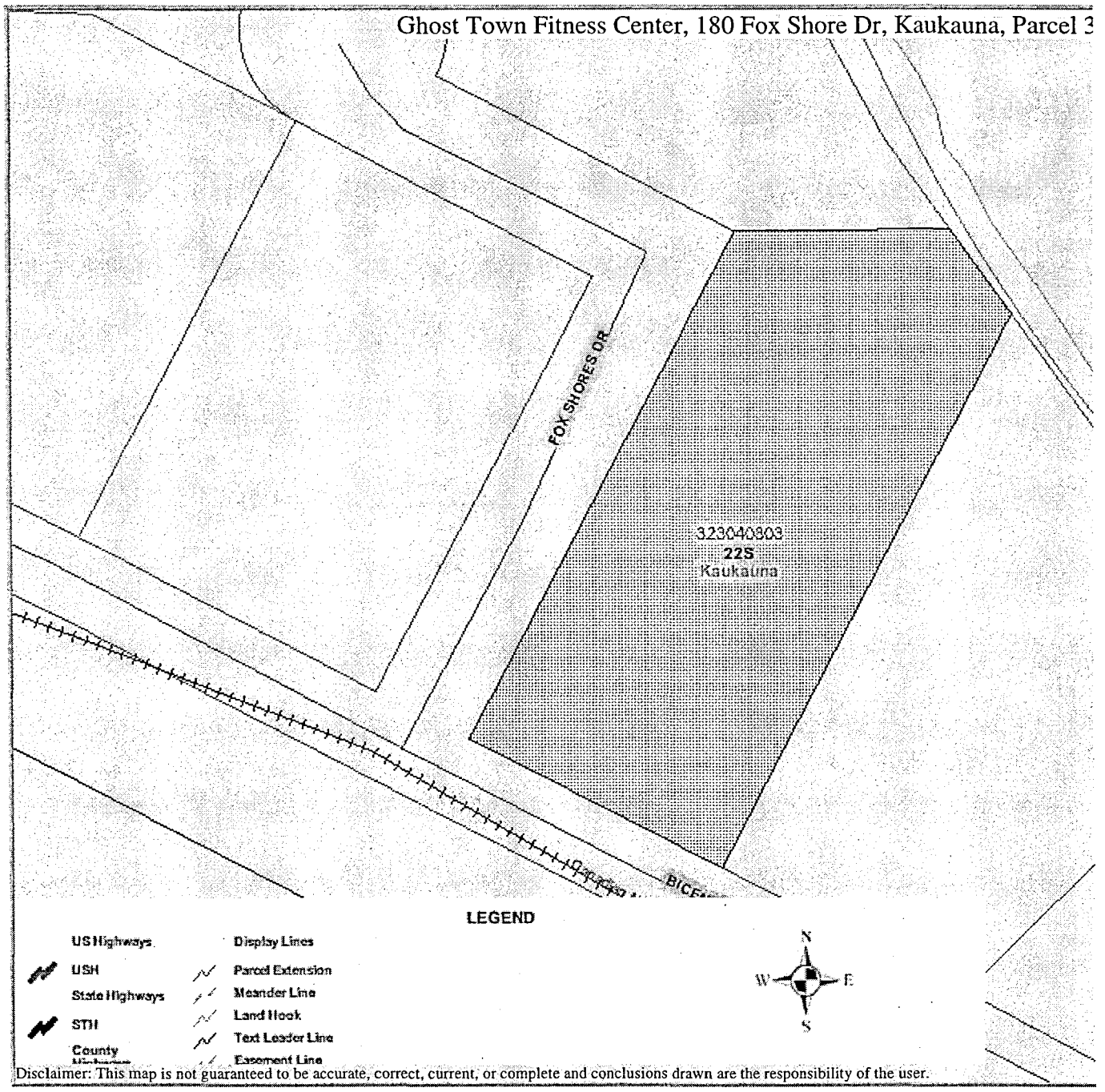
PHOTOGRAPH COURTESY OF THE OUTAGAMIE COUNTY GEOGRAPHIC INFORMATION WEB SERVER. YEAR OF PHOTOGRAPH: 2005

N

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SITE MAP
GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

Project Mngr:	JBL	Terracon	Project No. 38067035
Designed By:	AJP	3011B E. Capitol Drive Appleton, WI 54911	Scale: 1" = 120' (approx)
Checked By:	JBL		Date: 8/1/06
Approved By:	BRS		Drawn By: AJP (38)
File Name:	38067035.dwg	Layout1	Figure No. 1


Ghost Town Fitness Center, 180 Fox Shore Dr, Kaukauna, Parcel 3
FOX SHORES DR
323040803
22S
Kaukauna
LEGEND
US Highways
USH
State Highways
STH
County
Display Lines
Parcel Extension
Meander Line
Land Hook
Text Leader Line
Easement Line
N
W
E
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3011B East Capitol Drive
Appleton, Wisconsin 54911
Phone 920.993.9096
Fax 920.993.9108
www.terracon.com

September 20, 2006

Wisconsin Department of Natural Resources
625 East County Road Y, STE. 700
Oshkosh, WI 54901-9731

Attn: Ms. Jennifer Borski
Telephone: (920) 424-7887
Fax: (920) 424-4404

R+R-OSH
RECEIVED
SEP 22 2006
TRACKED ☑ 79
REVIEWED ☐

Re: Limited Groundwater Assessment
Ghost-town Fitness Center
180 Fox Shores Drive
Kaukauna, Wisconsin
WDNR BRRTS #02-45-547911
Terracon Project No. 38067037

FEE RECEIVED
$750
Date 9/22/06 #4296
WDNR - NER

Dear Ms. Borski:

On behalf of Ghost-town Fitness Center, Terracon Consultants, Inc. (Terracon) is pleased to submit this Limited Groundwater Assessment report for the above-referenced site. Based upon the previously conducted soil assessment and two rounds of groundwater monitoring identifying select compounds below NR 140, Wisconsin Administrative Code, Enforcement Standards (NR 140 ES), this report recommends that the Wisconsin Department of Natural Resources (WDNR) consider this site for closure.

BACKGROUND

Terracon prepared a Transaction Screen for the above-referenced site dated July 12, 2006. A review of Sanborn Fire Insurance Maps dated 1890 through 1956 indicated that the subject site property was previously occupied by a train roundabout, a building labeled "Combined Locks Paper Co." (1945 and 1956) and "Machine Shop" (1906) and another building labeled "Black Smith" (1906 and 1945). As a result, Terracon performed a Limited Site Assessment (LSA) of the property and prepared an LSA report dated August 10, 2006. The assessment consisted of advancing a push-probe boring near the center of the gravel parking lot (see Figure 1). This was also the estimated location where the machine shop/paper company building and train roundabout adjoined each other. Soil and groundwater samples were collected and analyzed for diesel range organics (DRO), volatile organic compounds (VOC), and Resource Conservation and Recovery Act (RCRA) Metals. RCRA Metals including arsenic, lead, and selenium were detected in groundwater at concentrations exceeding NR 140, Wisconsin Administrative Code, Preventative Action Limits (NR 140 PAL). The detections were subsequently reported to the WDNR. In a telephone conversation on August 24, 2006, the

WDNR required at least one additional round of groundwater monitoring from an NR 141 monitoring well before site closure or a "no action required" status could be achieved.

FIELD ACTIVITIES

Terracon mobilized to the site on September 8, 2006 to install an NR 141 water table monitoring well. The monitoring well was installed in the approximate location of push-probe boring B-1 (see Figure 1) and was advanced using hollow stem auger (HSA) drilling methods. Because samples were already collected during the installation of push-probe boring B-1 (advanced to a depth of 11 feet below grade), samples were not collected from the upper 11 feet during the installation of monitoring well MW-1. Terracon attempted to collect a sample beginning at 12 feet below grade; however, what was believed to be fractured bedrock was not recovered within the split spoon. The probable fractured bedrock was encountered from approximately 11 to 13.5 feet below grade. Refusal (possibly more competent bedrock) was encountered at a depth of approximately 13.5 feet below grade. Terracon installed a 10-slot, 10-foot long screen from approximately 3.5 to 13.5 feet below grade. Filter pack was placed from approximately 3 to 13.5 feet below grade and the monitoring well was sealed with bentonite. The monitoring well was completed with a flush-grade protective cover. A boring log and well construction form are attached.

Terracon returned to the site on September 12, 2006 to develop and sample the monitoring well. The depth to groundwater was measured using an electronic water level indicator that was decontaminated with methanol prior to measurement. Terracon measured the depth to groundwater at approximately 3.87 feet below the top of the casing or approximately 4 feet below grade. The monitoring well was subsequently developed per NR 141, Wisconsin Administrative Code using a disposable bailer. The sample was collected using the same disposable bailer, field-filtered with a 0.45-micron filter cup, and submitted to a Wisconsin-certified laboratory for analysis of arsenic, lead, and selenium. Because soil samples collected during the push-probe assessment did not exceed applicable Residual Contaminant Levels (RCL), cuttings were thin-spread on site. Purge water generated during development was containerized in a 55-gallon drum pending laboratory analysis. A Monitoring Well Development Form, Groundwater Sampling Information Sheet, and laboratory analytical report are attached.

RESULTS AND DISCUSSION

The attached laboratory analytical report indicates that arsenic and selenium, but not lead, continue to be detected at concentrations exceeding respective NR 140 PALs. The NR 140 PAL for arsenic is 1 microgram per liter (µg/L). Arsenic was detected at a concentration of 7.8 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and

was detected at a concentration of 3.0 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for selenium is 10 µg/L. Selenium was detected at a concentration of 32 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 14.7 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for lead is 1.5 µg/L. Lead was detected at a concentration of 5.8 µg/L during the July 26, 2006 push-probe assessment but was not detected in the groundwater sample collected from the monitoring well on September 12, 2006.

We discussed the laboratory analytical data with you on September 14, 2006. It is our understanding that the WDNR closure committee, based upon the current and historical analytical data, indicated that closure of the site under NR 726, Wisconsin Administrative Code, is now appropriate. Based upon the limited amount of assessment and reported concentrations, you indicated that a Case Summary and Close Out Request would not be necessary. However, you did indicate that a closure fee of $750, in addition to the following information, would be required in order to obtain closure of the site:

- Acres: Approximately 0.94 acres
- WTM Coordinates: X=657716, Y=424486 (per WDNR GIS Website)
- Zoning: Commercial Core District (CCD)
- Soil Type: The upper approximately 5.5 feet of the subsurface soil includes alternating layers of gravel and top soil, which overlies clay to a depth of approximately 11 feet below grade. Bedrock appears to exist approximately 11 feet below grade (see Terracon's August 10, 2006 LSA Report for a Soil Boring Log).
- Drill/Soil Cutting Disposal Location: Drill cuttings were disposed on the ground surface during the well installation.
- Purge Water Disposal Location: Purge water was temporarily stored in a 55-gallon drum pending receipt of laboratory analytical data. Due to concentrations below NR 140 ESs, purge water will be disposed on the ground surface. Discussed w/ Borski and approved.

On behalf of Ghost-town Fitness Center, Terracon respectfully requests that the WDNR consider this site for closure. A Borehole Abandonment Form prepared by Terracon will be sent separately once monitoring well MW-1 is abandoned. The $750 closure fee will be submitted directly to the WDNR by Ghost-town Fitness Center.

GENERAL COMMENTS

The analysis and opinions expressed in this report are based upon data obtained from the previous assessments and laboratory chemical analyses at the indicated locations or from other information discussed in this report. This report does not reflect variations in subsurface stratigraphy, hydrogeology, and contaminant distribution that may occur across the site. Actual subsurface conditions may vary and may not become evident without further assessment. This report is prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted environmental engineering practices. No warranties, express or implied are intended or made. In the event any changes in the nature or location of suspected sources of contamination as outlined in this report are observed, the conclusions and recommendations contained in this report shall not be valid unless these changes are reviewed and the opinions of this report are modified or verified in writing by Terracon.

Please contact either of the undersigned at (920) 993-9096 if you have questions regarding the information provided in the report.

Sincerely,
Terracon

Prepared by:

Jason B. Lowery, P.G.
Project Hydrogeologist

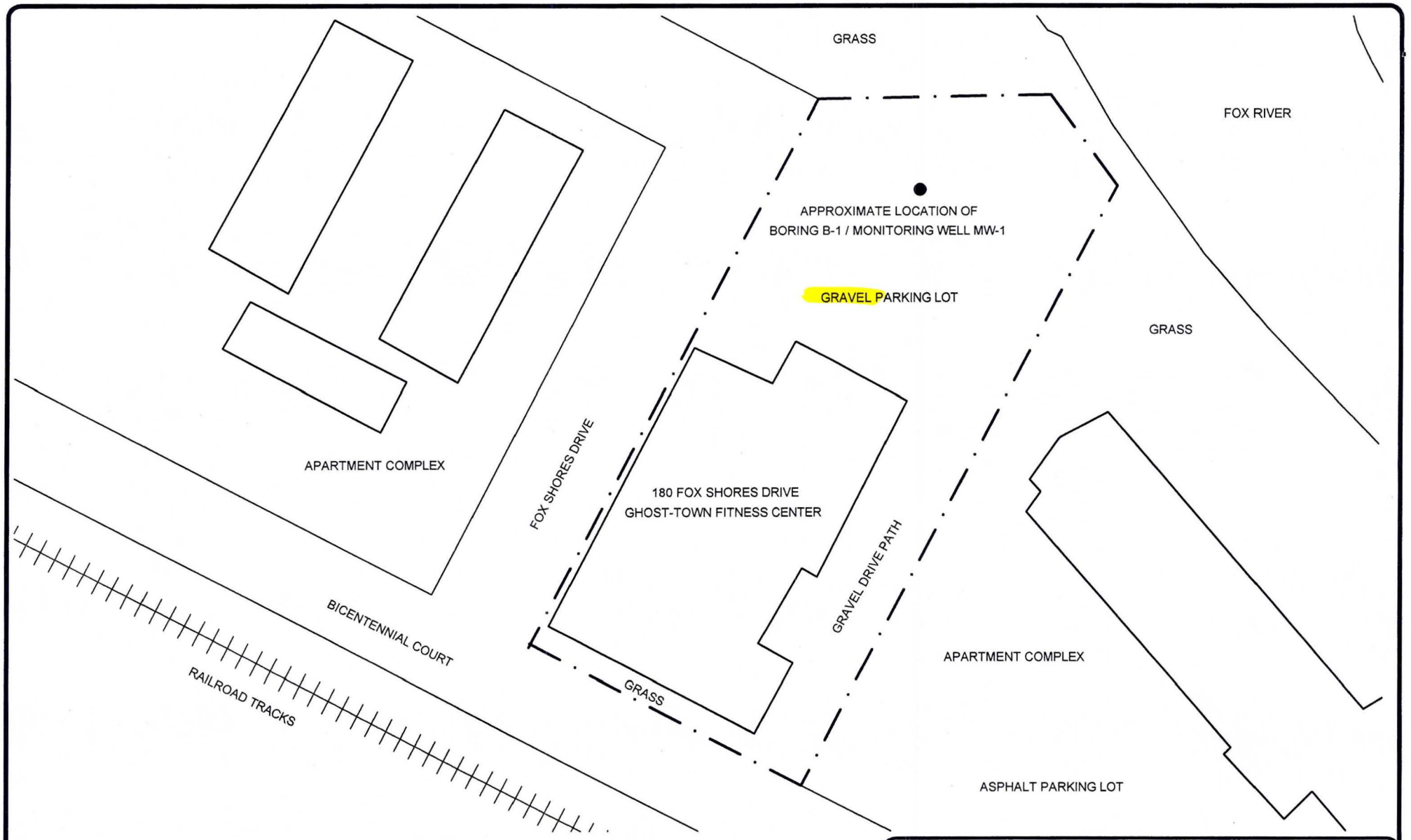
Reviewed by:

Blaine R. Schroyer, P.E.
Office Manager

JBL/BRS:jbl/N:\Projects\2006\38067037\Ghost-Town.LGA.Rpt.doc

Attachments
- Figure 1
- Soil Boring Log
- Monitoring Well Construction Form
- Monitoring Well Development Form
- Groundwater Sampling Information Sheet
- Laboratory Analytical Report

Copy to: Clay Eiting, Ghost-town Fitness Center
Kim Van Den Elzen, Citizens Bank



SITE MAP
GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

Project Mngr:	JBL	Project No.	38067037
Designed By:	AJP	Scale:	1" = 60'
Checked By:	JBL	Date:	9/18/06
Approved By:	JBL	Drawn By:	AJP (38)
File Name:	38067037sm.dwg Layout2	Figure No.	1

Terracon
3011B E. Capitol Drive
Appleton, WI 54911

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Ghost-town Fitness Center (38067037)		MW-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Craig Plant EDS	9/8/2006	9/8/2006	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
PJ425			Feet MSL	Feet MSL	8.00 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
NW 1/4 of NW 1/4 of Section 22, T 21 N, R 18 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N Feet ☐ S ☐ E Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/(pH)	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	RQD/ Comments
			1–10	Monitoring well blind drilled. See boring B-1 for lithology.									
			11	Fractured Bedrock (Assumed) (Blind drilled)									
1 SS	48 0	50/0	12–13	Refusal @ 13.5'									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
	Terracon Consultants, Inc. 3011B E. Capitol Dr. Appleton, WI 54911	Tel: 920-993-9096 Fax: 920-993-9108

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Ghost-town Fitness	Local Grid Location of Well: _____ ft. ☐N. ☐S. _____ ft. ☐E. ☐W.	Well Name: MW-1
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: PJ425 / DNR Well ID No.: ____
Facility ID: _____	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 09/08/2006 (m m d d y y y y)
Type of Well: Well Code ____ / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec, ____ T. ____ N, R. ____ ☐E ☐W	Well Installed By: Name (first, last) and Firm
Distance from Waste/Source _____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number: _____

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or ____ 1 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☒ 41
Other ☐ _____

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe _____

17. Source of water (attach analysis, if required):

_____

E. Bentonite seal, top _____ ft. MSL or ____ 1 ft.

F. Fine sand, top _____ ft. MSL or ~~2.5~~ 3.0 ft.

G. Filter pack, top _____ ft. MSL or ~~2.5~~ 3.0 ft.

H. Screen joint, top _____ ft. MSL or 3.5 ft.

I. Well bottom _____ ft. MSL or 13.5 ft.

J. Filter pack, bottom _____ ft. MSL or 13.5 ft.

K. Borehole, bottom _____ ft. MSL or 13.5 ft.

L. Borehole, diameter 2.04 in.

M. O.D. well casing 2.37 in.

N. I.D. well casing 8 in.

1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04
Other ☐ _____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☐ 30
Concrete ☒ 01
Other ☐ _____

4. Material between well casing and protective pipe:
Bentonite ☒ 30
Other ☐ _____

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01
Tremie pumped ☐ 02
Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☒3/8 in. ☐1/2 in. Bentonite chips ☐ 32
c. _____ Other ☐ _____

7. Fine sand material: Manufacturer, product name & mesh size
a. None
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Badger Mining
b. Volume added 3 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
Other ☐ _____

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11
Continuous slot ☐ 01
Other ☐ Johnson
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☒ 14
Other ☐ _____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] Firm: EDS

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	County Name	Well Name
Ghost-town Fitness	Outagamie	MW-1
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well ID Number**
	45	PJ425	___

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☒	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☐	51
pumped slowly	☐	50
Other _____	☐	

3. Time spent developing well 65 min.

4. Depth of well (from top of well casisng) 13.5 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing ~~3.2~~ 9.4 gal. NA

7. Volume of water removed from well 25.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added NA

10. Analysis performed on water added? ~~NA~~ ☒ Yes ☐ No NA
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 3.87 ft.	4.84 ft.
Date	b. 09/12/2006 (m m d d y y y y)	09/12/2006
Time	c. 10:45 ☒ a.m. ☐ p.m.	12:03 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	0.0 inches	0.0 inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe)	Clear ☒ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Tracy Last Name: Houston
Firm: Terracon Consultants, Inc.

17. Additional comments on development:
bailed until there was no sediment in the groundwater. (Sediment)

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Clay Last Name: Eitting
Facility/Firm: Ghost-town Fitness Center
Street: 180 Fox Shores Dr.
City/State/Zip: Kaukauna, WI 54130

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Tracy Houston
Print Name: Tracy Houston
Firm: Terracon Consultants, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Phone Log

August 24, 2006

Site Name: Ghost Town Fitness Center
Site ID: pending

Name: Clay Eiting
Phone: 920-766-0149
Initiated By: Borski
Time: 2:45 PM

Subject: NR 141 monitoring well needed

Borski contacted Eiting and stated that based on information provided by Terracon, exceedances of standards exist in groundwater and additional sampling is necessary. (As, Pb and Se > PAL from 1" diam temp well). Borski explained the work needed. Eiting requested Borski contact Terracon and relay this information and request Terracon provide Eiting with a cost estimate. Eiting will decide if he intends to move forward with Terracon or another consultant.

Borski contacted Jason Lowery at Terracon on 8/24/06 at approximately 2:55 PM. Borski informed Lowery of the following required work and possible closure scenarios:
A 2" diameter well should be installed in accordance with NR 141 in the same location as the temp well and sampled for As, Pb & Se. Lowery stated that the initial temp well was a 1" diam, two-foot screen with water at 4 ft but dry clay beneath it and refusal (dolomite chips) at 11 ft. Borski agreed that a 2" diameter, five-foot screen is appropriate in this situation. Lowery will screen from 4-9 ft. Borski stated that one or two weeks may be needed after development to collect enough water for the sample.

If results are below PALs, the case can be created as a NAR (09) after well abandonment. A letter can be issued for $500 "other technical assistance" or the property owner can print off the activity detail report from BRRTS on the Web for free. If results are above PALs, the case will be created as an ERP (02) and a second event required. If the second event from the NR 141 well has results below PALs, a NFA under NR 708 can be issued for $250. If the second event from the NR 141 well has results above PALs, closure under NR 726 can be granted for $750. If closure under NR 726 is required, Borski should review the information previously submitted and determine if it is necessary for a case creation form to be submitted or determine that additional documentation be submitted in a brief update.

Lowery will put together a cost estimate to provide Eiting.

Jennifer Borski JB

Second NR141 event not needed after discussion w/ KL (JB)

Terracon

LIMITED SITE ASSESSMENT

GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, OUTAGAMIE COUNTY, WISCONSIN

TERRACON PROJECT NO. 38067035
AUGUST 11, 2006

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) conducted a Limited Site Assessment (LSA) at the Ghost-town Fitness Center site located at 180 Fox Shores Drive in Kaukauna, Outagamie County, Wisconsin . At your request, Terracon's LSA was undertaken in response to the results of Terracon's Transaction Screen dated July 12, 2006 which identified the following potential environmental concern (PEC):

- Historic Sanborn Fire Insurance Maps depict a train roundabout and buildings labeled "Combined Locks Paper Co.", "Machine Shop", and "Black Smith" at the subject site.

The objective of the LSA was to evaluate the presence of volatile organic compounds (VOC), Resource Conservation and Recovery Act (RCRA) metals, and diesel range organics (DRO) in the on-site soil and groundwater as a result of potential releases associated with the above-referenced PEC. The LSA was completed in general accordance with our proposal dated July 13, 2006.

1.1 Site Description

Site Name	Ghost-town Fitness Center
Site Location/Address	180 Fox Shores Drive, Kaukauna, Wisconsin
General Site Description	A fitness center and gravel parking lot with streets (Bicentennial Court and Fox Shores Drive) to the southwest and northwest, an apartment complex to the southeast, and the Fox River to the northeast.

An aerial photograph is included as Figure 1 of Appendix A.

LIMITED SITE ASSESSMENT

GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

TERRACON PROJECT NO. 38067035
AUGUST 10, 2006

Prepared for:

CITIZENS

KAUKAUNA, WISCONSIN

Prepared by:

Terracon

APPLETON, WISCONSIN

Terracon

Form 101—1-87

TABLE 1

Soil Analytical Summary

Ghost-town Fitness Center
Kaukauna, Wisconsin
Terracon Project No. 38067035

Depth?

Sample ID (Depth)	Sample Location	Sample Date	VOC	DRO	RCRA Metals							
			Volatile Organic Compounds	Diesel Range Organics	Mercury	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
NR 720.09, WAC, Generic RCL			NE	100	NE	NE	NE	NE	NE	NE	NE	NE
NR 720.09, WAC, Non-Industrial Direct Contact RCL			NE	NE	NE	0.039	NE	8	16,000	50	NE	NE
Site Specific RCL[1]			NE	NE	4.69	NE	3,130	NE	NE	NE	78.2	NE
B-1	Center of parking lot	26-Jul-06	<MDL	<10	0.021	<0.074	20	0.67	5.9	5.3	3.2	<0.0037

Notes:

Concentrations are listed in milligrams per kilogram (mg/kg)

" < " Indicates compound not detected above listed laboratory method detection limit

RCL Indicates Residual Contaminant Level

[1] Based on U.S. EPA Soil Screening Guidance Calculator (http://risk.lsd.ornl.gov/epa/ssl1.htm) using WDNR Default Parameters per WDNR PUB-RR-682 dated January 11, 2002

NE Indicates standard not established or calculated

<MDL Indicates VOC compounds not detected above compound-specific method detection limits (MDL)

TABLE 2

Groundwater Analytical Summary

Ghost-town Fitness Center
Kaukauna, Wisconsin
Terracon Project No. 38067035

1" diam.

Sample ID (Depth)	Sample Location	Sample Date	VOC	DRO	RCRA Metals							
			Volatile Organic Compounds	Diesel Range Organics	Mercury	Arsenic	Barium (mg/L)	Cadmium	Chromium	Lead	Selenium	Silver
NR 140, WAC, Enforcement Standard			NE	NE	2	10	2	5	100	15	50	50
NR 140, WAC, Preventative Action Limit			NE	NE	0.2	1	0.4	0.5	10	1.5	10	10
B-1	Center of parking lot	26-Jul-06	<MDL	120	0.084	7.8	0.076	<0.7	<3.1	5.8	32	<3

PAL < LOD
LOD < 7.8 < LOQ

Notes:
Concentrations are listed in micrograms per liter (µg/L) unless noted otherwise
mg/L - milligrams per liter
" < " Indicates compound not detected above listed laboratory method detection limit
NE Indicates standard not established
<MDL Indicates VOC compounds not detected above compound-specific method detection limits (MDL)

> PAL

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Ghost-town Fitness Center (38067035)		B-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dustin Harvey Kitson Environmental	7/26/2006	7/26/2006	Push-Probe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	Feet MSL	2.00 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
NW 1/4 of NW 1/4 of Section 22, T 21 N, R 18 E
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/(pH)	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
PP	48 24		1	SANDY GRAVEL - Brown, well graded, medium dense, dry	GW									
			2	TOPSOIL, trace SAND - Dark brown, lean, dry	OL			0						
			3	SANDY GRAVEL - Brown, well graded, medium dense, slightly moist	GW									
PP	48 38		4 5	TOPSOIL, trace SAND - Dark brown, lean, wet	OL		▼	0						
			6 7	CLAY - Brown, lean, low plasticity, slightly moist	CL			0						
PP	48 30		8 9 10	CLAY W/GRAVEL - Red, stiff, lean, low plasticity, dry	CL			0 0						
			11	Dolomite chips REFUSAL - 11'				0						

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
Jason B Lowery	Terracon Consultants, Inc. 3011B E. Capitol Dr. Appleton, WI 54911	Tel: 920-993-9096 Fax: 920-993-9108

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Terracon
Consulting Engineers & Scientists

Terracon Consultants, Inc.
3011B East Capitol Drive
Appleton, Wisconsin 54911
Phone 920.993.9096
Fax 920.993.9108
www.terracon.com

September 20, 2006

Wisconsin Department of Natural Resources
625 East County Road Y, STE. 700
Oshkosh, WI 54901-9731

Attn: Ms. Jennifer Borski
Telephone: (920) 424-7887
Fax: (920) 424-4404

R + R - OSH
RECEIVED
SEP 22 2006
TRACKED ☑ 79
REVIEWED ☐

FEE RECEIVED
$750
Date 9/22/06 #4296
WDNR - NER

Re: Limited Groundwater Assessment
Ghost-town Fitness Center
180 Fox Shores Drive
Kaukauna, Wisconsin
WDNR BRRTS #02-45-547911
Terracon Project No. 38067037

Dear Ms. Borski:

On behalf of Ghost-town Fitness Center, Terracon Consultants, Inc. (Terracon) is pleased to submit this Limited Groundwater Assessment report for the above-referenced site. Based upon the previously conducted soil assessment and two rounds of groundwater monitoring identifying select compounds below NR 140, Wisconsin Administrative Code, Enforcement Standards (NR 140 ES), this report recommends that the Wisconsin Department of Natural Resources (WDNR) consider this site for closure.

BACKGROUND

Terracon prepared a Transaction Screen for the above-referenced site dated July 12, 2006. A review of Sanborn Fire Insurance Maps dated 1890 through 1956 indicated that the subject site property was previously occupied by a train roundabout, a building labeled "Combined Locks Paper Co." (1945 and 1956) and "Machine Shop" (1906) and another building labeled "Black Smith" (1906 and 1945). As a result, Terracon performed a Limited Site Assessment (LSA) of the property and prepared an LSA report dated August 10, 2006. The assessment consisted of advancing a push-probe boring near the center of the gravel parking lot (see Figure 1). This was also the estimated location where the machine shop/paper company building and train roundabout adjoined each other. Soil and groundwater samples were collected and analyzed for diesel range organics (DRO), volatile organic compounds (VOC), and Resource Conservation and Recovery Act (RCRA) Metals. RCRA Metals including arsenic, lead, and selenium were detected in groundwater at concentrations exceeding NR 140, Wisconsin Administrative Code, Preventative Action Limits (NR 140 PAL). The detections were subsequently reported to the WDNR. In a telephone conversation on August 24, 2006, the

WDNR required at least one additional round of groundwater monitoring from an NR 141 monitoring well before site closure or a "no action required" status could be achieved.

FIELD ACTIVITIES

Terracon mobilized to the site on September 8, 2006 to install an NR 141 water table monitoring well. The monitoring well was installed in the approximate location of push-probe boring B-1 (see Figure 1) and was advanced using hollow stem auger (HSA) drilling methods. Because samples were already collected during the installation of push-probe boring B-1 (advanced to a depth of 11 feet below grade), samples were not collected from the upper 11 feet during the installation of monitoring well MW-1. Terracon attempted to collect a sample beginning at 12 feet below grade; however, what was believed to be fractured bedrock was not recovered within the split spoon. The probable fractured bedrock was encountered from approximately 11 to 13.5 feet below grade. Refusal (possibly more competent bedrock) was encountered at a depth of approximately 13.5 feet below grade. Terracon installed a 10-slot, 10-foot long screen from approximately 3.5 to 13.5 feet below grade. Filter pack was placed from approximately 3 to 13.5 feet below grade and the monitoring well was sealed with bentonite. The monitoring well was completed with a flush-grade protective cover. A boring log and well construction form are attached.

Terracon returned to the site on September 12, 2006 to develop and sample the monitoring well. The depth to groundwater was measured using an electronic water level indicator that was decontaminated with methanol prior to measurement. Terracon measured the depth to groundwater at approximately 3.87 feet below the top of the casing or approximately 4 feet below grade. The monitoring well was subsequently developed per NR 141, Wisconsin Administrative Code using a disposable bailer. The sample was collected using the same disposable bailer, field-filtered with a 0.45-micron filter cup, and submitted to a Wisconsin-certified laboratory for analysis of arsenic, lead, and selenium. Because soil samples collected during the push-probe assessment did not exceed applicable Residual Contaminant Levels (RCL), cuttings were thin-spread on site. Purge water generated during development was containerized in a 55-gallon drum pending laboratory analysis. A Monitoring Well Development Form, Groundwater Sampling Information Sheet, and laboratory analytical report are attached.

RESULTS AND DISCUSSION

The attached laboratory analytical report indicates that arsenic and selenium, but not lead, continue to be detected at concentrations exceeding respective NR 140 PALs. The NR 140 PAL for arsenic is 1 microgram per liter (µg/L). Arsenic was detected at a concentration of 7.8 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and

was detected at a concentration of 3.0 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for selenium is 10 µg/L. Selenium was detected at a concentration of 32 µg/L in the groundwater sample collected during the July 26, 2006 push-probe assessment and was detected at a concentration of 14.7 µg/L in the groundwater sample collected from the monitoring well on September 12, 2006. The NR 140 PAL for lead is 1.5 µg/L. Lead was detected at a concentration of 5.8 µg/L during the July 26, 2006 push-probe assessment but was not detected in the groundwater sample collected from the monitoring well on September 12, 2006.

We discussed the laboratory analytical data with you on September 14, 2006. It is our understanding that the WDNR closure committee, based upon the current and historical analytical data, indicated that closure of the site under NR 726, Wisconsin Administrative Code, is now appropriate. Based upon the limited amount of assessment and reported concentrations, you indicated that a Case Summary and Close Out Request would not be necessary. However, you did indicate that a closure fee of $750, in addition to the following information, would be required in order to obtain closure of the site:

- Acres: Approximately 0.94 acres
- WTM Coordinates: X=657716, Y=424486 (per WDNR GIS Website)
- Zoning: Commercial Core District (CCD)
- Soil Type: The upper approximately 5.5 feet of the subsurface soil includes alternating layers of gravel and top soil, which overlies clay to a depth of approximately 11 feet below grade. Bedrock appears to exist approximately 11 feet below grade (see Terracon's August 10, 2006 LSA Report for a Soil Boring Log).
- Drill/Soil Cutting Disposal Location: Drill cuttings were disposed on the ground surface during the well installation.
- Purge Water Disposal Location: Purge water was temporarily stored in a 55-gallon drum pending receipt of laboratory analytical data. Due to concentrations below NR 140 ESs, purge water will be disposed on the ground surface. Discussed w/ Borski and approved.

On behalf of Ghost-town Fitness Center, Terracon respectfully requests that the WDNR consider this site for closure. A Borehole Abandonment Form prepared by Terracon will be sent separately once monitoring well MW-1 is abandoned. The $750 closure fee will be submitted directly to the WDNR by Ghost-town Fitness Center.

GENERAL COMMENTS

The analysis and opinions expressed in this report are based upon data obtained from the previous assessments and laboratory chemical analyses at the indicated locations or from other information discussed in this report. This report does not reflect variations in subsurface stratigraphy, hydrogeology, and contaminant distribution that may occur across the site. Actual subsurface conditions may vary and may not become evident without further assessment. This report is prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted environmental engineering practices. No warranties, express or implied are intended or made. In the event any changes in the nature or location of suspected sources of contamination as outlined in this report are observed, the conclusions and recommendations contained in this report shall not be valid unless these changes are reviewed and the opinions of this report are modified or verified in writing by Terracon.

Please contact either of the undersigned at (920) 993-9096 if you have questions regarding the information provided in the report.

Sincerely,
Terracon

Prepared by:

Jason B. Lowery, P.G.
Project Hydrogeologist

Reviewed by:

Blaine R. Schroyer, P.E.
Office Manager

JBL/BRS:jbl/N:\Projects\2006\38067037\Ghost-Town.LGA.Rpt.doc

Attachments
- Figure 1
- Soil Boring Log
- Monitoring Well Construction Form
- Monitoring Well Development Form
- Groundwater Sampling Information Sheet
- Laboratory Analytical Report

Copy to: Clay Eiting, Ghost-town Fitness Center
Kim Van Den Elzen, Citizens Bank

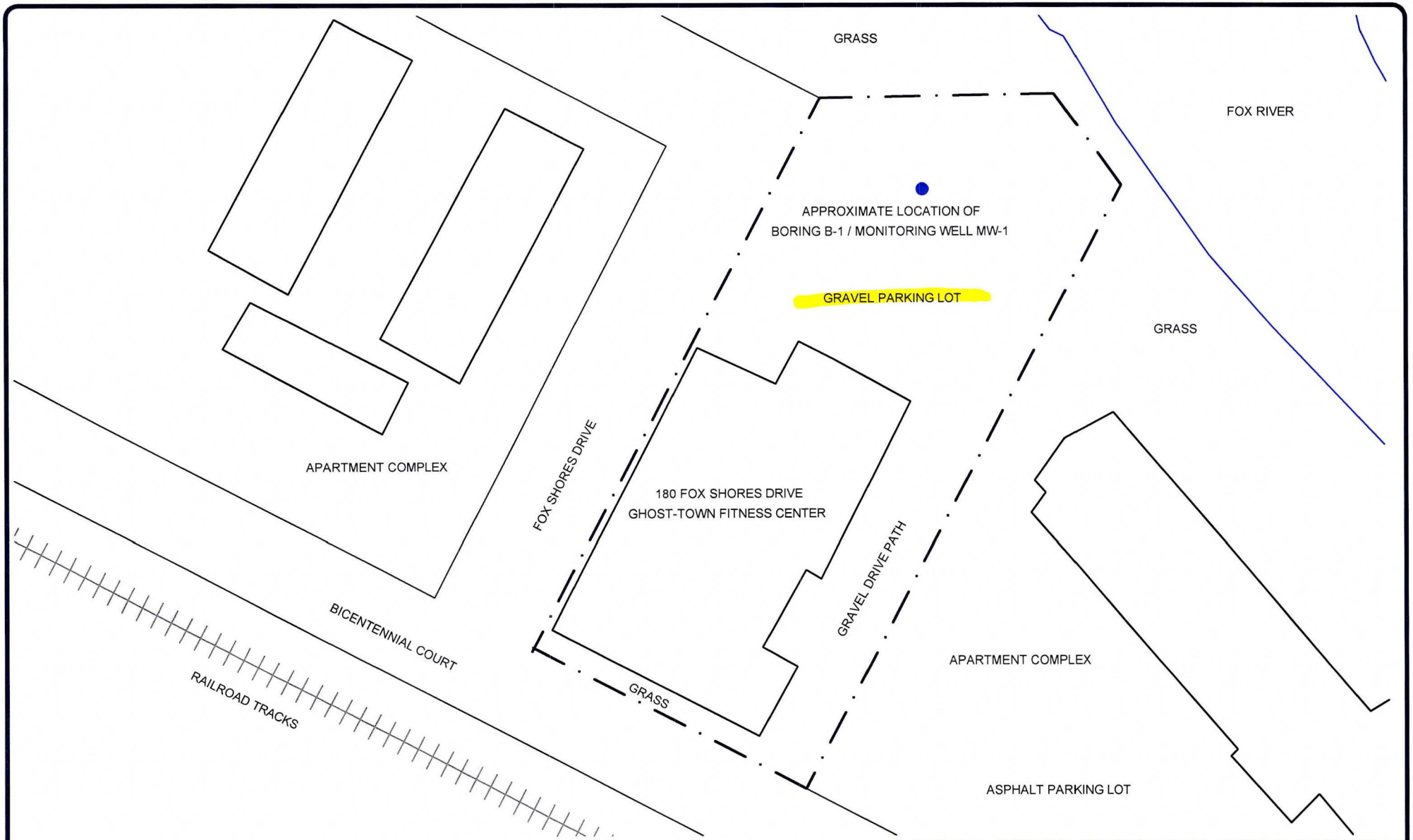


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SITE MAP
GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

Project Mngr:	JBL	Terracon	Project No. 38067037
Designed By:	AJP		Scale: 1" = 60'
Checked By:	JBL	3011B E. Capitol Drive Appleton, WI 54911	Date: 9/18/06
Approved By:	JBL		Drawn By: AJP (38)
File Name:	38067037sm.dwg	Layout2	Figure No. 1

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Ghost-town Fitness Center (38067037)		MW-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Craig Plant EDS	9/8/2006	9/8/2006	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
PJ425			Feet MSL	Feet MSL	8.00 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
NW 1/4 of NW 1/4 of Section 22, T 21 N, R 18 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/(pH)	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	RQD/ Comments
			1	Monitoring well blind drilled. See boring B-1 for lithology.									
			2										
			3										
			4										
			5										
			6										
			7										
			8										
			9										
			10										
			11	Fractured Bedrock (Assumed) (Blind drilled)									
1 SS	48 0	50/0	12										
			13	Refusal @ 13.5'									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Terracon Consultants, Inc.
3011B E. Capitol Dr. Appleton, WI 54911
Tel: 920-993-9096
Fax: 920-993-9108

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State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Ghost-town Fitness	Local Grid Location of Well: ____ ft. ☐N. ☐S. ____ ft. ☐E. ☐W.	Well Name: MW-1
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: PJ425 / DNR Well ID No.
Facility ID	St. Plane ____ ft. N, ____ ft. E. S/C/N	Date Well Installed: 09/08/2006 (m m d d y y y y)
Type of Well: Well Code ____ / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec, ____ T. ____ N, R. ____ ☐E ☐W	Well Installed By: Name (first, last) and Firm
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation ____ ft. MSL

C. Land surface elevation ____ ft. MSL

D. Surface seal, bottom ____ ft. MSL or ____ 1 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe ____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or ____ 1 ft.

F. Fine sand, top ____ ft. MSL or 3.0 ~~2.5~~ ft.

G. Filter pack, top ____ ft. MSL or 3.0 ~~2.5~~ ft.

H. Screen joint, top ____ ft. MSL or 3.5 ft.

I. Well bottom ____ ft. MSL or 13.5 ft.

J. Filter pack, bottom ____ ft. MSL or 13.5 ft.

K. Borehole, bottom ____ ft. MSL or 13.5 ft.

L. Borehole, diameter 2.04 in.

M. O.D. well casing 2.37 in.

N. I.D. well casing 8 in.

1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04 / Other ☐
d. Additional protection? ☐ Yes ☒ No
If yes, describe: ____

3. Surface seal: Bentonite ☐ 30 / Concrete ☒ 01 / Other ☐

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 32
c. ____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. None
b. Volume added ____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Badger Mining
b. Volume added 50 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐
b. Manufacturer Johnson
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☒ 14 / Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
[signature]	EDS

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	County Name	Well Name
Ghost-town Fitness	Outagamie	MW-1

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	45	PJ425	___

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☒ 41
surged with bailer and pumped	☐ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐ [redacted]

3. Time spent developing well 65 min.

4. Depth of well (from top of well casisng) 13.5 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 9.4 NA ~~13.2~~ gal.

7. Volume of water removed from well 25.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added NA

10. Analysis performed on water added? NA ☐ Yes ☐ No (If yes, attach results)

11. Depth to Water (from top of well casing)	Before Development	After Development
a.	3.87 ft.	4.84 ft.
b. Date (m m d d y y y y)	09/12/2006	09/12/2006
c. Time	10:45 ☒ a.m. ☐ p.m.	12:03 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	0.0 inches	0.0 inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe)	Clear ☒ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Tracy Last Name: Houston
Firm: Terracon Consultants, Inc.

17. Additional comments on development:
bailed until there was no sediment in the groundwater.

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Clay Last Name: Eiting
Facility/Firm: Ghost-town Fitness Center
Street: 180 Fox Shores Dr.
City/State/Zip: Kaukauna, WI 54130

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: [signature]
Print Name: Tracy Houston
Firm: Terracon Consultants, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

TERRACON GROUND WATER SAMPLING INFORMATION SHEET

PROJECT NAME: Ghost Town	PROJECT NO. 38067037
PROJECT LOCATION: Kaukauna, WI	
SAMPLE POINT: MW-1	SAMPLE POINT DESCRIPTION: center of parking lot
CASING DIAMETER: 2"	
WELL DEPTH: 13.5 ft	
DATE: 9/12/06	TIME: ~~12:03~~ 1045 AM/PM DEPTH TO GROUND WATER (FT): ~~4.86~~ 3.87

CALCULATION: ~~4.86~~ 3.87
13.5 - ~~4.86~~ 3.87 · .017 · 3 = ~~4.14~~ 4.1 gallons removed

SAMPLING METHOD: bailer (disposable)

DATE	TIME (AM/PM)	GALLONS REMOVED	COMMENTS
9/12/06	1050		began purging & surging
	1155	25	stopped bailing water sediment free.
↓	1210		sample taken

DISSOLVED OXYGEN:	FERROUS IRON:	NITRATE
----	----	---------

pH:	ORP:	TEMP:	SPECIFIC CONDUCTANCE (uS/cm) x1000
-------	----	--------	----

SAMPLE APPEARANCE: VERY TURBID TURBID SLIGHTLY TURBID CLEAR
ODOR: YES NO NOT NOTED
ANALYSES: dissolved lead, selenium & arsenic

CLEANING PERFORMED IN FIELD: *METHANOL AND DISPOSABLE GLOVES* * INITIAL TO VERIFY OR NOTE OTHER CLEANING METHOD PERFORMED
TLH

COMMENTS:

SAMPLED BY: TLH DATE: 9/12/06

REVIEWED BY: JBZ DATE: 9/12/06

Synergy Environmental Lab, Inc.

1990 Prospect Ct., Appleton, WI 54914 *P 920-830-2455 * F 920-733-0631

TRACY HOUSTON
TERRACON
3011B E. Capitol Drive
APPLETON WI 54911

Report Date *13-Sep-06*

Project Name GHOST-TOWN LSA/KAUKAUNA **Invoice #** E14108
Project # 38067037

Lab Code 5014108A
Sample ID MW-1
Sample Matrix Water
Sample Date 9/12/2006

	Result	Units	LOD	LOQ	Dil	Method	Run Date	Analyst	Code
Inorganic									
Metals									
Selenium, dissolved	14.7	ug/l	4.4	14.1	1	200.7	9/12/2006	CWT	1
Arsenic, Dissolved	3.0	ug/l	0.6	1.9	1	7060A	9/12/2006	CWT	1
Lead, Dissolved	< 0.7	ug/l	0.7	2.5	1	SW846 7421	9/12/2006	CWT	1

"J" Flag: Analyte detected between LOD and LOQ LOD Limit of Detection LOQ Limit of Quantitation

Code	*Comment*
1	Laboratory QC within limits.

Authorized Signature Michael J. Ricker

CHAIN OF CUSTODY RECORD

Synergy Environmental Lab, LLC.

1990 Prospect Ct. • Appleton, WI 54914
920-830-2455 • FAX 920-733-0631

Chain # № 4826

Page 1 of 1

Sample Handling Request
X Rush Analysis Date Required ____
(Rushes accepted only with prior authorization)
___ Normal Turn Around

Lab I.D. #

Account No. : **Quote No.:**

Project #: 38067037

Sampler: (signature)

Project (Name / Location): Ghost-town LSA / Kaukauna, WI

Reports To: Tracy Houston	Invoice To:
Company Terracon	Company
Address 3011 B East. Capitol Dr.	Address
City State Zip Appleton, WI 54911	City State Zip
Phone (920) 993-9096	Phone
FAX (920) 993-9108	FAX

Analysis Requested

Other Analysis

Lab I.D.	Sample I.D.	Collection Date	Collection Time	Comp	Grab	Filtered Y/N	No. of Containers	Sample Type (Matrix)*	Preservation	DRO (Mod DRO Sep 95)	GRO (Mod GRO Sep 95)	PVOC (EPA 8021)	VOC (EPA 8260)	VOC DW (EPA 524.2)	PAH (EPA 8270)	Total Suspended Solids	Lead	Arsenic & dissolved	Selenium	PID/ FID
5-14108A	MW-1	9/12/06	1210		X	Y	1	GW	nitric acid								X	X	X	

Comments/Special Instructions (*Specify groundwater "GW", Drinking Water "DW", Waste Water "WW", Soil "S", Air "A", Oil, Sludge etc.)

Sample Integrity - To be completed by receiving lab.
Method of Shipment : client
Temp. of Temp. Blank. ____ °C On Ice: X
Cooler seal intact upon receipt: X Yes ____ No

Relinquished By: (sign)	Time	Date	Received By: (sign)	Time	Date
	1305	9/12/06			

Received in Laboratory By: Time: 1305 Date: 9/12/06

Borski, Jennifer - DNR

From: Borski, Jennifer - DNR
Sent: Monday, September 25, 2006 11:09 AM
To: 'Clay Eiting'
Subject: RE: Ghost-town

Based on current backlog, it will likely be approximately two weeks for the closure committee to route, review and approve the closure once they receive the request. It is then forwarded back to me to send you a letter. I can typically get the letter out within a week but will call you with the answer the day that I receive the packet back on my desk.

I will include a note with the request that your financing is pending closure of the case. That information may move it faster.

From: Clay Eiting [mailto:ceiting38@hotmail.com]
Sent: Monday, September 25, 2006 10:39 AM
To: Borski, Jennifer - DNR
Subject: Re: Ghost-town

What time frame are we looking at?

> ----- Original Message -----
> **From:** Borski, Jennifer - DNR
> **To:** Lowery, Jason
> **Cc:** Clay Eiting
> **Sent:** Monday, September 25, 2006 10:30 AM
> **Subject:** RE: Ghost-town
>
> I received the $750 closure fee and closure request on 9/22. I anticipate forwarding the information with my recommendation for closure with a PAL exemption to the closure committee this week.
>
> ---
>
> **From:** Lowery, Jason [mailto:jblowery@terracon.com]
> **Sent:** Thursday, September 21, 2006 4:47 PM
> **To:** Borski, Jennifer - DNR
> **Cc:** Clay Eiting
> **Subject:** Ghost-town
>
> Jennifer
>
> You should have gotten our assessment report today or tomorrow for Ghost-town Fitness Center. Please let us know when you are absolutely sure that it is OK to abandon the monitoring well. We want to do that ASAP. Thanks.
>
> **Jason B. Lowery, P.G.**
> **Project Hydrogeologist I Appleton**
> **Terracon**
> 3011B East Capitol Drive I Appleton, Wisconsin 54911
> P 920-993-9096 I F 920-993-9108

jblowery@terracon.com I www.terracon.com

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Borski, Jennifer - DNR

From: Borski, Jennifer - DNR
Sent: Friday, September 22, 2006 9:50 AM
To: Lowery, Jason
Subject: RE: Ghost-town

When the request and fee are received, I will route to the committee ASAP for their review. "Absolutely sure that it is OK to abandon the monitoring well" means waiting for the entire closure committee to review the request for closure. As stated in the past, I've discussed the details of this case with Keld Lauridsen and he is in support of no additional monitoring. I do not anticipate any disagreement from the rest of the committee with my and Keld's support of abandonment. Regardless, I will call you with the closure committee decision once it is final.

From: Lowery, Jason [mailto:jblowery@terracon.com]
Sent: Thu 9/21/2006 4:47 PM
To: Borski, Jennifer - DNR
Cc: Clay Eiting
Subject: Ghost-town

Jennifer

You should have gotten our assessment report today or tomorrow for Ghost-town Fitness Center. Please let us know when you are absolutely sure that it is OK to abandon the monitoring well. We want to do that ASAP. Thanks.

Jason B. Lowery, P.G.
Project Hydrogeologist I Appleton
Terracon
3011B East Capitol Drive I Appleton, Wisconsin 54911
P 920-993-9096 I F 920-993-9108
jblowery@terracon.com I **www.terracon.com**

Terracon is a dynamic and growing consulting firm of engineers and scientists

providing multiple related service lines to local, regional, and national clients.

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Borski, Jennifer - DNR

From: Lowery, Jason [jblowery@terracon.com]
Sent: Thursday, September 21, 2006 4:47 PM
To: Borski, Jennifer - DNR
Cc: Clay Eiting
Subject: Ghost-town

Jennifer

You should have gotten our assessment report today or tomorrow for Ghost-town Fitness Center. Please let us know when you are absolutely sure that it is OK to abandon the monitoring well. We want to do that ASAP. Thanks.

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Borski, Jennifer - DNR

From: Borski, Jennifer - DNR
Sent: Wednesday, September 20, 2006 2:31 PM
To: 'ceiting38@hotmail.com'
Subject: Closure Fee

Clay,

Wisconsin Administrative Code, NR 749.04, requires a fee of $750 for Department review of a request for closure under chapter NR 726. Please submit a check made payable to "Department of Natural Resources" and send to:

Jennifer Borski, WDNR
625 E Cty Rd Y, STE. 700
Oshkosh, WI 54901-9731

Please reference BRRTS # 02-45-547911 on the check to assure proper tracking of the payment.

A link to NR 749 is included for your reference, if interested:
http://folio.legis.state.wi.us/cgi-bin/om_isapi.dll?clientID=35078414&infobase=code.nfo&jump=ch.%20nr%20749

Also, attached is a link to the Remediation & Redevelopment Program's webpage regarding fees:
http://www.dnr.state.wi.us/org/aw/rr/Services_Fees/index.htm

Jennifer Borski

Hydrogeologist
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
625 East County Road Y, STE. 700
Oshkosh, WI 54901-9731
(☎) phone: (920) 424-7887
(☎) fax: (920) 424-4404
(✉) e-mail: jennifer.borski@dnr.state.wi.us
Internet address: www.dnr.wi.gov/org/aw/rr

Borski, Jennifer - DNR

From: Borski, Jennifer - DNR
Sent: Wednesday, September 20, 2006 8:49 AM
To: jblowery@terracon.com
Subject: Ghost Town Fitness Center 02-45-547911

Ghost Town Fitness Center
BRRTS # 02-45-547911

I am in the process of working with Clay to pay the $750 fee. I understand he intends to send in the fee separately from the closure packet. As I informed Clay, the request for closure cannot be reviewed until the fee is paid.

Jennifer Borski

Hydrogeologist
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
625 East County Road Y, STE. 700
Oshkosh, WI 54901-9731
(☎) phone: (920) 424-7887
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(✉) e-mail: jennifer.borski@dnr.state.wi.us
Internet address: www.dnr.wi.gov/org/aw/rr

Borski, Jennifer - DNR

From: Borski, Jennifer - DNR
Sent: Thursday, September 14, 2006 2:11 PM
To: 'jblowery@terracon.com'
Subject: RE: Ghost Town Fitness

OK to dispose PAL purge water on site. 4B 9/19/06

A closure form does not need to be submitted but the following should be included in the request for closure along with the soil and groundwater data summaries and basic site map showing property boundaries with respect to roads/waterways, etc, land use cover (e.g. structure, grass, gravel, etc), boring/well locations:

- acres
- WTM coordinates
- zoning
- soil type
- drill/soil cutting disposal location
- purge water disposal location

The request should also discuss the reason for the boring/well locations as identified in the Phase I.

From: Borski, Jennifer - DNR
Sent: Thursday, September 14, 2006 8:58 AM
To: jblowery@terracon.com
Subject: Ghost Town Fitness

create ERP
- PAL gw disposal method ?

Jason,

My understanding from your message is that the NR 141 replacement well revealed no PAL exceedance for lead but arsenic at 3 ppb (PAL = 1 ppb) and selenium at 14.7 ppb (PAL = 10 ppb). These concentrations are similar to the original concentrations detected in groundwater from the 1" diam temp well of arsenic = 7.8 ppb (J flag) and selenium = 32 ppb.

First of all, the NR 141 results should be reviewed to confirm that they are in fact PAL exceedances in accordance with NR 140.14, WAC. I talked with the closure committee regarding this situation to confirm the owner has two options under the NR 700 series if they are PAL exceedances under NR 140.14:

1. DNR will create a case (assign an ERP BRRTS #) and owner needs to request closure under NR 726 by submitting the necessary documentation along with a fee of $750 and receive closure with a PAL exemption for arsenic and selenium once the well is abandoned (no closure form necessary but acres and some other details need to be included in a cover letter & site map).

2. DNR will continue to hold this case in "pending" and owner needs to resample the NR 141 well for arsenic and selenium. If PAL exceedances remain, DNR will create an ERP case and closure should be requested as discussed in #1 above. If PAL exceedances are no longer present, DNR will create a NAR case ("no action required") and nothing further is needed aside from well abandonment.

Let me know if you have further questions.

Jennifer Borski

Hydrogeologist
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
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Oshkosh, WI 54901-9731

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Internet address: www.dnr.wi.gov/org/aw/rr

Borski, Jennifer - DNR

From: Borski, Jennifer - DNR
Sent: Thursday, September 14, 2006 8:58 AM
To: jblowery@terracon.com
Subject: Ghost Town Fitness

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Let me know if you have further questions.

Jennifer Borski

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State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Phone Log

August 24, 2006

Site Name: Ghost Town Fitness Center
Site ID: pending

Name: Clay Eiting
Phone: 920-766-0149
Initiated By: Borski
Time: 2:45 PM

Subject: NR 141 monitoring well needed

Borski contacted Eiting and stated that based on information provided by Terracon, exceedances of standards exist in groundwater and additional sampling is necessary. (As, Pb and Se > PAL from 1" diam temp well). Borski explained the work needed. Eiting requested Borski contact Terracon and relay this information and request Terracon provide Eiting with a cost estimate. Eiting will decide if he intends to move forward with Terracon or another consultant.

Borski contacted Jason Lowery at Terracon on 8/24/06 at approximately 2:55 PM. Borski informed Lowery of the following required work and possible closure scenarios:
A 2" diameter well should be installed in accordance with NR 141 in the same location as the temp well and sampled for As, Pb & Se. Lowery stated that the initial temp well was a 1" diam, two-foot screen with water at 4 ft but dry clay beneath it and refusal (dolomite chips) at 11 ft. Borski agreed that a 2" diameter, five-foot screen is appropriate in this situation. Lowery will screen from 4-9 ft. Borski stated that one or two weeks may be needed after development to collect enough water for the sample.

If results are below PALs, the case can be created as a NAR (09) after well abandonment. A letter can be issued for $500 "other technical assistance" or the property owner can print off the activity detail report from BRRTS on the Web for free. If results are above PALs, the case will be created as an ERP (02) and a second event required. If the second event from the NR 141 well has results below PALs, a NFA under NR 708 can be issued for $250. If the second event from the NR 141 well has results above PALs, closure under NR 726 can be granted for $750. If closure under NR 726 is required, Borski should review the information previously submitted and determine if it is necessary for a case creation form to be submitted or determine that additional documentation be submitted in a brief update.

Lowery will put together a cost estimate to provide Eiting.

Jennifer Borski JB

Borski, Jennifer

From: Borski, Jennifer
Sent: Thursday, August 24, 2006 12:05 PM
To: Danelski, Denise D; Jones, Casey L.
Subject: RE: Ghost Town Fitness Center - Pending

Updated information - I forgot we cannot issue a NFA under NR 708 if groundwater is above a PAL. It must be a NR 726 closure then... I underlined the additions to the original message below.

From: Borski, Jennifer
Sent: Thursday, August 24, 2006 11:58 AM
To: Danelski, Denise D; Jones, Casey L.
Subject: Ghost Town Fitness Center - Pending

Denise and Casey,

I took a look at the documentation provided to us for the Ghost Town Fitness Center (pending case). They have three PAL exceedances for arsenic, lead and selenium but no apparent issue in the one soil sample collected. The PAL exceedances are likely due to the fact that the water sample was collected from a 1" diam temp well and was turbid (high particle count). Unfortunately, we need them to follow-up to determine if there are actually exceedances of the PALs.

I am going to request the property owner install a NR 141 well and resample for these metals to determine if PAL exceedances actually exist. This is consistent with how we've handled other PAL exceedances reported from temp wells. If there is no confirmed PAL exceedance, it will become a NAR as no release could be confirmed. If there is a release (PAL exceedance), they will need to do more investigation into the source for the PAL exceedances (since there does not appear to be a soil issue) and we'll create this as an ERP. I anticipate that if an ERP is created, we can close under NR 726 once they collect two rounds from the NR 141 well to confirm a PAL exceedance with a stable trend.

This may be pending for more than two months and you may get results back after I'm on maternity leave. If that is the case, I hope this e-mail will help decide how to address the NR 141 well data. You can also reference the APEX Real Estate NAR 09-45-544973 (8/16/06) and the Sulpaco West (former) - Parking Lot (02 yet to be assigned) for guidance on how to deal with the results if needed after I'm gone.

I spoke with Jason Lowry with Terracon this morning. Terracon was hired by the bank that is looking to loan the son, Clay Eiting, money to purchase the property from his father, Jeff Eiting. Unfortunately, Terracon advised Clay that the Department would likely not require anything further. I have yet to reach Clay but will document that conversation as well. Hopefully, Clay will be willing to install the NR 141 well voluntarily while the case is "pending". Otherwise, we will need to issue Jeff an RP letter based on the reported PAL exceedances, create the 02 and require the NR 141 well & sampling. If we are forced into this route, I believe we can issue a NFA under ch. NR 708 if the NR 141 well shows no PAL exceedance but will have to close under NR 726 if there is a confirmed PAL exceedance.

Jennifer Borski

Hydrogeologist
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(✉) e-mail: jennifer.borski@dnr.state.wi.us
Internet address: www.dnr.wi.gov/org/aw/rr

CORRESPONDENCE/MEMORANDUM — **State of Wisconsin**

DATE: August 23, 2006

FILE REF: Ghost Town Fitness Center
BRRTS#: None Assigned - system down

TO: Jenna Borski - Oshkosh

FROM: Diane Hansen
Green Bay

Diane

Assigned yet? 9/14/06 Assign 02

SUBJECT: REVIEW AND DECISION AS TO TYPE OF ACTIVITY

Attached is the paperwork for a tank closure/substance release. Please review the material and submit a "Case Creation Form" to me, or let me know if I should create a case. Please indicate if this is a clean tank pull or if it is an ERP/LUST that you are not requiring clean-up.

Originally I received the fax cover sheet (with attachments), and then was mailed the complete packet of information. If you have any questions, give me a call.

Thanks.

Diane

8/24/06

Attach.

Need NR 141 well + sampling for As, Pb + Se to confirm PAL exceedances.

If no PAL → NAR

If metals > PAL, create 02, confirm stable trend + issue closure ~~NFA~~, (assuming additional SI shows no soil issue + localized PAL exceedances) (4B)

5' screen ok
4-11'

(NFA not appropriate if PAL exceeded)

Printed on Recycled Paper

FAX COVER SHEET

GHOST-TOWN FITNESS CENTER
180 FOX SHORE DR.
KAUKAUNA, WI 54130
UNITED STATES
(920)766-0149
(920)766-9328

SEND TO	
Company name: WDNR	From: Clay
Attention: Diane Hanson	Date: 8/22/06
Office location:	Office location:
Fax number:	Phone number:

☐ Urgent ☐ Reply ASAP ☐ Please comment ☐ Please review ☐ For your information

Total pages, including cover: _____

COMMENTS

State of Wisconsin
Department of Natural Resources

Fax Notification For Hazardous Substance Discharge (Non-Emergency Only)

Emergency Discharges / Spills should be reported via the 24-Hour Hotline: 1-800-943-0003

Notice: **Hazardous substance discharges must be reported immediately** according to the "Spills Law", s. 292.11 Wis. Stats., Section NR 706.05(1)(b), Wis. Adm. Code, requires that hazardous substance discharges are to be reported by one of three methods: telephoning the Department (toll free Spill Hotline number above), telefaxing a report to the Department or visiting a Department office in person. If you choose to notify the Department by telefax, you should use this form to be sure that all necessary information is included. However use of this form is not mandatory. Under s. 292.99, Wis. Stats., the penalty for violating the reporting requirements of ch. 292 Wis. Stats., shall be no less than $10 nor more than $5000 for each violation. Each day of continued violation is a separate offense. It is not the Department's intention to use any personally identifiable information from this form for any purpose other than program administration. However, information submitted on this form may also be made available to requesters under Wisconsin's Open Records Law (ss. 19.31 – 19.39, Wis. Stats.). Confirmatory laboratory data should be included with this form, to assist the DNR in processing this Hazardous Substance Release Notification.

Complete this form. **TYPE or PRINT LEGIBLY.** FAX it to the appropriate DNR region (see next page) **IMMEDIATELY** upon discovery of a potential release from **(check one)**:

- ☐ Underground Petroleum Storage Tank System
- ☐ Aboveground Petroleum Storage Tank System
- ☐ Dry Cleaner Facility (DERP eligibility based on: ☐ Facility owner/operator ☐ Property owner of licensed facility)
- ☐ Other - Describe:

TO DNR, ATTN: **R & R Program Assistant**	(Area Code) FAX Number
	(920) 766-9338

1. Discharge reported by:

Name	Firm	Date FAXed to DNR
Clay J Eiting	Ghost-Town Fitness Center	8/22/06
Mailing Address		**(Area Code) Phone Number**
180 Fox Shores Dr Kaukauna WI 54130		(920) 766-0149

2. Site Information

Name of site at which discharge occurred. Include local name of site/business, not responsible party name, unless a residence / vacant property

Ghost-town Fitness Center

Location: Include street address, not PO Box. If no street address, describe as precisely as possible, i.e., 1/4 mile NW of CTHs 60 & 123 on E side of CTH 60

180 Fox Shores Dr

Municipality (City, Village, Township) Specify municipality in which the site is located, not mailing address/city

Kaukauna

County:	Legal Description:
Outagamie	____ 1/4, NW 1/4, Section 22, Tn 21N, Range 18 (E)/ W (circle one)

3. Responsible Party (RP) and/or RP Representative

☒ Responsible Party Name: Business or owner name that is responsible for cleanup. If more than one, list all Attach additional pages as necessary

Jeff Eiting

☑ Reported in compliance with s. 292.11(2), Wis. Stats., by a local government exempt from liability under s. 292.11(9)(e), Wis. Stats. For more information see http://dnr.wi.gov/org/aw/rr/liability/muni_1.html

Contact Person Name (if different)			Phone Number
Clay Eiting			(920) 766-0149
Mailing Address	**City**	**State**	**ZIP Code**
180 Fox Shores Dr	Kaukauna	WI	54130

(continued)

State of Wisconsin
Department of Natural Resources

Fax Notification For Hazardous Substance Discharge (Non-Emergency Only)

4. Hazardous Substance Impact Information

Identify hazardous substance ~~discharged~~ detected (check all that apply):

METALS
- [x] Arsenic
- [x] Chromium
- [x] Lead
- [x] Mercury
- [x] Metals (specify): _____

SOLVENTS
- [ ] Solvent-Chlorinated
- [ ] Solvent-Non Chlorinated
- [ ] PERC
- [ ] VOC's

INDUSTRIAL CHEMICALS
- [ ] Ammonia
- [ ] Cyanide
- [ ] Paint
- [ ] PCB's
- [ ] VOC's
- [ ] Fertilizers
- [ ] Pesticide/Herbicide/Insecticide(s)
- [ ] Leachate
- [ ] RCRA Hazardous Waste

PETROLEUM
- [x] Diesel/Fuel Oil (DRO)
- [ ] Engine Oil/Waste Oil
- [ ] Mineral/Transmission/Hydraulic Oil
- [ ] Gasoline (Pb/Non-Pb/Unknown)
- [ ] Jet Fuel/Kerosene
- [ ] MTBE
- [ ] VOC's
- [ ] PAH's/SVOC
- [ ] Petroleum-Unknown Type
- [ ] Unknown
- [ ] Other (specify):_____

Impacts to the environment (enter "K" for known/confirmed or "P" for potential for all that apply)

___ Air Contamination	___ Contamination in Right of Way	___ Sanitary Sewer Contamination
___ Co-contamination	___ Direct Contact	K Soil ~~Contamination~~ detection
___ Concrete/Asphalt	___ Expanding Plume	___ Storm Sewer Contamination
___ Contained/Recovered	___ Fire Explosion Threat	___ Surface Water Contamination
___ Contamination Within 1 Meter of Bedrock	___ Free Product	___ Within 100 ft of Private Well
___ Contaminated Private Well	K Groundwater ~~Contamination~~ detection	___ Within 1000 ft of Public Well
___ Contaminated Public Well	___ Off-Site Contamination	
___ Contamination in Fractured Bedrock	___ Other	

Contamination was discovered as a result of:

[ ] Tank closure assessment	[x] Site assessment	Other – Describe:
Date	Date	Date

Lab results:
- [ ] Lab results will be faxed upon receipt
- [x] Lab results are attached

Additional Comments: Include a brief description of immediate actions taken to halt the release and contain or cleanup hazardous substances that have been discharged.

Concentrate doesn't appear for further action!

FAX numbers to report non-emergency releases in DNR's five regions are as follows:

Northeast Region (920-662-5197); Attention - RR Program Assistant:
Brown, Calumet, Door, Fond du Lac ***(except City of Waupun - see South Central Region)***, Green Lake, Kewaunee, Manitowoc, Marinette, Marquette, Menominee, Oconto, Outagamie, Shawano, Waupaca, Waushara, Winnebago counties

Northern Region (715-365-8932); Attention - RR Program Assistant:
Ashland, Barron, Bayfield, Burnett, Douglas, Forest, Florence, Iron, Langlade, Lincoln, Oneida, Polk, Price, Rusk, Sawyer, Taylor, Vilas, Washburn counties

South Central Region (608-275-3338); Attention - RR Program Assistant:
Columbia, Dane, Dodge, Fond du Lac ***(City of Waupun only)***, Grant, Green, Iowa, Jefferson, Lafayette, Richland, Rock, Sauk counties

Southeast Region (414-263-8483); Attention - RR Program Assistant:
Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington, Waukesha counties

West Central Region (715-839-6076); Attention – RR Program Assistant:
Adams, Buffalo, Chippewa, Clark, Crawford, Dunn, Eau Claire, Jackson, Juneau, LaCrosse, Marathon, Monroe, Pepin

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ents
t Questions
Links

Soil Screening Guidance Calculator

Equation Values for Ingestion

Noncarcinogenic Parameter	Value	Carcinogenic Age-adjusted Parameter	Value	Carcinogenic Nonadjusted Parameter	Value
Target Hazard Quotient (unitless)	0.2	Target Risk (unitless)	1.0E-7	Target Risk (unitless)	1.0E-6
Body Weight (kg)	15	Adult Body Weight (kg)	70	Body Weight (kg)	70
		Child Body Weight (kg)	15		
Exposure Duration (yr)	6	Adult Exposure Duration (yr)	24	Exposure Duration (yr)	25
		Child Exposure Duration (yr)	6		
Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	250
Intake Rate (mg/day)	200	Adult Intake Rate (mg/day)	100	Intake Rate (mg/day)	100
		Child Intake Rate (mg/day)	200		
		Average Lifetime (yr)	70	Average Lifetime (yr)	70
		Age-adjusted Ingestion Factor (mg-yr/kg-day)	114.29		

Soil Screening Levels for Ingestion (mg/kg)

Analyte	Cas Number	Oral RfD	Oral Slope Factor	Noncarcinogenic	Carcinogenic (Age-adjusted)	Carcinogenic (Nonadjusted)
Barium	7440393	2.00E-01 [a]		3.13E+03		

Pierce, Portage, St. Croix, Trempealeau, Vernon, Wood counties

CHAIN OF CUSTODY RECORD

Synergy Environmental Lab, Inc.

1990 Prospect Ct. • Appleton, WI 54914
920-830-2455 • FAX 920-733-0631

Chain #

Page 1

Sample Hand
___ Rush Analysis D
(Rushes accepted only w
X Normal

Lab I.D. #

Account No. : | Quote No.:

Project #: 3967035

Sampler: (signature)

Project (Name / Location):

Reports To:	Invoice To:
Company	Company
Address	Address
City State Zip	City State Zip
Phone	Phone
FAX	FAX

Analysis Requested

Lab I.D.	Sample I.D.	Collection Date	Collection Time	Comp	Grab	Filtered Y/N	No. of Containers	Sample Type (Matrix)*	Preservation	DRO (Mod DRO Sep 95)	GRO (Mod GRO Sep 95)	PVOC (EPA 8021)	VOC (EPA 8260)	VOC DW (EPA 524.2)	PAH (EPA 8270)	Total Suspended Solids	Lead	Other A: RCRA Metals
	K-1(4)	7/6	945		X	N	3	S	None/Cool	X			X					X
	B-1	↓	↓		X	Y/N	5	GW	HCl/Cool	X			X					X

Comments/Special Instructions (*Specify groundwater "GW", Drinking Water "DW", Waste Water "WW", Soil "S", Air "A", Oil, Sludge etc.)

Sample Integrity - To be completed by receiving lab.

Method of Shipment: ___

Temp. of Temp. Blank: ___ °C On Ice: Y

Cooler seal intact upon receipt: ___ Yes ___ No

Relinquished By: (sign)	Time	Date	Received By: (sign)
	1030		

Received in Laboratory By: Time:

Synergy Environmental Lab, Inc.

1990 Prospect Ct., Appleton, WI 54914 *P 920-830-2455 * F 920-733-0631

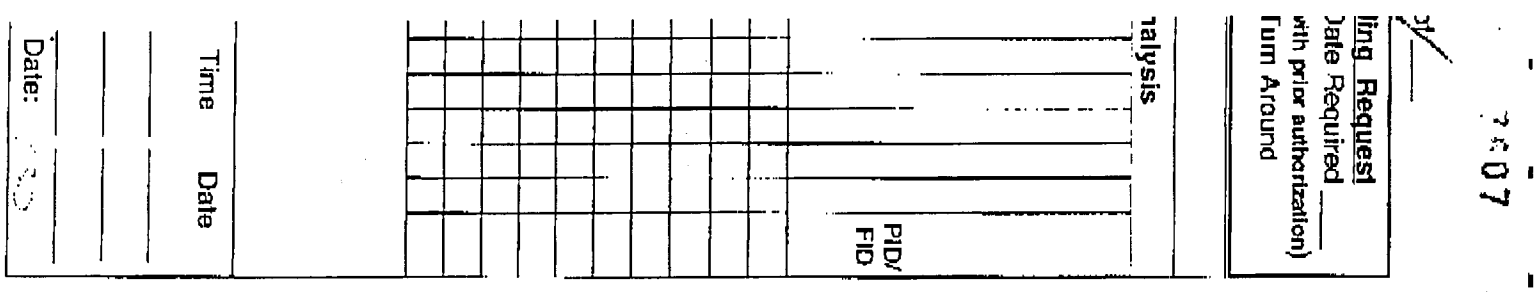
JASON LOWERY
TERRACON
3011B E. Capitol Drive
APPLETON WI 54911

Report *09-Aug-06*

Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864A
Sample ID B-1(4)
Sample Soil
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
General									
General									
Solids Percent	94.2	%			1	5021	7/28/2006	CJR	1
Inorganic									
Metals									
Mercury, Total	0.021	mg/kg	0.002	0.02	1	7470A	8/3/2006	ESC	1
Arsenic, Total	< 0.074	mg/kg	0.074	5	5	EPA 6010B	8/3/2006	ESC	1 49
Barium, Total	20	mg/kg	0.001	0.25	1	EPA 6010B	8/2/2006	ESC	1
Cadmium, Total	0.67	mg/kg	0.001	0.25	1	EPA 6010B	8/2/2006	ESC	1
Chromium, Total	5.9	mg/kg	0.002	0.5	1	EPA 6010B	8/2/2006	ESC	1
Lead, Total	5.3	mg/kg	0.012	0.25	1	EPA 6010B	8/2/2006	ESC	1
Selenium, Total	3.2	mg/kg	0.021	1	1	EPA 6010B	8/2/2006	ESC	1
Silver, Total	< 0.0037	mg/kg	0.003	0.5	1	EPA 6010B	8/2/2006	ESC	1
Organic									
General									
Diesel Range Organics	< 10	mg/kg	0.72	2.3	1	DRO95	8/4/2006	MJR	1
VOC's									
Benzene	< 25	ug/kg	5.2	16	1	8260B	8/2/2006	CJR	1
Bromobenzene	< 25	ug/kg	21	66	1	8260B	8/2/2006	CJR	1
Bromodichloromethane	< 25	ug/kg	13	42	1	8260B	8/2/2006	CJR	1
Bromoform	< 25	ug/kg	15	48	1	8260B	8/2/2006	CJR	1
tert-Butylbenzene	< 25	ug/kg	5.6	18	1	8260B	8/2/2006	CJR	1
sec-Butylbenzene	< 25	ug/kg	8	26	1	8260B	8/2/2006	CJR	1
n-Butylbenzene	< 25	ug/kg	20	65	1	8260B	8/2/2006	CJR	1
Carbon Tetrachloride	< 25	ug/kg	8.7	28	1	8260B	8/2/2006	CJR	1
Chlorobenzene	< 25	ug/kg	11	35	1	8260B	8/2/2006	CJR	1
Chloroethane	< 25	ug/kg	13	42	1	8260B	8/2/2006	CJR	1
Chloroform	< 25	ug/kg	5.9	19	1	8260B	8/2/2006	CJR	1
Chloromethane	< 25	ug/kg	8.4	27	1	8260B	8/2/2006	CJR	1



Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864B
Sample ID B-1
Sample Water
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
1,3,5-Trimethylbenzene	< 1.2	ug/l	1.2	3.7	1	8260B	7/29/2006	CJR	1
Vinyl Chloride	< 0.11	ug/l	0.11	0.35	1	8260B	7/29/2006	CJR	1
m&p-Xylene	< 1.1	ug/l	1.1	3.4	1	8260B	7/29/2006	CJR	1
o-Xylene	< 0.18	ug/l	0.18	0.56	1	8260B	7/29/2006	CJR	1

"J" Flag: Analyte detected between LOD and LOQ LOD Limit of Detection LOQ Limit of Quantitation

Code	*Comment*
1	Laboratory QC within limits.
3	The matrix spike not within established limits.
4	The continuing calibration standard not within established limits.
49	Sample diluted to compensate for matrix interference.
64	Spike recovery failed due to matrix interference. Sample results unaffected.

Authorized Signature Michael J. Ricker

Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864A
Sample ID B-1(4)
Sample Soil
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
2-Chlorotoluene	< 25	ug/kg	5.1	16	1	8260B	8/2/2006	CJR	1
4-Chlorotoluene	< 25	ug/kg	17	53	1	8260B	8/2/2006	CJR	1
1,2-Dibromo-3-chloropropane	< 25	ug/kg	19	61	1	8260B	8/2/2006	CJR	1
Dibromochloromethane	< 25	ug/kg	17	54	1	8260B	8/2/2006	CJR	1
1,4-Dichlorobenzene	< 25	ug/kg	22	72	1	8260B	8/2/2006	CJR	1
1,3-Dichlorobenzene	< 25	ug/kg	19	59	1	8260B	8/2/2006	CJR	1
1,2-Dichlorobenzene	< 25	ug/kg	20	64	1	8260B	8/2/2006	CJR	1
Dichlorodifluoromethane	< 25	ug/kg	10	32	1	8260B	8/2/2006	CJR	1
1,2-Dichloroethane	< 25	ug/kg	11	36	1	8260B	8/2/2006	CJR	1
1,1-Dichloroethane	< 25	ug/kg	9	29	1	8260B	8/2/2006	CJR	1
1,1-Dichloroethene	< 25	ug/kg	15	48	1	8260B	8/2/2006	CJR	1
cis-1,2-Dichloroethene	< 25	ug/kg	16	51	1	8260B	8/2/2006	CJR	1
trans-1,2-Dichloroethene	< 25	ug/kg	8.9	28	1	8260B	8/2/2006	CJR	1
1,2-Dichloropropane	< 25	ug/kg	11	34	1	8260B	8/2/2006	CJR	1
2,2-Dichloropropane	< 25	ug/kg	18	57	1	8260B	8/2/2006	CJR	1
1,3-Dichloropropane	< 25	ug/kg	14	45	1	8260B	8/2/2006	CJR	1
Di-isopropyl ether	< 25	ug/kg	3.9	12	1	8260B	8/2/2006	CJR	1
EDB (1,2-Dibromoethane)	< 25	ug/kg	15	49	1	8260B	8/2/2006	CJR	1
Ethylbenzene	< 25	ug/kg	9.8	31	1	8260B	8/2/2006	CJR	1
Hexachlorobutadiene	< 25	ug/kg	12	38	1	8260B	8/2/2006	CJR	1
Isopropylbenzene	< 25	ug/kg	12	39	1	8260B	8/2/2006	CJR	1
p-Isopropyltoluene	< 25	ug/kg	15	47	1	8260B	8/2/2006	CJR	1
Methylene chloride	< 25	ug/kg	19	61	1	8260B	8/2/2006	CJR	1
Methyl tert-butyl ether (MTBE)	< 25	ug/kg	17	55	1	8260B	8/2/2006	CJR	1
Naphthalene	< 25	ug/kg	16	52	1	8260B	8/2/2006	CJR	1
n-Propylbenzene	< 25	ug/kg	12	40	1	8260B	8/2/2006	CJR	1
1,1,2,2-Tetrachloroethane	< 25	ug/kg	15	48	1	8260B	8/2/2006	CJR	1
1,1,1,2-Tetrachloroethane	< 25	ug/kg	24	76	1	8260B	8/2/2006	CJR	1
Tetrachloroethene	< 25	ug/kg	18	58	1	8260B	8/2/2006	CJR	1
Toluene	< 25	ug/kg	12	39	1	8260B	8/2/2006	CJR	1
1,2,4-Trichlorobenzene	< 25	ug/kg	25	80	1	8260B	8/2/2006	CJR	1
1,2,3-Trichlorobenzene	< 25	ug/kg	11	35	1	8260B	8/2/2006	CJR	1
1,1,1-Trichloroethane	< 25	ug/kg	21	66	1	8260B	8/2/2006	CJR	1
1,1,2-Trichloroethane	< 25	ug/kg	18	57	1	8260B	8/2/2006	CJR	1
Trichloroethene (TCE)	< 25	ug/kg	20	63	1	8260B	8/2/2006	CJR	1
Trichlorofluoromethane	< 25	ug/kg	11	35	1	8260B	8/2/2006	CJR	1
1,2,4-Trimethylbenzene	< 25	ug/kg	7.9	25	1	8260B	8/2/2006	CJR	1
1,3,5-Trimethylbenzene	< 25	ug/kg	8.6	27	1	8260B	8/2/2006	CJR	1
Vinyl Chloride	< 25	ug/kg	5.5	18	1	8260B	8/2/2006	CJR	1
m&p-Xylene	< 50	ug/kg	17	53	1	8260B	8/2/2006	CJR	1
o Xylene	< 25	ug/kg	8.8	28	1	8260B	8/2/2006	CJR	1

Lab 5013864B
Sample ID B-1
Sample Water
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
Inorganic									
Metals									
Cadmium, dissolved	< 0.7	ug/l	0.7	5	1	EPA 6010B	8/3/2006	ESC	1
Chromium, Dissolved	< 3.1	ug/l	3.1	10	1	EPA 6010B	8/3/2006	ESC	1
Mercury, dissolved	0.084 "J"	ug/l	0.066	0.2	1	7470A	8/3/2006	ESC	1
Selenium, dissolved	32	ug/l	7.2	20	1	EPA 6010B	8/4/2006	ESC	1
Silver, dissolved	< 3	ug/l	3	10	1	EPA 6010B	8/3/2006	ESC	1
Barium, Dissolved	76	ug/l	1.6	5	1	EPA 6010B	8/3/2006	ESC	1

Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864B
Sample ID B-1
Sample Water
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
Arsenic, Dissolved	7.8 "J"	ug/l	7.4	20	1	EPA 6010B	8/4/2006	ESC	1
Lead, Dissolved	5.8	ug/l	4.1	5	1	EPA 6010B	8/3/2006	ESC	1
Organic									
General									
Diesel Range Organics	120	ug/l	11	35	1	DRO95	8/3/2006	MJR	1
VOC's									
Benzene	< 0.17	ug/l	0.17	0.53	1	8260B	7/29/2006	CJR	3 64
Bromobenzene	< 0.62	ug/l	0.62	2	1	8260B	7/29/2006	CJR	1
Bromodichloromethane	< 0.82	ug/l	0.82	2.6	1	8260B	7/29/2006	CJR	1
Bromoform	< 0.3	ug/l	0.3	0.97	1	8260B	7/29/2006	CJR	1
tert-Butylbenzene	< 0.6	ug/l	0.6	1.9	1	8260B	7/29/2006	CJR	1
sec-Butylbenzene	< 0.76	ug/l	0.76	2.4	1	8260B	7/29/2006	CJR	1
n-Butylbenzene	< 1.1	ug/l	1.1	3.5	1	8260B	7/29/2006	CJR	1
Carbon Tetrachloride	< 0.52	ug/l	0.52	1.7	1	8260B	7/29/2006	CJR	1
Chlorobenzene	< 0.56	ug/l	0.56	1.8	1	8260B	7/29/2006	CJR	1
Chloroethane	< 0.54	ug/l	0.54	1.7	1	8260B	7/29/2006	CJR	1
Chloroform	< 0.61	ug/l	0.61	1.9	1	8260B	7/29/2006	CJR	1
Chloromethane	< 0.91	ug/l	0.91	2.9	1	8260B	7/29/2006	CJR	1
2-Chlorotoluene	< 1.1	ug/l	1.1	3.4	1	8260B	7/29/2006	CJR	1
4-Chlorotoluene	< 0.62	ug/l	0.62	2	1	8260B	7/29/2006	CJR	1
1,2-Dibromo-3 chloropropane	< 2.5	ug/l	2.5	8.1	1	8260B	7/29/2006	CJR	1
Dibromochloromethane	< 0.65	ug/l	0.65	2.1	1	8260B	7/29/2006	CJR	1
1,4-Dichlorobenzene	< 0.68	ug/l	0.68	2.2	1	8260B	7/29/2006	CJR	1
1,3-Dichlorobenzene	< 0.72	ug/l	0.72	2.3	1	8260B	7/29/2006	CJR	1
1,2-Dichlorobenzene	< 0.69	ug/l	0.69	2.2	1	8260B	7/29/2006	CJR	1
Dichlorodifluoromethane	< 0.5	ug/l	0.5	1.6	1	8260B	7/29/2006	CJR	1
1,2-Dichloroethane	< 0.72	ug/l	0.72	2.3	1	8260B	7/29/2006	CJR	1
1,1-Dichloroethane	< 0.22	ug/l	0.22	0.69	1	8260B	7/29/2006	CJR	1
1,1-Dichloroethene	< 0.3	ug/l	0.3	0.97	1	8260B	7/29/2006	CJR	1
cis-1,2-Dichloroethene	< 0.5	ug/l	0.5	1.6	1	8260B	7/29/2006	CJR	1
trans-1,2-Dichloroethene	< 0.65	ug/l	0.65	2.1	1	8260B	7/29/2006	CJR	1
1,2-Dichloropropane	< 0.21	ug/l	0.21	0.67	1	8260B	7/29/2006	CJR	1
2,2-Dichloropropane	< 1.2	ug/l	1.2	4	1	8260B	7/29/2006	CJR	1
1,3-Dichloropropane	< 0.67	ug/l	0.67	2.1	1	8260B	7/29/2006	CJR	1
Di-isopropyl ether	< 0.079	ug/l	0.079	0.25	1	8260B	7/29/2006	CJR	1
EDB (1,2-Dibromoethane)	< 0.21	ug/l	0.21	0.67	1	8260B	7/29/2006	CJR	1
Ethylbenzene	< 0.2	ug/l	0.2	0.62	1	8260B	7/29/2006	CJR	1
Hexachlorobutadiene	< 2.1	ug/l	2.1	6.7	1	8260B	7/29/2006	CJR	1
Isopropylbenzene	< 0.99	ug/l	0.99	3.2	1	8260B	7/29/2006	CJR	1
p-Isopropyltoluene	< 0.81	ug/l	0.81	2.6	1	8260B	7/29/2006	CJR	1
Methylene chloride	< 0.61	ug/l	0.61	1.9	1	8260B	7/29/2006	CJR	1
Methyl tert-butyl ether (MTBE)	< 0.34	ug/l	0.34	1.1	1	8260B	7/29/2006	CJR	1
Naphthalene	< 2.2	ug/l	2.2	6.8	1	8260B	7/29/2006	CJR	4
n-Propylbenzene	< 0.61	ug/l	0.61	2	1	8260B	7/29/2006	CJR	1
1,1,2,2-Tetrachloroethane	< 0.89	ug/l	0.89	2.8	1	8260B	7/29/2006	CJR	1
1,1,1,2-Tetrachloroethane	< 0.48	ug/l	0.48	1.5	1	8260B	7/29/2006	CJR	1
Tetrachloroethene	< 0.37	ug/l	0.37	1.2	1	8260B	7/29/2006	CJR	1
Toluene	< 0.59	ug/l	0.59	1.9	1	8260B	7/29/2006	CJR	1
1,2,4-Trichlorobenzene	< 1.5	ug/l	1.5	4.8	1	8260B	7/29/2006	CJR	1
1,2,3-Trichlorobenzene	< 1.4	ug/l	1.4	4.4	1	8260B	7/29/2006	CJR	1
1,1,1-Trichloroethane	< 0.42	ug/l	0.42	1.3	1	8260B	7/29/2006	CJR	1
1,1,2-Trichloroethane	< 0.36	ug/l	0.36	1.1	1	8260B	7/29/2006	CJR	1
Trichloroethene (TCE)	< 0.39	ug/l	0.39	1.3	1	8260B	7/29/2006	CJR	1
Trichlorofluoromethane	< 0.22	ug/l	0.22	0.71	1	8260B	7/29/2006	CJR	1
1,2,4-Trimethylbenzene	< 0.16	ug/l	0.16	0.5	1	8260B	7/29/2006	CJR	1

TERRACON GROUND WATER SAMPLING INFORMATION SHEET

PROJECT NAME: Ghost-town Fitness Center		PROJECT NO.
PROJECT LOCATION: Kaukauna, WI		
SAMPLE POINT: B-1	SAMPLE POINT DESCRIPTION: Center of parking lot	
CASING DIAMETER: 1"		
WELL DEPTH: 11 feet		
DATE: 7/26/06	TIME: 0915 AM/PM	DEPTH TO GROUND WATER (FT): ≈5

CALCULATION: N/A

SAMPLING METHOD: VOC & DRO - Stainless steel screen (2-foot long) & HDPE tubing & check valve
RCRA metals - 5" PVC screen & disposable bailer - 5-foot long

DATE	TIME (AM/PM)	GALLONS REMOVED	COMMENTS
7/26/06	0910	0.25?	Started pursing water
	0912		Started sampling
7/26/06	0945		Collected sample (finished)

DISSOLVED OXYGEN:	FERROUS IRON:	NITRATE
----	----	----

pH:	ORP:	TEMP:	SPECIFIC CONDUCTANCE (uS/cm) x1000
----	----	----	----

SAMPLE APPEARANCE: VERY TURBID (TURBID) SLIGHTLY TURBID CLEAR

ODOR: YES (NO) NOT NOTED

ANALYSES: VOC, DRO, RCRA Metals

CLEANING PERFORMED IN FIELD: METHANOL AND DISPOSABLE GLOVES JBL

COMMENTS:
Filtered sample for RCRA Metals - filters kept clogging hence the long sampling time above

SAMPLED BY: JBL DATE: 7/26/06

REVIEWED BY: MAC DATE: 8/10/06

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 10/03)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☒ Remediation/Redevelopment ☐ Other: _____

1. General Information

WI Unique Well No. | DNR Well ID No. | County: Outagamie

Common Well Name: B-1 | Gov't Lot # (if applicable)

¼ ¼ | ¼: NW | Section: 22 | Township: 21 N | Range: 18 ☒ E ☐ W

Grid Location: Feet ☐ N ☐ S | Feet ☐ E ☐ W | ☐ Local Grid Origin ☐ (estimated) OR ☐ Well Location

Latitude: DEG MIN SEC N | Longitude: DEG MIN SEC W

Reason For Abandonment: Finished sampling | WI Unique Well No. of Replacement Well: _____

2. Facility / Owner Information

Facility Name: Ghost-town Fitness Center

Facility ID | License/Permit/Monitoring No | City, Village or Town

Street Address of Well: 180 Fox Shores Drive

Present Well Owner | Original Well Owner

Street Address or Route of Owner

City: Kaukauna | State: WI | ZIP Code: 54130

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole

Original Construction Date: 7/26/06

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): Push-probe

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 11 | Casing Diameter (in.): 1

Lower Drillhole Diameter (in.): 2 | Casing Depth (ft.)

Was well annular space grouted? ☐ Yes ☒ No ☐ Unknown

If yes, to what depth (feet)? | Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☐ N/A
Liner(s) removed?	☐ Yes	☐ No	☐ N/A
Screen removed?	☐ Yes	☐ No	☐ N/A
Casing left in place?	☐ Yes	☐ No	☐ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☐ N/A
Did sealing material rise to surface?	☐ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☐ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☐ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☐ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☒ Screened & Poured (Bentonite Chips) ☐ Other (Explain): _____

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks, Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite - 3/8" Chips	Surface	2	1/20	
Sand	2	11	1/4	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work | Date of Abandonment: 7/26/06

DNR Use Only

Date Received | Noted By

Street or Route	Telephone Number	Comments
3018 E. Capitol Drive	(920) 993-9096	

City	State	ZIP Code	Signature of Person Doing Work	Date Signed
Appleton	WI	54911		7/26/06

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Page 1 of 1

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Ghost-town Fitness Center (38067035)		B-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dustin Harvey Kitson Environmental	7/26/2006	7/26/2006	Push-Probe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	Feet MSL	2.00 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
NW 1/4 of NW 1/4 of Section 22, T 21 N, R 18 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/(pH)	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
PP	48 24		1	SANDY GRAVEL - Brown, well graded, medium dense, dry	GW									
			2	TOPSOIL, trace SAND - Dark brown, lean, dry	OL			0						
			3	SANDY GRAVEL - Brown, well graded, medium dense, slightly moist	GW									
PP	48 38		4	TOPSOIL, trace SAND - Dark brown, lean, wet	OL		▼	0						
			5											
			6	CLAY - Brown, lean, low plasticity, slightly moist	CL			0						
			7											
PP	48 30		8	CLAY W/GRAVEL - Red, stiff, lean, low plasticity, dry	CL			0						
			9											
			10					0						
			11	REFUSAL - 11'				0						

I hereby certify that the information on this form is true and correct to the best of my knowledge.

TABLE 2

Groundwater Analytical Summary

Ghost-town Fitness Center
Kaukauna, Wisconsin
Terracon Project No. 38067035

			VOC	DRO	RCRA Metals							
mple ID (Depth)	Sample Location	Sample Date	Volatile Organic Compounds	Diesel Range Organics	Mercury	Arsenic	Barium (mg/L)	Cadmium	Chromium	Lead	Selenium	Silver
NR 140, WAC, Enforcement Standard			NE	NE	2	10	2	5	100	15	50	50
NR 140, WAC, Preventative Action Limit			NE	NE	0.2	1	0.4	0.5	10	1.5	10	10
B-1	Center of parking lot	26-Jul-06	<MDL	120	0.084	7.8	0.076	<0.7	<3.1	5.8	32	<3

E:
entrations are listed in micrograms per liter (µg/L) unless noted otherwise
- milligrams per liter
ndicates compound not detected above listed laboratory method detection limit
dicates standard not established
. Indicates VOC compounds not detected above compound-specific method detection limits (MDL)

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may

Signature

Firm Terracon Consultants, Inc.
3011B E. Capitol Dr. Appleton, WI 54911

Tel: 920-993-9096
Fax: 920-993-9108

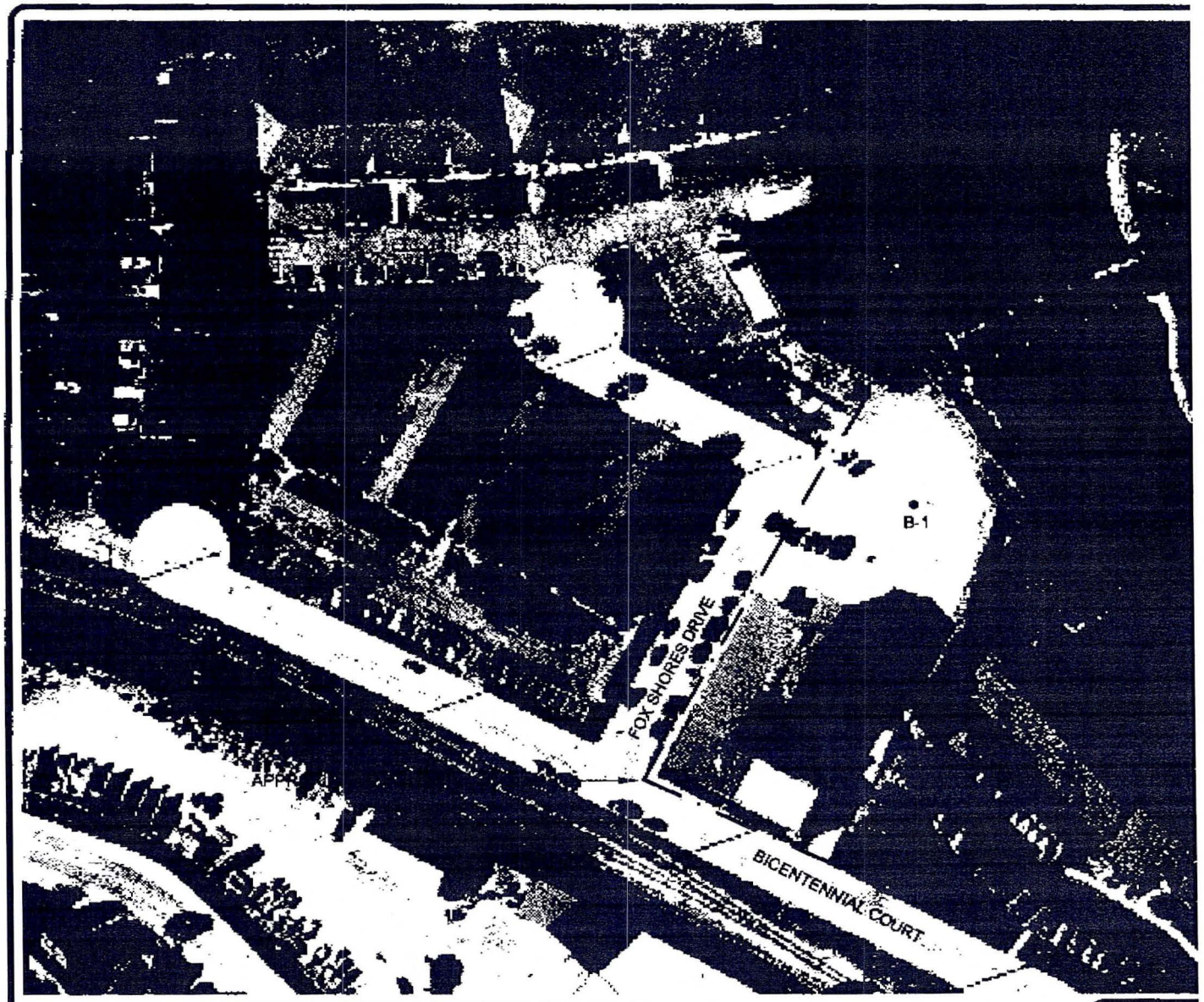
TABLE 1

Soil Analytical Summary

Ghost-town Fitness Center -
Kaukauna, Wisconsin
Terracon Project No. 38067035

th) Sample Location	Sample Date	VOC	DRO	RCRA Metals							
		Volatile Organic Compounds	Diesel Range Organics	Mercury	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
NR 720.09, WAC, Generic RCL		NE	100	NE	NE	NE	NE	NE	NE	NE	NE
NR 720.09, WAC, Non-Industrial Direct Contact RCL		NE	NE	NE	0.039	NE	5	16,000	50	NE	NE
Site Specific RCL[1]		NE	NE	4.69	NE	3,130	NE	NE	NE	78.2	NE
Center of parking lot	26-Jul-06	<MDL	<10	0.021	<0.074	20	0.67	5.9	5.3	3.2	<0.0037

listed in milligrams per kilogram (mg/kg)
pound not detected above listed laboratory method detection limit
sidual Contaminant Level
PA Soil Screening Guidance Calculator (http://risk.lsd.ornl.gov/epa/ssl1.htm) using WDNR Default Parameters per WDNR PUB-RR-682 dated January 11, 2002
dard not established or calculated
OC compounds not detected above compound-specific method detection limits (MDL)



PHOTOGRAPH COURTESY OF THE OUTAGAMIE COUNTY GEOGRAPHIC INFORMATION WEB SERVER YEAR OF PHOTOGRAPH: 2005

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DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Mngr:	
Designed By:	
Checked By:	
Approved By:	
File Name:	

N:\Projects\2006\3806703

Notes:
Concentrations an
'<' Indicates con
RCL Indicates Re
'Based on U.S. El
NE Indicates stani
<MDL Indicates V

Sample ID (De
B-1

State of Wisconsin
Department of Natural Resources

WI DNR RECEIVED AUG 23 2006 NER WASTE/RR

Fax Notification For Hazardous Substance Discharge (Non-Emergency Only)

Emergency Discharges / Spills should be reported via the 24-Hour Hotline: 1-800-943-0003

Notice: Hazardous substance discharges must be reported immediately according to the "Spills Law", s. 292.11 Wis. Stats., Section NR 706.05(1)(b), Wis. Adm. Code, requires that hazardous substance discharges are to be reported by one of three methods: telephoning the Department (toll free Spill Hotline number above), telefaxing a report to the Department or visiting a Department office in person. If you choose to notify the Department by telefax, you should use this form to be sure that all necessary information is included. However use of this form is not mandatory. Under s. 292.99, Wis. Stats., the penalty for violating the reporting requirements of ch. 292 Wis. Stats., shall be no less than $10 nor more than $5000 for each violation. Each day of continued violation is a separate offense. It is not the Department's intention to use any personally identifiable information from this form for any purpose other than program administration. However, information submitted on this form may also be made available to requesters under Wisconsin's Open Records Law (ss. 19.31 – 19.39, Wis. Stats.).
Confirmatory laboratory data should be included with this form, to assist the DNR in processing this Hazardous Substance Release Notification.

Complete this form. **TYPE or PRINT LEGIBLY.** FAX it to the appropriate DNR region (see next page) **IMMEDIATELY** upon discovery of a potential release from **(check one)**:

- ☐ Underground Petroleum Storage Tank System
- ☐ Aboveground Petroleum Storage Tank System
- ☐ Dry Cleaner Facility (DERP eligibility based on: ☐ Facility owner/operator ☐ Property owner of licensed facility)
- ☐ Other - Describe:

TO DNR, ATTN: **R & R Program Assistant**	(Area Code) FAX Number (920) 766-9328

1. Discharge reported by:

Name	Firm	Date FAXed to DNR
Clay J Eiting	Ghost-Town Fitness Center	8/22/06
Mailing Address		**(Area Code) Phone Number**
180 Fox Shores Dr Kaukauna WI 54130		(920) 766-0149

2. Site Information

Name of site at which discharge occurred. Include local name of site/business, not responsible party name, unless a residence / vacant property

Ghost-town Fitness Center

Location: Include street address, not PO Box. If no street address, describe as precisely as possible, i.e., 1/4 mile NW of CTHs 60 & 123 on E side of CTH 60

180 Fox Shores Dr

Municipality (City, Village, Township) Specify municipality in which the site is located, not mailing address/city

Kaukauna

County:	Legal Description:
Outagamie	____1/4, NW 1/4, Section 22, Tn 21N, Range 18 (E)/ W (circle one)

3. Responsible Party (RP) and/or RP Representative

☒ Responsible Party Name: Business or owner name that is responsible for cleanup. If more than one, list all Attach additional pages as necessary

Jeff Eiting

☒ Reported in compliance with s. 292.11(2), Wis. Stats., by a local government exempt from liability under s. 292.11(9)(e), Wis. Stats. For more information see http://dnr.wi.gov/org/aw/rr/liability/muni_1.html

Contact Person Name (if different)			Phone Number
Clay Eiting			(920) 766-0149
Mailing Address	**City**	**State**	**ZIP Code**
180 Fox Shores Dr	Kaukauna	WI	54130

(continued)

State of Wisconsin
Department of Natural Resources

Fax Notification For Hazardous Substance Discharge (Non-Emergency Only)

4. Hazardous Substance Impact Information

Identify hazardous substance ~~discharged~~ detected (check all that apply):

METALS
- [x] Arsenic
- [x] Chromium
- [x] Lead
- [x] Mercury
- [x] Metals (specify): _____

INDUSTRIAL CHEMICALS
- [ ] Ammonia
- [ ] Cyanide
- [ ] Paint
- [ ] PCB's
- [ ] VOC's
- [ ] Fertilizers
- [ ] Pesticide/Herbicide/Insecticide(s)
- [ ] Leachate
- [ ] RCRA Hazardous Waste

PETROLEUM
- [x] Diesel/Fuel Oil (DRO)
- [ ] Engine Oil/Waste Oil
- [ ] Mineral/Transmission/Hydraulic Oil
- [ ] Gasoline (Pb/Non-Pb/Unknown)
- [ ] Jet Fuel/Kerosene
- [ ] MTBE
- [ ] VOC's
- [ ] PAH's/SVOC
- [ ] Petroleum-Unknown Type

SOLVENTS
- [ ] Solvent-Chlorinated
- [ ] Solvent-Non Chlorinated
- [ ] PERC
- [ ] VOC's

- [ ] Unknown
- [ ] Other (specify):_____

Impacts to the environment (enter "K" for known/confirmed or "P" for potential for all that apply)

- ___ Air Contamination
- ___ Co-contamination
- ___ Concrete/Asphalt
- ___ Contained/Recovered
- ___ Contamination Within 1 Meter of Bedrock
- ___ Contaminated Private Well
- ___ Contaminated Public Well
- ___ Contamination in Fractured Bedrock
- ___ Contamination in Right of Way
- ___ Direct Contact
- ___ Expanding Plume
- ___ Fire Explosion Threat
- ___ Free Product
- P Groundwater ~~Contamination~~ detection
- ___ Off-Site Contamination
- ___ Other
- ___ Sanitary Sewer Contamination
- K Soil ~~Contamination~~ detection
- ___ Storm Sewer Contamination
- ___ Surface Water Contamination
- ___ Within 100 ft of Private Well
- ___ Within 1000 ft of Public Well

Contamination was discovered as a result of:

- [ ] Tank closure assessment — Date
- [x] Site assessment — Date
- Other – Describe: — Date

Lab results:

- [ ] Lab results will be faxed upon receipt
- [x] Lab results are attached

Additional Comments: Include a brief description of immediate actions taken to halt the release and contain or cleanup hazardous substances that have been discharged.

Concentrate doesn't appear for further action!

FAX numbers to report non-emergency releases in DNR's five regions are as follows:

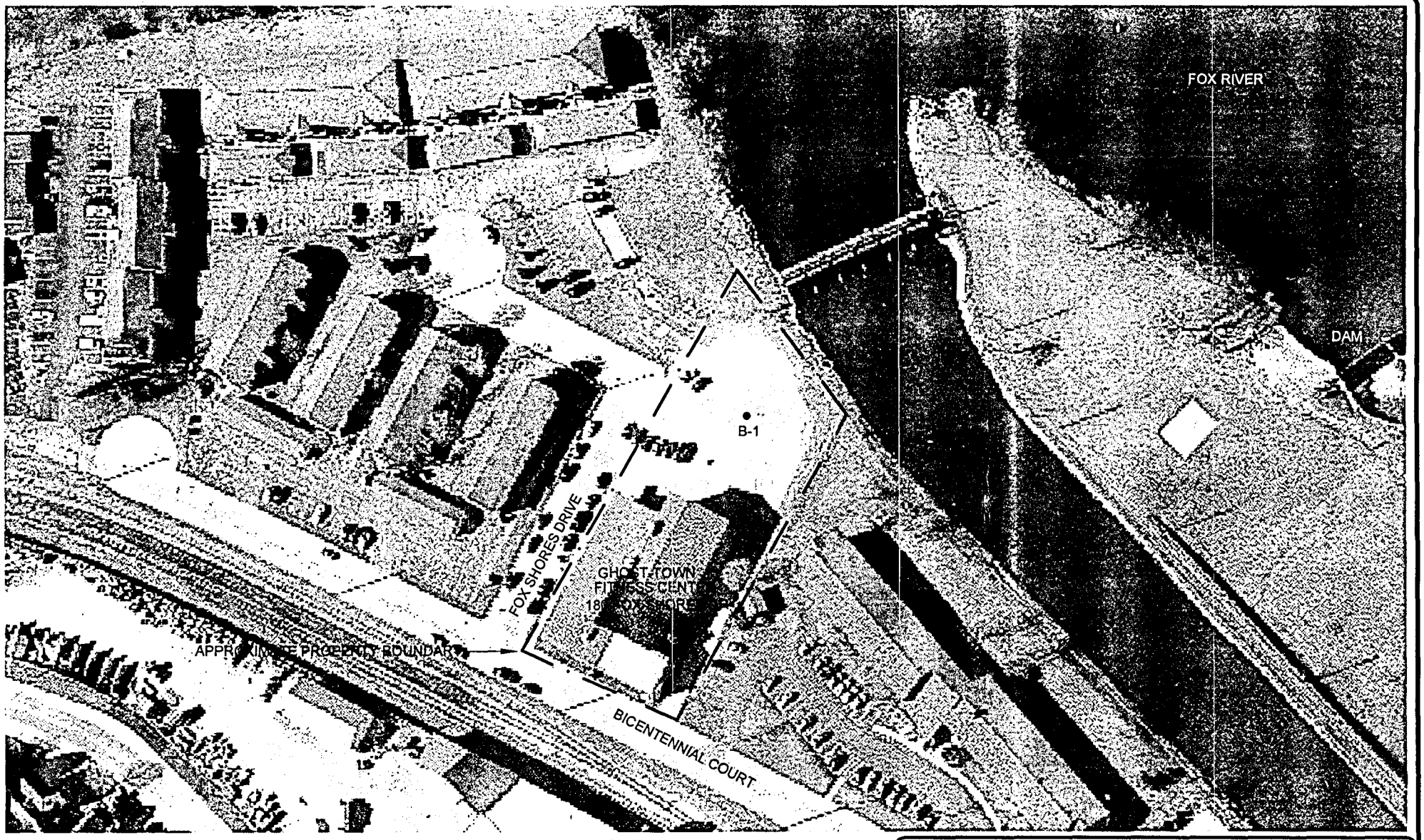
Northeast Region (920-662-5197); Attention - RR Program Assistant:
Brown, Calumet, Door, Fond du Lac ***(except City of Waupun - see South Central Region)***, Green Lake, Kewaunee, Manitowoc, Marinette, Marquette, Menominee, Oconto, Outagamie, Shawano, Waupaca, Waushara, Winnebago counties

Northern Region (715-365-8932); Attention - RR Program Assistant:
Ashland, Barron, Bayfield, Burnett, Douglas, Forest, Florence, Iron, Langlade, Lincoln, Oneida, Polk, Price, Rusk, Sawyer, Taylor, Vilas, Washburn counties

South Central Region (608-275-3338); Attention - RR Program Assistant:
Columbia, Dane, Dodge, Fond du Lac ***(City of Waupun only)***, Grant, Green, Iowa, Jefferson, Lafayette, Richland, Rock, Sauk counties

Southeast Region (414-263-8483); Attention - RR Program Assistant:
Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington, Waukesha counties

West Central Region (715-839-6076); Attention – RR Program Assistant:
Adams, Buffalo, Chippewa, Clark, Crawford, Dunn, Eau Claire, Jackson, Juneau, LaCrosse, Marathon, Monroe, Pepin, Pierce, Portage, St. Croix, Trempealeau, Vernon, Wood counties



PHOTOGRAPH COURTESY OF THE OUTAGAMIE COUNTY GEOGRAPHIC INFORMATION WEB SERVER. YEAR OF PHOTOGRAPH: 2005

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DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SITE MAP
GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

Project Mngr:	JBL	Terracon	Project No. 38067035
Designed By:	AJP	3011B E. Capitol Drive Appleton, WI 54911	Scale: 1" = 120' (approx)
Checked By:	JBL		Date: 8/1/06
Approved By:	BRS		Drawn By: AJP (38)
File Name:	38067035.dwg	Layout1	Figure No. 1

Terracon

LIMITED SITE ASSESSMENT

GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, OUTAGAMIE COUNTY, WISCONSIN

TERRACON PROJECT NO. 38067035
AUGUST 11, 2006

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) conducted a Limited Site Assessment (LSA) at the Ghost-town Fitness Center site located at 180 Fox Shores Drive in Kaukauna, Outagamie County, Wisconsin . At your request, Terracon's LSA was undertaken in response to the results of Terracon's Transaction Screen dated July 12, 2006 which identified the following potential environmental concern (PEC):

- Historic Sanborn Fire Insurance Maps depict a train roundabout and buildings labeled "Combined Locks Paper Co.", "Machine Shop", and "Black Smith" at the subject site.

The objective of the LSA was to evaluate the presence of volatile organic compounds (VOC), Resource Conservation and Recovery Act (RCRA) metals, and diesel range organics (DRO) in the on-site soil and groundwater as a result of potential releases associated with the above-referenced PEC. The LSA was completed in general accordance with our proposal dated July 13, 2006.

1.1 Site Description

Site Name	Ghost-town Fitness Center
Site Location/Address	180 Fox Shores Drive, Kaukauna, Wisconsin
General Site Description	A fitness center and gravel parking lot with streets (Bicentennial Court and Fox Shores Drive) to the southwest and northwest, an apartment complex to the southeast, and the Fox River to the northeast.

An aerial photograph is included as Figure 1 of Appendix A.

LIMITED SITE ASSESSMENT

GHOST-TOWN FITNESS CENTER
180 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

TERRACON PROJECT NO. 38067035
AUGUST 10, 2006

Prepared for:

CITIZENS

KAUKAUNA, WISCONSIN

Prepared by:

Terracon

APPLETON, WISCONSIN

Terracon

TABLE 1

Soil Analytical Summary

Ghost-town Fitness Center
Kaukauna, Wisconsin
Terracon Project No. 38067035

Depth?

Sample ID (Depth)	Sample Location	Sample Date	VOC	DRO	RCRA Metals							
			Volatile Organic Compounds	Diesel Range Organics	Mercury	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
NR 720.09, WAC, Generic RCL			NE	100	NE	NE	NE	NE	NE	NE	NE	NE
NR 720.09, WAC, Non-Industrial Direct Contact RCL			NE	NE	NE	0.039	NE	8	16,000	50	NE	NE
Site Specific RCL[1]			NE	NE	4.69	NE	3,130	NE	NE	NE	78.2	NE
B-1	Center of parking lot	26-Jul-06	<MDL	<10	0.021	<0.074	20	0.67	5.9	5.3	3.2	<0.0037

Notes:

Concentrations are listed in milligrams per kilogram (mg/kg)

" < " Indicates compound not detected above listed laboratory method detection limit

RCL Indicates Residual Contaminant Level

[1] Based on U.S. EPA Soil Screening Guidance Calculator (http://risk.lsd.ornl.gov/epa/ssl1.htm) using WDNR Default Parameters per WDNR PUB-RR-682 dated January 11, 2002

NE Indicates standard not established or calculated

<MDL Indicates VOC compounds not detected above compound-specific method detection limits (MDL)

TABLE 2

Groundwater Analytical Summary

Ghost-town Fitness Center
Kaukauna, Wisconsin
Terracon Project No. 38067035

1" diam.

			VOC	DRO	RCRA Metals							
Sample ID (Depth)	**Sample Location**	**Sample Date**	Volatile Organic Compounds	Diesel Range Organics	Mercury	Arsenic	Barium (mg/L)	Cadmium	Chromium	Lead	Selenium	Silver
NR 140, WAC, Enforcement Standard			NE	NE	2	10	2	5	100	15	50	50
NR 140, WAC, Preventative Action Limit			NE	NE	0.2	1	0.4	0.5	10	1.5	10	10
B-1	Center of parking lot	26-Jul-06	<MDL	120	0.084	7.8	0.076	<0.7	<3.1	5.8	32	<3

PAL < LOD
LOD < 7.8 < LOQ

Notes:
Concentrations are listed in micrograms per liter (µg/L) unless noted otherwise
mg/L - milligrams per liter
" < " Indicates compound not detected above listed laboratory method detection limit
NE Indicates standard not established
<MDL Indicates VOC compounds not detected above compound-specific method detection limits (MDL)

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Ghost-town Fitness Center (38067035)		B-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dustin Harvey Kitson Environmental	7/26/2006	7/26/2006	Push-Probe

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	Feet MSL	2.00 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
NW 1/4 of NW 1/4 of Section 22, T 21 N, R 18 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N Feet ☐ S ☐ E Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Outagamie	45	Kaukauna

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/(pH)	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
PP	48 24		1	SANDY GRAVEL - Brown, well graded, medium dense, dry	GW									
			2	TOPSOIL, trace SAND - Dark brown, lean, dry	OL			0						
			3	SANDY GRAVEL - Brown, well graded, medium dense, slightly moist	GW									
PP	48 38		4	TOPSOIL, trace SAND - Dark brown, lean, wet	OL		▼	0						
			5											
			6	CLAY - Brown, lean, low plasticity, slightly moist	CL			0						
			7											
PP	48 30		8	CLAY W/GRAVEL - Red, stiff, lean, low plasticity, dry	CL			0						
			9											
			10					0						
			11	Dolomite chips REFUSAL - 11'				0						

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Jason Blowey Firm Terracon Consultants, Inc.
3011B E. Capitol Dr. Appleton, WI 54911
Tel: 920-993-9096
Fax: 920-993-9108

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 10/03)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☒ Remediation/Redevelopment ☐ Other: _____

1. General Information

WI Unique Well No.: — — — — — —
DNR Well ID No.:
County: Outagamie
Common Well Name: B-1
Gov't Lot # (if applicable):
¼¼: ¼: NW
Section: 22
Township: 21 N
Range: 18 ☒ E ☐ W
Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W ☐ Local Grid Origin ☐ (estimated) OR ☐ Well Location
Latitude: DEG MIN SEC N
Longitude: DEG MIN SEC W
Reason For Abandonment: Finished sampling
WI Unique Well No. of Replacement We: — — — — — —

2. Facility / Owner Information

Facility Name: Ghost-town Fitness Center
Facility ID:
License/Permit/Monitoring No:
City, Village or Town:
Street Address of Well: 180 Fox Shores Drive
Present Well Owner:
Original Well Owner:
Street Address or Route of Owner:
City: Kaukauna
State: WI
ZIP Code: 54130

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☒ Borehole / Drillhole
Original Construction Date: 7/26/06
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (specify): push-probe

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 11
Casing Diameter (in.): 1
Lower Drillhole Diameter (in.): 2
Casing Depth (ft.):

Was well annular space grouted? ☐ Yes ☒ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☐ N/A
Liner(s) removed?	☐ Yes	☐ No	☐ N/A
Screen removed?	☐ Yes	☐ No	☐ N/A
Casing left in place?	☐ Yes	☐ No	☐ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☐ N/A
Did sealing material rise to surface?	☐ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☐ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☐ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☐ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☒ Screened & Poured (Bentonite Chips) ☐ Other (Explain):

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☒ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

Material	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Bentonite - 3/8" Chips	Surface	2	1/20	
Sand	2	11	1/4	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Jason Lowery
Date of Abandonment: 7/26/06
Street or Route: 3611B E. Capitol Drive
Telephone Number: (920) 993-9096
City: Appleton
State: WI
ZIP Code: 54911
Signature of Person Doing Work:
Date Signed: 7/26/06

DNR Use Only
Date Received:
Noted By:
Comments:

TERRACON GROUND WATER SAMPLING INFORMATION SHEET

PROJECT NAME: Ghost-Town Fitness Center	PROJECT NO.
PROJECT LOCATION: Kenosha, WI	
SAMPLE POINT: B-1	SAMPLE POINT DESCRIPTION: Center of parking lot
CASING DIAMETER: 1"	
WELL DEPTH: 11 feet	

DATE: 7/26/06	TIME: 0915 AM /PM	DEPTH TO GROUND WATER (FT): ≈5

CALCULATION: N/A

SAMPLING METHOD: VOC & DRO - Stainless steel screen (2-foot long) & HDPE tubing & check valve
RCRA Metals - 5' PVC screen & disposable bailer - 5-foot long

DATE	TIME (AM/PM)	GALLONS REMOVED	COMMENTS
7/26/06	0910	0.25?	Started pursing water
	0912		Started sampling
7/26/06	0945		Collected sample (finished)

DISSOLVED OXYGEN:	FERROUS IRON:	NITRATE
----	----	--------

pH:	ORP:	TEMP:	SPECIFIC CONDUCTANCE (uS/cm) x1000
-------	----	--------	----

SAMPLE APPEARANCE: VERY TURBID (TURBID) SLIGHTLY TURBID CLEAR

ODOR: YES (NO) NOT NOTED

ANALYSES: VOC, DRO, RCRA Metals

CLEANING PERFORMED IN FIELD: *METHANOL AND DISPOSABLE GLOVES* *INITIAL TO VERIFY OR NOTE OTHER CLEANING METHOD PERFORMED
JBL

COMMENTS:
Filtered sample for RCRA Metals - filters kept clogging hence the long sampling time above

SAMPLED BY: JBL	DATE: 7/26/06
REVIEWED BY: MHC	DATE: 8/1/06

Synergy Environmental Lab, Inc.

1990 Prospect Ct., Appleton, WI 54914 *P 920-830-2455 * F 920-733-0631

JASON LOWERY
TERRACON
3011B E. Capitol Drive
APPLETON WI 54911

Report *09-Aug-06*

Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864A
Sample ID B-1(4)
Sample Soil
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
General									
General									
Solids Percent	94.2	%			1	5021	7/28/2006	CJR	1
Inorganic									
Metals									
Mercury, Total	0.021	mg/kg	0.002	0.02	1	7470A	8/3/2006	ESC	1
Arsenic, Total	< 0.074	mg/kg	0.074	5	5	EPA 6010B	8/3/2006	ESC	1 49
Barium, Total	20	mg/kg	0.001	0.25	1	EPA 6010B	8/2/2006	ESC	1
Cadmium, Total	0.67	mg/kg	0.001	0.25	1	EPA 6010B	8/2/2006	ESC	1
Chromium, Total	5.9	mg/kg	0.002	0.5	1	EPA 6010B	8/2/2006	ESC	1
Lead, Total	5.3	mg/kg	0.012	0.25	1	EPA 6010B	8/2/2006	ESC	1
Selenium, Total	3.2	mg/kg	0.021	1	1	EPA 6010B	8/2/2006	ESC	1
Silver, Total	< 0.0037	mg/kg	0.003	0.5	1	EPA 6010B	8/2/2006	ESC	1
Organic									
General									
Diesel Range Organics	< 10	mg/kg	0.72	2.3	1	DRO95	8/4/2006	MJR	1
VOC's									
Benzene	< 25	ug/kg	5.2	16	1	8260B	8/2/2006	CJR	1
Bromobenzene	< 25	ug/kg	21	66	1	8260B	8/2/2006	CJR	1
Bromodichloromethane	< 25	ug/kg	13	42	1	8260B	8/2/2006	CJR	1
Bromoform	< 25	ug/kg	15	48	1	8260B	8/2/2006	CJR	1
tert-Butylbenzene	< 25	ug/kg	5.6	18	1	8260B	8/2/2006	CJR	1
sec-Butylbenzene	< 25	ug/kg	8	26	1	8260B	8/2/2006	CJR	1
n-Butylbenzene	< 25	ug/kg	20	65	1	8260B	8/2/2006	CJR	1
Carbon Tetrachloride	< 25	ug/kg	8.7	28	1	8260B	8/2/2006	CJR	1
Chlorobenzene	< 25	ug/kg	11	35	1	8260B	8/2/2006	CJR	1
Chloroethane	< 25	ug/kg	13	42	1	8260B	8/2/2006	CJR	1
Chloroform	< 25	ug/kg	5.9	19	1	8260B	8/2/2006	CJR	1
Chloromethane	< 25	ug/kg	8.4	27	1	8260B	8/2/2006	CJR	1

Project Name GHOST-TOWN FITNESS
Project # 38067035

Invoice # E13864

Lab 5013864A
Sample ID B-1(4)
Sample Soil
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
2-Chlorotoluene	< 25	ug/kg	5.1	16	1	8260B	8/2/2006	CJR	1
4-Chlorotoluene	< 25	ug/kg	17	53	1	8260B	8/2/2006	CJR	1
1,2-Dibromo-3-chloropropane	< 25	ug/kg	19	61	1	8260B	8/2/2006	CJR	1
Dibromochloromethane	< 25	ug/kg	17	54	1	8260B	8/2/2006	CJR	1
1,4-Dichlorobenzene	< 25	ug/kg	22	72	1	8260B	8/2/2006	CJR	1
1,3-Dichlorobenzene	< 25	ug/kg	19	59	1	8260B	8/2/2006	CJR	1
1,2-Dichlorobenzene	< 25	ug/kg	20	64	1	8260B	8/2/2006	CJR	1
Dichlorodifluoromethane	< 25	ug/kg	10	32	1	8260B	8/2/2006	CJR	1
1,2-Dichloroethane	< 25	ug/kg	11	36	1	8260B	8/2/2006	CJR	1
1,1-Dichloroethane	< 25	ug/kg	9	29	1	8260B	8/2/2006	CJR	1
1,1-Dichloroethene	< 25	ug/kg	15	48	1	8260B	8/2/2006	CJR	1
cis-1,2-Dichloroethene	< 25	ug/kg	16	51	1	8260B	8/2/2006	CJR	1
trans-1,2-Dichloroethene	< 25	ug/kg	8.9	28	1	8260B	8/2/2006	CJR	1
1,2-Dichloropropane	< 25	ug/kg	11	34	1	8260B	8/2/2006	CJR	1
2,2-Dichloropropane	< 25	ug/kg	18	57	1	8260B	8/2/2006	CJR	1
1,3-Dichloropropane	< 25	ug/kg	14	45	1	8260B	8/2/2006	CJR	1
Di-isopropyl ether	< 25	ug/kg	3.9	12	1	8260B	8/2/2006	CJR	1
EDB (1,2-Dibromoethane)	< 25	ug/kg	15	49	1	8260B	8/2/2006	CJR	1
Ethylbenzene	< 25	ug/kg	9.8	31	1	8260B	8/2/2006	CJR	1
Hexachlorobutadiene	< 25	ug/kg	12	38	1	8260B	8/2/2006	CJR	1
Isopropylbenzene	< 25	ug/kg	12	39	1	8260B	8/2/2006	CJR	1
p-Isopropyltoluene	< 25	ug/kg	15	47	1	8260B	8/2/2006	CJR	1
Methylene chloride	< 25	ug/kg	19	61	1	8260B	8/2/2006	CJR	1
Methyl tert-butyl ether (MTBE)	< 25	ug/kg	17	55	1	8260B	8/2/2006	CJR	1
Naphthalene	< 25	ug/kg	16	52	1	8260B	8/2/2006	CJR	1
n-Propylbenzene	< 25	ug/kg	12	40	1	8260B	8/2/2006	CJR	1
1,1,2,2-Tetrachloroethane	< 25	ug/kg	15	48	1	8260B	8/2/2006	CJR	1
1,1,1,2-Tetrachloroethane	< 25	ug/kg	24	76	1	8260B	8/2/2006	CJR	1
Tetrachloroethene	< 25	ug/kg	18	58	1	8260B	8/2/2006	CJR	1
Toluene	< 25	ug/kg	12	39	1	8260B	8/2/2006	CJR	1
1,2,4-Trichlorobenzene	< 25	ug/kg	25	80	1	8260B	8/2/2006	CJR	1
1,2,3-Trichlorobenzene	< 25	ug/kg	11	35	1	8260B	8/2/2006	CJR	1
1,1,1-Trichloroethane	< 25	ug/kg	21	66	1	8260B	8/2/2006	CJR	1
1,1,2-Trichloroethane	< 25	ug/kg	18	57	1	8260B	8/2/2006	CJR	1
Trichloroethene (TCE)	< 25	ug/kg	20	63	1	8260B	8/2/2006	CJR	1
Trichlorofluoromethane	< 25	ug/kg	11	35	1	8260B	8/2/2006	CJR	1
1,2,4-Trimethylbenzene	< 25	ug/kg	7.9	25	1	8260B	8/2/2006	CJR	1
1,3,5-Trimethylbenzene	< 25	ug/kg	8.6	27	1	8260B	8/2/2006	CJR	1
Vinyl Chloride	< 25	ug/kg	5.5	18	1	8260B	8/2/2006	CJR	1
m&p-Xylene	< 50	ug/kg	17	53	1	8260B	8/2/2006	CJR	1
o-Xylene	< 25	ug/kg	8.8	28	1	8260B	8/2/2006	CJR	1

Lab 5013864B
Sample ID B-1
Sample Water
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
Inorganic									
Metals									
Cadmium, dissolved	< 0.7	ug/l	0.7	5	1	EPA 6010B	8/3/2006	ESC	1
Chromium, Dissolved	< 3.1	ug/l	3.1	10	1	EPA 6010B	8/3/2006	ESC	1
Mercury, dissolved	0.084 "J"	ug/l	0.066	0.2	1	7470A	8/3/2006	ESC	1
Selenium, dissolved	32	ug/l	7.2	20	1	EPA 6010B	8/4/2006	ESC	1
Silver, dissolved	< 3	ug/l	3	10	1	EPA 6010B	8/3/2006	ESC	1
Barium, Dissolved	76	ug/l	1.6	5	1	EPA 6010B	8/3/2006	ESC	1

Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864B
Sample ID B-1
Sample Water
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
Arsenic, Dissolved	7.8 "J"	ug/l	7.4	20	1	EPA 6010B	8/4/2006	ESC	1
Lead, Dissolved	5.8	ug/l	4.1	5	1	EPA 6010B	8/3/2006	ESC	1
Organic									
General									
Diesel Range Organics	120	ug/l	11	35	1	DRO95	8/3/2006	MJR	1
VOC's									
Benzene	< 0.17	ug/l	0.17	0.53	1	8260B	7/29/2006	CJR	3 64
Bromobenzene	< 0.62	ug/l	0.62	2	1	8260B	7/29/2006	CJR	1
Bromodichloromethane	< 0.82	ug/l	0.82	2.6	1	8260B	7/29/2006	CJR	1
Bromoform	< 0.3	ug/l	0.3	0.97	1	8260B	7/29/2006	CJR	1
tert-Butylbenzene	< 0.6	ug/l	0.6	1.9	1	8260B	7/29/2006	CJR	1
sec-Butylbenzene	< 0.76	ug/l	0.76	2.4	1	8260B	7/29/2006	CJR	1
n-Butylbenzene	< 1.1	ug/l	1.1	3.5	1	8260B	7/29/2006	CJR	1
Carbon Tetrachloride	< 0.52	ug/l	0.52	1.7	1	8260B	7/29/2006	CJR	1
Chlorobenzene	< 0.56	ug/l	0.56	1.8	1	8260B	7/29/2006	CJR	1
Chloroethane	< 0.54	ug/l	0.54	1.7	1	8260B	7/29/2006	CJR	1
Chloroform	< 0.61	ug/l	0.61	1.9	1	8260B	7/29/2006	CJR	1
Chloromethane	< 0.91	ug/l	0.91	2.9	1	8260B	7/29/2006	CJR	1
2-Chlorotoluene	< 1.1	ug/l	1.1	3.4	1	8260B	7/29/2006	CJR	1
4-Chlorotoluene	< 0.62	ug/l	0.62	2	1	8260B	7/29/2006	CJR	1
1,2-Dibromo-3-chloropropane	< 2.5	ug/l	2.5	8.1	1	8260B	7/29/2006	CJR	1
Dibromochloromethane	< 0.65	ug/l	0.65	2.1	1	8260B	7/29/2006	CJR	1
1,4-Dichlorobenzene	< 0.68	ug/l	0.68	2.2	1	8260B	7/29/2006	CJR	1
1,3-Dichlorobenzene	< 0.72	ug/l	0.72	2.3	1	8260B	7/29/2006	CJR	1
1,2-Dichlorobenzene	< 0.69	ug/l	0.69	2.2	1	8260B	7/29/2006	CJR	1
Dichlorodifluoromethane	< 0.5	ug/l	0.5	1.6	1	8260B	7/29/2006	CJR	1
1,2-Dichloroethane	< 0.72	ug/l	0.72	2.3	1	8260B	7/29/2006	CJR	1
1,1-Dichloroethane	< 0.22	ug/l	0.22	0.69	1	8260B	7/29/2006	CJR	1
1,1-Dichloroethene	< 0.3	ug/l	0.3	0.97	1	8260B	7/29/2006	CJR	1
cis-1,2-Dichloroethene	< 0.5	ug/l	0.5	1.6	1	8260B	7/29/2006	CJR	1
trans-1,2-Dichloroethene	< 0.65	ug/l	0.65	2.1	1	8260B	7/29/2006	CJR	1
1,2-Dichloropropane	< 0.21	ug/l	0.21	0.67	1	8260B	7/29/2006	CJR	1
2,2-Dichloropropane	< 1.2	ug/l	1.2	4	1	8260B	7/29/2006	CJR	1
1,3-Dichloropropane	< 0.67	ug/l	0.67	2.1	1	8260B	7/29/2006	CJR	1
Di-isopropyl ether	< 0.079	ug/l	0.079	0.25	1	8260B	7/29/2006	CJR	1
EDB (1,2-Dibromoethane)	< 0.21	ug/l	0.21	0.67	1	8260B	7/29/2006	CJR	1
Ethylbenzene	< 0.2	ug/l	0.2	0.62	1	8260B	7/29/2006	CJR	1
Hexachlorobutadiene	< 2.1	ug/l	2.1	6.7	1	8260B	7/29/2006	CJR	1
Isopropylbenzene	< 0.99	ug/l	0.99	3.2	1	8260B	7/29/2006	CJR	1
p-Isopropyltoluene	< 0.81	ug/l	0.81	2.6	1	8260B	7/29/2006	CJR	1
Methylene chloride	< 0.61	ug/l	0.61	1.9	1	8260B	7/29/2006	CJR	1
Methyl tert-butyl ether (MTBE)	< 0.34	ug/l	0.34	1.1	1	8260B	7/29/2006	CJR	1
Naphthalene	< 2.2	ug/l	2.2	6.8	1	8260B	7/29/2006	CJR	4
n-Propylbenzene	< 0.61	ug/l	0.61	2	1	8260B	7/29/2006	CJR	1
1,1,2,2-Tetrachloroethane	< 0.89	ug/l	0.89	2.8	1	8260B	7/29/2006	CJR	1
1,1,1,2-Tetrachloroethane	< 0.48	ug/l	0.48	1.5	1	8260B	7/29/2006	CJR	1
Tetrachloroethene	< 0.37	ug/l	0.37	1.2	1	8260B	7/29/2006	CJR	1
Toluene	< 0.59	ug/l	0.59	1.9	1	8260B	7/29/2006	CJR	1
1,2,4-Trichlorobenzene	< 1.5	ug/l	1.5	4.8	1	8260B	7/29/2006	CJR	1
1,2,3-Trichlorobenzene	< 1.4	ug/l	1.4	4.4	1	8260B	7/29/2006	CJR	1
1,1,1-Trichloroethane	< 0.42	ug/l	0.42	1.3	1	8260B	7/29/2006	CJR	1
1,1,2-Trichloroethane	< 0.36	ug/l	0.36	1.1	1	8260B	7/29/2006	CJR	1
Trichloroethene (TCE)	< 0.39	ug/l	0.39	1.3	1	8260B	7/29/2006	CJR	1
Trichlorofluoromethane	< 0.22	ug/l	0.22	0.71	1	8260B	7/29/2006	CJR	1
1,2,4-Trimethylbenzene	< 0.16	ug/l	0.16	0.5	1	8260B	7/29/2006	CJR	1

Project Name GHOST-TOWN FITNESS **Invoice #** E13864
Project # 38067035

Lab 5013864B
Sample ID B-1
Sample Water
Sample Date 7/26/2006

	Result	Unit	LOD	LOQ	Dil	Method	Run	Analyst	Code
1,3,5-Trimethylbenzene	< 1.2	ug/l	1.2	3.7	1	8260B	7/29/2006	CJR	1
Vinyl Chloride	< 0.11	ug/l	0.11	0.35	1	8260B	7/29/2006	CJR	1
m&p-Xylene	< 1.1	ug/l	1.1	3.4	1	8260B	7/29/2006	CJR	1
o-Xylene	< 0.18	ug/l	0.18	0.56	1	8260B	7/29/2006	CJR	1

"J" Flag: Analyte detected between LOD and LOQ LOD Limit of Detection LOQ Limit of Quantitation

Code	*Comment*
1	Laboratory QC within limits.
3	The matrix spike not within established limits.
4	The continuing calibration standard not within established limits.
49	Sample diluted to compensate for matrix interference.
64	Spike recovery failed due to matrix interference. Sample results unaffected.

Authorized Signature Michael J. Ricker

CHAIN OF CUSTODY RECORD

Synergy
Environmental Lab, Inc.

1990 Prospect Ct. • Appleton, WI 54914
920-830-2455 • FAX 920-733-0631

Chain # 7607

Page 1 of 1

Lab I.D. #	
Account No. :	Quote No.:
Project #: 38067035	
Sampler: (signature) [signature]	
Project (Name / Location): Ghost-town Fitness / Kaukauna	

Sample Handling Request
___ Rush Analysis Date Required ____
(Rushes accepted only with prior authorization)
X Normal Turn Around

Reports To:	Jason Lowery	Invoice To:	Jason Lowery
Company	Terracon	Company	Terracon
Address	3018 E Circle Dr	Address	
City State Zip	Appleton WI 54911	City State Zip	Same
Phone	920-493-9096	Phone	
FAX	920-793-9108	FAX	

Analysis Requested

Lab I.D.	Sample I.D.	Collection Date	Collection Time	Comp	Grab	Filtered Y/N	No. of Containers	Sample Type (Matrix)*	Preservation	DRO (Mod DRO Sep 95)	GRO (Mod GRO Sep 95)	PVOC (EPA 8021)	VOC (EPA 8260)	VOC DW (EPA 524.2)	PAH (EPA 8270)	Total Suspended Solids	Lead	RCRA Metals	PID/ FID
	B-1 (4)	7/26	945		X	N	3	S	None/[illegible]	X			X					X	
	B-1	↓	↓		X	Y/N	5	GW	[illegible]	X			X					X	

No Further Samples
[signature]

Comments/Special Instructions (*Specify groundwater "GW", Drinking Water "DW", Waste Water "WW", Soil "S", Air "A", Oil, Sludge etc.)

Sample Integrity - To be completed by receiving lab.
Method of Shipment : [illegible]
Temp. of Temp. Blank. ____ °C On Ice: ____
Cooler seal intact upon receipt: X Yes ____ No

Relinquished By: (sign)	Time	Date	Received By: (sign)	Time	Date
[signature]	7/26/06	1030			

Received in Laboratory By: [illegible] Time: [illegible] Date: [illegible]

Waste and Cleanup Risk Assessment Home
Basic Information
Where You Live
Waste and Cleanup Programs' Risk Assessment
Risk Assessment Topics
Policy Guidance
Databases and Tools
Alphabetical List of Documents
Frequent Questions
Related Links
Glossary
Site Map

Soil Screening Guidance Calculator

Equation Values for Ingestion

Noncarcinogenic Parameter	Value	Carcinogenic Age-adjusted Parameter	Value	Carcinogenic Nonadjusted Parameter	Value
Target Hazard Quotient (unitless)	0.2	Target Risk (unitless)	1.0E-7	Target Risk (unitless)	1.0E-6
Body Weight (kg)	15	Adult Body Weight (kg)	70	Body Weight (kg)	70
		Child Body Weight (kg)	15		
Exposure Duration (yr)	6	Adult Exposure Duration (yr)	24	Exposure Duration (yr)	25
		Child Exposure Duration (yr)	6		
Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	250
Intake Rate (mg/day)	200	Adult Intake Rate (mg/day)	100	Intake Rate (mg/day)	100
		Child Intake Rate (mg/day)	200		
		Average Lifetime (yr)	70	Average Lifetime (yr)	70
		Age-adjusted Ingestion Factor (mg-yr/kg-day)	114.29		

Soil Screening Levels for Ingestion (mg/kg)

Analyte	Cas Number	Oral RfD	Oral Slope Factor	Noncarcinogenic	Carcinogenic (Age-adjusted)	Carcinogenic (Nonadjusted)
Barium	7440393	2.00E-01 [a]		3.13E+03		

RACE

United States® Census Bureau

Note: The table shown may have been modified by user selections. Some information may be missing.

DATA NOTES	
TABLE ID:	P1
SURVEY/PROGRAM:	Decennial Census
VINTAGE:	2020
DATASET:	DECENNIALPL2020
PRODUCT:	DEC Redistricting Data (PL 94-171)
UNIVERSE:	Total population
MLA:	U.S. Census Bureau. "RACE." Decennial Census, DEC Redistricting Data (PL 94-171), Table P1, 2020, https://data.census.gov/table/DECENNIALPL2020.P1?g=160XX00US5538800. Accessed on October 2, 2024.
FTP URL:	https://www2.census.gov/programs-surveys/decennial/2020/data/
API URL:	https://api.census.gov/data/2020/dec/pl
USER SELECTIONS	
GEOS	Kaukauna city, Wisconsin
EXCLUDED COLUMNS	None
APPLIED FILTERS	None
APPLIED SORTS	None
PIVOT & GROUPING	
PIVOT COLUMNS	None
PIVOT MODE	Off
ROW GROUPS	None

VALUE COLUMNS	None
WEB ADDRESS	https://data.census.gov/table/DECENNIALPL2020.P1?g=160XX00US5538800
TABLE NOTES	
	Note: For information on data collection, confidentiality protection, nonsampling error, and definitions, see 2020 Census Redistricting Data (Public Law 94-171) Summary File Technical Documentation.
	For information on the statistical methods used to protect confidentiality in these tables, see Disclosure Avoidance and the 2020 Census.
	Source: U.S. Census Bureau, 2020 Census Redistricting Data (Public Law 94-171)
COLUMN NOTES	None

Income in the Past 12 Months (in 2022 Inflation-Adjusted Dollars)

United States® Census Bureau

Note: The table shown may have been modified by user selections. Some information may be missing.

DATA NOTES	
TABLE ID:	S1901
SURVEY/PROGRAM:	American Community Survey
VINTAGE:	2022
DATASET:	ACSST5Y2022
PRODUCT:	ACS 5-Year Estimates Subject Tables
UNIVERSE:	None
MLA:	U.S. Census Bureau. "Income in the Past 12 Months (in 2022 Inflation-Adjusted Dollars)." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1901, 2022, https://data.census.gov/table/ACSST5Y2022.S1901?g=160XX00US5538800. Accessed on October 2, 2024.
FTP URL:	None
API URL:	https://api.census.gov/data/2022/acs/acs5/subject
USER SELECTIONS	
GEOS	Kaukauna city, Wisconsin
EXCLUDED COLUMNS	None
APPLIED FILTERS	None
APPLIED SORTS	None
PIVOT & GROUPING	
PIVOT COLUMNS	None
PIVOT MODE	Off
ROW GROUPS	None
VALUE COLUMNS	None

WEB ADDRESS	https://data.census.gov/table/ACSST5Y2022.S1901?g=160XX00US5538800
TABLE NOTES	
	Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, the decennial census is the official source of population totals for April 1st of each decennial year. In between censuses, the Census Bureau's Population Estimates Program produces and disseminates the official estimates of the population for the nation, states, counties, cities, and towns and estimates of housing units for states and counties.
	Information about the American Community Survey (ACS) can be found on the ACS website. Supporting documentation including code lists, subject definitions, data accuracy, and statistical testing, and a full list of ACS tables and table shells (without estimates) can be found on the Technical Documentation section of the ACS website. Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.
	Source: U.S. Census Bureau, 2018-2022 American Community Survey 5-Year Estimates
	Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see ACS Technical Documentation). The effect of nonsampling error is not represented in these tables.
	When information is missing or inconsistent, the Census Bureau logically assigns an acceptable value using the response to a related question or questions. If a logical assignment is not possible, data are filled using a statistical process called allocation, which uses a similar individual or household to provide a donor value. The "Allocated" section is the number of respondents who received an allocated value for a particular subject.

	Between 2018 and 2019 the American Community Survey retirement income question changed. These changes resulted in an increase in both the number of households reporting retirement income and higher aggregate retirement income at the national level. For more information see Changes to the Retirement Income Question .
	The 2018-2022 American Community Survey (ACS) data generally reflect the March 2020 Office of Management and Budget (OMB) delineations of metropolitan and micropolitan statistical areas. In certain instances, the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB delineation lists due to differences in the effective dates of the geographic entities.
	Estimates of urban and rural populations, housing units, and characteristics reflect boundaries of urban areas defined based on 2020 Census data. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.
	Explanation of Symbols:- The estimate could not be computed because there were an insufficient number of sample observations. For a ratio of medians estimate, one or both of the median estimates falls in the lowest interval or highest interval of an open-ended distribution. For a 5-year median estimate, the margin of error associated with a median was larger than the median itself.N The estimate or margin of error cannot be displayed because there were an insufficient number of sample cases in the selected geographic area. (X) The estimate or margin of error is not applicable or not available.median- The median falls in the lowest interval of an open-ended distribution (for example "2,500-")median+ The median falls in the highest interval of an open-ended distribution (for example "250,000+").** The margin of error could not be computed because there were an insufficient number of sample observations.*** The margin of error could not be computed because the median falls in the lowest interval or highest interval of an open-ended distribution.***** A margin of error is not appropriate because the corresponding estimate is controlled to an independent population or housing estimate. Effectively, the corresponding estimate has no sampling error and the margin of error may be treated as zero.
COLUMN NOTES	None

Selected Economic Characteristics

United States® Census Bureau

Note: The table shown may have been modified by user selections. Some information may be missing.

DATA NOTES	
TABLE ID:	DP03
SURVEY/PROGRAM:	American Community Survey
VINTAGE:	2022
DATASET:	ACSDP5Y2022
PRODUCT:	ACS 5-Year Estimates Data Profiles
UNIVERSE:	None
MLA:	U.S. Census Bureau. "Selected Economic Characteristics." American Community Survey, ACS 5-Year Estimates Data Profiles, Table DP03, 2022, https://data.census.gov/table/ACSDP5Y2022.DP03?g=160XX00US5538800. Accessed on October 2, 2024.
FTP URL:	None
API URL:	https://api.census.gov/data/2022/acs/acs5/profile
USER SELECTIONS	
GEOS	Kaukauna city, Wisconsin
EXCLUDED COLUMNS	None
APPLIED FILTERS	None
APPLIED SORTS	None
PIVOT & GROUPING	
PIVOT COLUMNS	None
PIVOT MODE	Off
ROW GROUPS	None
VALUE COLUMNS	None

WEB ADDRESS	https://data.census.gov/table/ACSDP5Y2022.DP03?g=160XX00US5538800
TABLE NOTES	
	Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, the decennial census is the official source of population totals for April 1st of each decennial year. In between censuses, the Census Bureau's Population Estimates Program produces and disseminates the official estimates of the population for the nation, states, counties, cities, and towns and estimates of housing units for states and counties.
	Information about the American Community Survey (ACS) can be found on the ACS website. Supporting documentation including code lists, subject definitions, data accuracy, and statistical testing, and a full list of ACS tables and table shells (without estimates) can be found on the Technical Documentation section of the ACS website. Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.
	Source: U.S. Census Bureau, 2018-2022 American Community Survey 5-Year Estimates
	Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see ACS Technical Documentation). The effect of nonsampling error is not represented in these tables.
	Employment and unemployment estimates may vary from the official labor force data released by the Bureau of Labor Statistics because of differences in survey design and data collection. For guidance on differences in employment and unemployment estimates from different sources go to Labor Force Guidance.
	Workers include members of the Armed Forces and civilians who were at work last week.

	Industry titles and their 4-digit codes are based on the 2017 North American Industry Classification System. The Industry categories adhere to the guidelines issued in Clarification Memorandum No. 2, "NAICS Alternate Aggregation Structure for Use By U.S. Statistical Agencies," issued by the Office of Management and Budget.
	Occupation titles and their 4-digit codes are based on the 2018 Standard Occupational Classification.
	Logical coverage edits applying a rules-based assignment of Medicaid, Medicare and military health coverage were added as of 2009 -- please see https://www.census.gov/library/working-papers/2010/demo/coverage_edits_final.html for more details. Select geographies of 2008 data comparable to the 2009 and later tables are available at https://www.census.gov/data/tables/time-series/acs/1-year-re-run-health-insurance.html. The health insurance coverage category names were modified in 2010. See https://www.census.gov/topics/health/health-insurance/about/glossary.html#par_textimage_18 for a list of the insurance type definitions.
	Beginning in 2017, selected variable categories were updated, including age-categories, income-to-poverty ratio (IPR) categories, and the age universe for certain employment and education variables. See user note entitled "Health Insurance Table Updates" for further details.
	Several means of transportation to work categories were updated in 2019. For more information, see: Change to Means of Transportation.
	Between 2018 and 2019 the American Community Survey retirement income question changed. These changes resulted in an increase in both the number of households reporting retirement income and higher aggregate retirement income at the national level. For more information see Changes to the Retirement Income Question .
	The categories for relationship to householder were revised in 2019. For more information see Revisions to the Relationship to Household item.
	In 2019, methodological changes were made to the class of worker question. These changes involved modifications to the question wording, the category wording, and the visual format of the categories on the questionnaire. The format for the class of worker categories are now listed under the headings "Private Sector Employee," "Government Employee," and "Self-Employed or Other." Additionally, the category of Active Duty was added as one of the response categories under the "Government Employee" section for the mail questionnaire. For more detailed information about the 2019 changes, see the 2016 American Community Survey Content Test Report for Class of Worker located at http://www.census.gov/library/working-papers/2017/acs/2017_Martinez_01.html.
	Beginning in data year 2019, respondents to the Weeks Worked question provided an integer value for the number of weeks worked. For data years 2008 through 2018, respondents selected a category corresponding to the number of weeks worked.

	The 2018-2022 American Community Survey (ACS) data generally reflect the March 2020 Office of Management and Budget (OMB) delineations of metropolitan and micropolitan statistical areas. In certain instances, the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB delineation lists due to differences in the effective dates of the geographic entities.
	Estimates of urban and rural populations, housing units, and characteristics reflect boundaries of urban areas defined based on 2020 Census data. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.
	Explanation of Symbols:- The estimate could not be computed because there were an insufficient number of sample observations. For a ratio of medians estimate, one or both of the median estimates falls in the lowest interval or highest interval of an open-ended distribution. For a 5-year median estimate, the margin of error associated with a median was larger than the median itself.N The estimate or margin of error cannot be displayed because there were an insufficient number of sample cases in the selected geographic area. (X) The estimate or margin of error is not applicable or not available.median- The median falls in the lowest interval of an open-ended distribution (for example "2,500-")median+ The median falls in the highest interval of an open-ended distribution (for example "250,000+").** The margin of error could not be computed because there were an insufficient number of sample observations.*** The margin of error could not be computed because the median falls in the lowest interval or highest interval of an open-ended distribution.***** A margin of error is not appropriate because the corresponding estimate is controlled to an independent population or housing estimate. Effectively, the corresponding estimate has no sampling error and the margin of error may be treated as zero.
COLUMN NOTES	None

United States
Environmental Protection
Agency
Office of Water (4305)

Department of The Army
US Army Corps of Engineers

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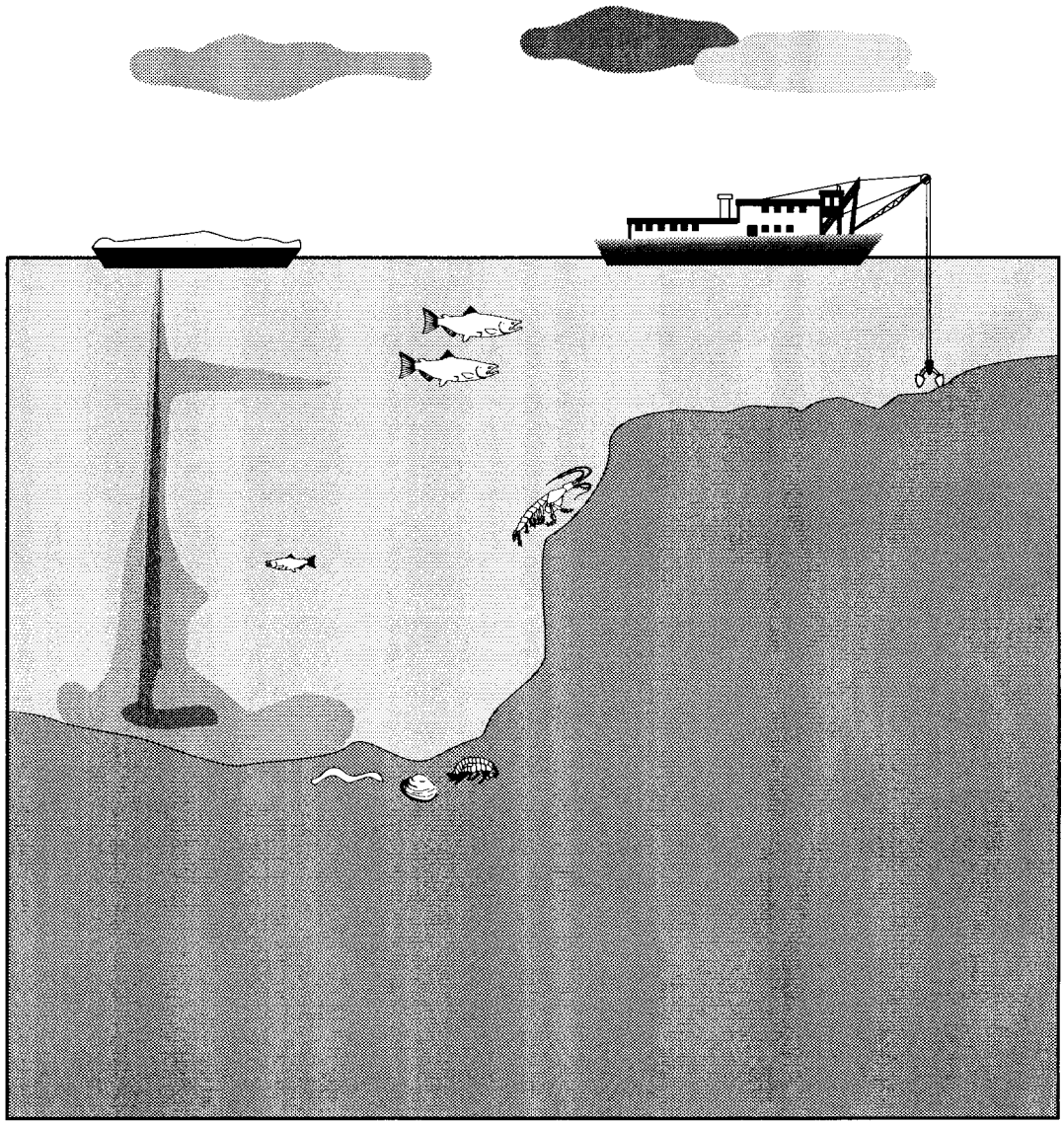
EPA

U.S. Army Corps
of Engineers

Evaluation of Dredged Material Proposed For Discharge in Waters of the U.S. - Testing Manual

Inland Testing Manual



EVALUATION OF DREDGED MATERIAL PROPOSED FOR DISCHARGE IN WATERS OF THE U.S. - TESTING MANUAL

(INLAND TESTING MANUAL)

Prepared by

ENVIRONMENTAL PROTECTION AGENCY
Office of Water
Office of Science and Technology
Washington, D.C.

and

DEPARTMENT OF THE ARMY
United States Army Corps of Engineers
Operations, Construction, and Readiness Division
Washington, D.C.

February 1998

The testing protocols set out in the Inland Testing Manual are intended solely as guidance for use in conducting testing of dredged material to assess the potential for contaminant-related impacts associated with dredged material disposal into open water. The Manual does not alter the statutory and regulatory framework for permitting decisions under section 404 of the CWA. Under that framework, testing is conducted in order to assist the permitting authority in making factual determinations regarding the effect of the discharge on the aquatic ecosystem, and in determining whether the discharge will comply with the 404(b)(1) Guidelines. See 40 C.F.R. 230.10 and 230.11. The current regulations provide for testing under certain circumstances, and this Manual provides suggested protocols to follow once it has been decided that testing is appropriate. The Guidelines provide flexibility to the permitting authority to decide, based upon the facts of a particular case, whether testing is warranted.

The Manual is intended solely as guidance. The Manual is not intended, nor can it be relied upon, to create any rights or obligations enforceable by any party. The Manual provides the best available technical guidance regarding how dredged material should be tested. While it is generally anticipated that the Agencies will follow the procedures in this Manual, Agency decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from the guidance in the Manual where determined to be appropriate. The document does not, and is not intended to, impose any legally-binding requirements on Federal agencies, States, or the regulated community.

TABLE OF CONTENTS

		Page No.
TITLE PAGE		i
TABLE OF CONTENTS		ii
LIST OF TABLES		vi
LIST OF FIGURES		vii
PREFACE		viii
DEFINITIONS		xi
LIST OF ACRONYMS		xxi
CONVERSIONS		xxiii
PART I - GENERAL CONSIDERATIONS		
1.0	INTRODUCTION	1-1
1.1	Background	1-1
1.2	Statutory/Regulatory Overview	1-1
1.2.1	Statutory Overview	1-1
1.2.2	Section 404 Regulatory Overview	1-2
1.2.2.1	The Section 404(b)(1) Guidelines	1-4
1.2.2.2	Particulars of Sections 230.60 and 230.61	1-5
1.2.3	Relationship to Section 401 CWA Water Quality Certification	1-6
2.0	SCOPE AND APPLICABILITY	2-1
2.1	This Manual is Intended to Address:	2-1
2.2	This Manual is Not Intended to Address:	2-1
2.3	Dredged Material Discharge for Beneficial Uses	2-2
2.4	The Role of Biological Evaluations (Toxicity and/or Bioaccumulation Tests) in the Manual	2-2
2.5	The Role of Water and Sediment Chemical Evaluations in the Manual	2-4
2.6	Water Column Effects	2-4
2.7	Mixing	2-5
2.8	Benthic Effects	2-5
2.9	Management Options	2-5
2.10	The Relationship of the Inland Testing Manual to Other USACE/EPA Dredged Material Management Efforts	2-6
2.10.1	Relationship of the Manual to the USACE/EPA Framework Document	2-6
2.10.2	Relationship of the Manual to the EPA/USACE Green Book	2-6
2.10.3	Relationship of the Manual to EPA's Contaminated Sediment Strategy and Sediment Quality Criteria	2-7
PART II - EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACT		

3.0	OVERVIEW OF TESTING AND EVALUATION	3-1
3.1	Tiered Testing and Evaluation	3-1
3.2	Control and Reference Sediments	3-2
3.2.1	Reference Sediment Sampling	3-6
3.2.2	Reference Sediment Sampling Plan	3-7
4.0	TIER I EVALUATION	4-1
4.1	Compilation of Existing Information	4-3
4.2	Identification of Contaminants of Concern	4-6
4.2.1	Microbial Contamination	4-7
4.2.2	Chemical Contamination	4-8
4.3	Tier I Conclusions	4-10
5.0	TIER II EVALUATION	5-1
5.1	Water Column Impact	5-1
5.1.1	Screen Relative To WQS	5-2
5.1.2	Elutriate Analysis Relative To WQS	5-2
5.2	Benthic Impact	5-2
5.3	Tier II Conclusions	5-3
6.0	TIER III EVALUATION	6-1
6.1	Water Column Toxicity Tests	6-2
6.2	Benthic Toxicity Tests	6-2
6.3	Benthic Bioaccumulation	6-3
6.4	Tier III Conclusions	6-8
7.0	TIER IV EVALUATION	7-1
7.1	Toxicity Tests	7-1
7.2	Benthic Bioaccumulation	7-2

PART III - SAMPLING AND ANALYSIS

8.0	SAMPLING	8-1
8.1	Preparation For Sampling	8-1
8.2	Components Of A Sampling Plan	8-4
8.2.1	Review of Dredging Plan	8-4
8.2.2	Historical Data	8-5
8.2.3	Subdivision of Dredging Area	8-6
8.2.4	Selection of Sampling Locations and Number of Samples	8-7
8.2.5	Sample Collection Methods	8-12
8.2.5.1	Sediment Sample Collection	8-12
8.2.5.2	Water Sample Collection	8-14
8.2.5.3	Organism Collection	8-14
8.2.6	Sample Handling, Preservation, and Storage	8-14
8.2.6.1	Sample Handling	8-14
8.2.6.2	Sample Preservation	8-20
8.2.6.3	Sample Storage	8-21

8.2.7	Logistical Considerations and Safety Precautions	8-21
8.2.8	Non-Indigenous Test Species	8-22
9.0	PHYSICAL ANALYSIS OF SEDIMENT AND CHEMICAL ANALYSIS OF SEDIMENT, WATER, AND TISSUE SAMPLES	9-1
9.1	Physical Analysis of Sediment	9-1
9.2	Target Detection Limits	9-2
9.3	Chemical Analysis of Sediment	9-3
9.3.1	Target Analytes	9-3
9.3.2	Selection of Analytical Techniques	9-6
9.4	Chemical Analysis of Water	9-13
9.4.1	Analytical Targets	9-13
9.4.2	Analytical Techniques	9-13
9.5	Chemical Analysis of Tissues	9-15
9.5.1	Target Analytes	9-15
9.5.2	Analytical Techniques	9-19
10.0	GUIDANCE FOR PERFORMING TIER II EVALUATIONS	10-1
10.1	Tier II: Water Column Effects	10-1
10.1.1	Screen Relative To WQS	10-1
10.1.2	Elutriate Analysis Relative To WQS	10-2
10.1.2.1	Standard Elutriate Preparation	10-3
10.1.2.2	Chemical Analysis	10-3
10.1.2.3	Comparison with WQS (Standard Elutriate Test)	10-3
10.2	Theoretical Bioaccumulation Potential (TBP) of Nonpolar Organic Chemicals	10-4
11.0	GUIDANCE FOR PERFORMING BIOLOGICAL EFFECTS TESTS	11-1
11.1	Tier III: Water Column Toxicity Tests	11-1
11.1.1	Species Selection	11-2
11.1.2	Apparatus	11-4
11.1.3	Laboratory Conditions	11-4
11.1.4	Laboratory Procedures	11-5
11.1.5	Data Presentation and Analysis	11-6
11.1.6	Conclusions	11-7
11.2	Tier III: Benthic Toxicity Tests	11-7
11.2.1	Species Selection	11-8
11.2.2	Laboratory Procedures	11-11
11.2.3	Chronic/Sublethal Tests	11-14
11.2.4	Data Presentation and Analysis	11-14
11.2.5	Conclusions	11-15
11.3	Tier IV: Chronic/Sublethal Effects Evaluations	11-15
11.4	Tier IV: Case Specific Evaluations	11-15
12.0	GUIDANCE FOR PERFORMING BIOACCUMULATION TESTS	12-1
12.1	Tier III: Determination Of Bioavailability	12-1
12.1.1	Species Selection and Apparatus	12-1

12.1.2	Experimental Conditions	12-3
12.1.3	Chemical Analysis	12-4
12.1.4	Data Presentation and Analysis	12-4
12.1.5	Conclusions	12-5
12.2	Tier IV: Determination Of Steady State Bioaccumulation	12-5
12.2.1	Laboratory Testing	12-5
12.2.2	Field Assessment of Steady State Bioaccumulation	12-6
12.2.2.1	Apparatus	12-7
12.2.2.2	Species Selection	12-7
12.2.2.3	Sampling Design and Conduct	12-8
12.2.2.4	Basis for Evaluation of Bioaccumulation	12-8
12.2.2.5	Sample Collection and Handling	12-8
12.2.2.6	Chemical Analysis	12-9
12.2.2.7	Data Presentation and Analysis	12-9
12.2.2.8	Conclusions	12-9
13.0	REFERENCES	13-1

APPENDICES

APPENDIX A:	40 CFR PART 230
APPENDIX B:	GUIDANCE FOR EVALUATION OF EFFLUENT DISCHARGES FROM CONFINED DISPOSAL FACILITIES
APPENDIX C:	EVALUATION OF MIXING
APPENDIX D:	STATISTICAL METHODS
APPENDIX E:	SUMMARY OF TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA FOR TIER III BIOASSAYS
APPENDIX F:	METHODOLOGIES FOR IDENTIFYING AMMONIA AS A TOXICANT IN DREDGED-MATERIAL TOXICITY TESTS
APPENDIX G:	QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) CONSIDERATIONS

LIST OF TABLES

		Page No.
Table 4-1.	Industries Associated with Sediment Contaminants.	4-5
Table 6-1.	Food and Drug Administration (FDA) Action Levels for Poisonous and Deleterious Substances in Fish and Shellfish for Human Food.	6-6
Table 8-1.	Type of Samples Which May Be Required Following Tier I to Conduct Dredged-Material Evaluation Tests.	8-2
Table 8-2.	Summary of Recommended Procedures for Sample Collection, Preservation, and Storage.	8-15
Table 9-1.	Potential Contaminants of Concern Listed According to Structural Compound Class.	9-4
Table 9-2.	PCDD and PCDF Compounds Determined by Method 1613	9-8
Table 9-3.	Polychlorinated Biphenyl (PCB) Congeners Recommended for Quantitation as Potential Contaminants of Concern.	9-9
Table 9-4.	Methodology for Toxicity Equivalency Factors	9-12
Table 9-5.	Octanol/Water Partition Coefficients (K_{ow}) for Organic Compound Priority Pollutants and 301(h) Pesticides.	9-16
Table 9-6.	Bioconcentration Factors (BCF) of Inorganic Priority Pollutants.	9-18
Table 11-1.	Candidate Toxicity Test Species for Determining Potential Water Column Impact of Dredged Material Disposal.	11-3
Table 11-2.	Candidate Acute Toxicity Test Species for Determining Potential Benthic Impact of Dredged-Material Disposal.	11-9
Table 12-1.	Candidate Test Species for Determining Potential Bioaccumulation from Whole Sediment Tests.	12-2

LIST OF FIGURES

Page No.

Figure 3-1. Simplified Overview of Tiered Approach to Evaluating Potential Impact of Aquatic Disposal of Dredged Material. 3-3

Figure 3-2. Illustration of Tiered Approach to Evaluating Potential Water Column Impacts of Dredged Material. 3-4

Figure 3-3. Illustration of Tiered Approach to Evaluating Potential Benthic Impacts of Deposited Dredged Material. 3-5

Figure 6-1. Expected proportion of steady-state concentration (Css) of neutral organic compounds reached in 28-day laboratory exposures. 6-5

PREFACE

The "Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual", commonly referred to as the Inland Testing Manual represents a major effort by the U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) to establish procedures applicable to the evaluation of potential contaminant-related environmental impacts associated with the discharge of dredged material in inland waters, near coastal waters, and surrounding environs (that is, all waters other than the ocean and the territorial seas, regulated pursuant to Section 404, CWA). This manual is consistent, to the maximum extent practicable, with the procedures established for ocean waters (i.e., the "Green Book" entitled "Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual" - EPA/USACE, 1991). The USACE and EPA have statutory and regulatory responsibilities with regard to the management of dredged material discharge activities in inland and near coastal waters. The USACE is responsible for regulating non-Federal dredging and dredged material discharge activities through a permit program, and for conducting Federal dredging and dredged material discharge activities in conjunction with its Civil Works Program. EPA is responsible for establishing, in conjunction with the USACE, guidelines pertaining to the evaluation of these activities, and performing oversight actions. Specifically, Section 404 of the Federal Water Pollution Control Act of 1972 (FWPCA), Public Law 92-500, as amended by the Clean Water Act of 1977 (CWA), Public Law 95-217, requires, among other things, that the discharge of dredged or fill material into waters of the U.S. be permitted by the USACE. The USACE also conducts Civil Works dredging and dredged material discharge activities in accordance with Section 404. Section 404 further requires that discharge sites be specified though the application of the Section 404(b)(1) Guidelines (Guidelines) developed by EPA in conjunction with the USACE. Section 404 requires that the "guidelines shall be based upon criteria comparable to the criteria applicable to the territorial seas, contiguous zone, and the ocean". Thus, a clear connection for comparable testing for ocean, inland and near coastal waters was established as early as 1972.

The Guidelines, which impart other requirements in addition to those associated with contaminant-related impacts, are published at 40 CFR 230. This manual provides testing procedures applicable to determining the potential for contaminant-related environmental impacts associated with the discharge of dredged material. Dredged material evaluated under the procedures described in this manual must also satisfy all other applicable requirements of 40 CFR 230-232, 33 CFR 320-330, and 33 CFR 335-338 in order to comply with the Guidelines and to be authorized for discharge.

This manual, which is designed to allow for regional flexibility in implementation and application including development of regional manuals and documentation, will be periodically revised and updated as warranted by advances in regulatory practice and technical understanding. This manual replaces the May 1976 proposed testing protocol, "Ecological Evaluation of Proposed Discharge of Dredged or Fill Material Into Navigable Waters", which will no longer be applicable. The 1976 protocol was developed in response to a requirement in the Federal Register notice of the Guidelines, Vol. 40, No. 173, Friday, 5 September 1975. That notice states the "EPA in conjunction with the Corps of Engineers will publish a procedures manual that will cover summary and description of tests, definitions, sample collection and preservation, procedures, calculations and references." In December 1980, the Guidelines were revised and finalized in the Federal Register Vol. 45, No. 249. The present joint effort by EPA and USACE contains up-to-date testing procedures to implement the Guidelines at Sections 230.60 and 230.61, and is

intended to bring compatibility and a comparable level of environmental protection for dredged material testing in ocean, inland and near coastal waters.

This manual is one of a series of guidance documents jointly developed by EPA and the USACE pertaining to dredged material disposal. This series includes a document entitled "Evaluating Environmental Effects of Dredged Material Management Alternatives - A Technical Framework" (Framework Document - USACE/EPA, 1992). The Framework Document articulates those factors to be considered in identifying the environmental effects of dredged material management alternatives on a continuum of discharge sites from uplands to the oceans (management alternatives include open water, confined and beneficial use situations) that meet the substantive and procedural requirements of the National Environmental Policy Act (NEPA), the CWA and the Marine Protection, Research, and Sanctuaries Act (MPRSA). The Green Book (EPA/USACE, 1991) is included in the series. Application of the testing guidance in this manual in addition to guidance provided in the Framework Document and the Green Book will allow for consistency in decision making with respect to technical considerations, across statutory boundaries and the continuum of dredged material discharge options.

The contributions made by many individuals from both agencies are gratefully acknowledged. The first and second drafts of the manual were completed by the Environmental Laboratory (EL) of the USACE Waterways Experiment Station (WES): Thomas Wright, primary author; Michael Palermo, author of Appendix B; Paul Schroeder, Michael Palermo, Robert Randall and Billy Johnson, authors of Appendix C. Succeeding drafts were completed by an EPA/USACE Workgroup established by EPA's Office of Science and Technology (OST) within the Office of Water (OW). Mike Kravitz of OST was the Work Assignment Manager. Appendix D was written by Dennis Brandon and Joan Clarke (WES) and Michael Paine (EVS Consultants). Appendix F was written by Gary Ankley (EPA). Appendix G was written by Sandra Salazar and Peter Chapman (EVS Consultants). Henry Lee and Bruce Boese (EPA) contributed valuable information pertaining to sediment bioaccumulation testing. Carie Schaffer and Robert Johnson (Tetra Tech, Inc.) provided computer support for internet and electronic versions of the document, respectively.

The Workgroup was comprised of individuals from headquarters, field offices and research laboratories of both agencies with scientific and/or programmatic experience related to dredged material discharge activities.

Co-Chairs:	Betsy Southerland	EPA/OW/OST
	Kirk Stark	USACE/Headquarters
Members:	Gary Ankley	EPA/Duluth Research Lab
	Tom Dillon	USACE/WES
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Review of this manual was conducted by EPA through OW [OST and the Office of Wetlands, Oceans and Watersheds (OWOW)] and by USACE through the Office of the Chief of Engineers (Regulatory Branch, Dredging and Navigation Branch, Office of Environmental Policy) and EL of WES. In addition, the results of the EPA's Science Advisory Board (SAB, 1992) review of the 1991 Green Book were considered in detail, where applicable, during development of this manual. The results of EPA's SAB (1994) review of the draft Inland Testing Manual were considered during its finalization. Regional issues which have National relevance were provided by EPA Region and USACE Division and District staff, and were incorporated into the appropriate sections of this document. This manual provides comprehensive testing guidance from a national perspective. Within the framework of this document, EPA Regions and USACE Districts and Divisions will develop region-specific guidance and/or procedures, as necessary (e.g., region-specific test species), to provide sufficient information to make informed dredged material discharge decisions.

This manual should be cited as follows:

EPA/USACE. 1998. Evaluation of dredged material proposed for discharge in waters of the U.S. - Testing manual. EPA-823-B-98-004, Washington, D.C.

DEFINITIONS

The following definitions of words and terms are specific to the use of this manual and, where applicable, are quoted verbatim from the Guidelines (cf. Definitions at 40 CFR 230.3 and/or other parts; such definitions are starred*). Thorough familiarization with the following definitions is required prior to use of this manual.

Accuracy: The ability to obtain a true value; determined by the degree of agreement between an observed value and an accepted reference value.

Acid volatile sulfide (AVS): The sulfides removed from sediment by cold acid extraction, consisting mainly of H_2S and FeS. AVS is a possible predictive tool for divalent metal sediment toxicity.

Acute: Having a sudden onset, lasting a short time.

Acute toxicity: Short-term toxicity to organism(s) that have been affected by the properties of a substance, such as contaminated sediment. The acute toxicity of a sediment is generally determined by quantifying the mortality of appropriately sensitive organisms that are put into contact with the sediment, under either field or laboratory conditions, for a specified period.

***Adjacent:** Bordering, contiguous or neighboring. Wetlands separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are "adjacent wetlands".

Application factor (AF): A numerical, unitless value, calculated as the threshold chronically toxic concentration of a test substance divided by its acutely toxic concentration. The AF is usually reported as a range and is multiplied by the median lethal concentration as determined in a short-term (acute) toxicity test to estimate an expected no-effect concentration under chronic exposure.

Benchmark organism: Test organism designated by USACE and EPA as appropriately sensitive and useful for determining biological data applicable to the real world. Test protocols with such organisms are published, reproducible and standardized.

Bioaccumulation: The accumulation of contaminants in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, pore water or dredged material. [The regulations require that bioaccumulation be considered as part of the environmental evaluation of dredged material proposed for disposal. This consideration involves predicting whether there will be a cause-and-effect relationship between an organism's presence in the area influenced by the dredged material and an environmentally important elevation of its tissue content or body burden of contaminants above that in similar animals not influenced by the disposal of the dredged material].

Bioaccumulation factor: The degree to which an organism accumulates a chemical compared to the source. It is a dimensionless number or factor derived by dividing the concentration in the organism by that in the source.

Bioassay: A bioassay is a test using a biological system. It involves exposing an organism to a test material and determining a response. There are two major types of bioassays differentiated by response: **toxicity tests** which measure an effect (e.g., acute toxicity, sublethal/chronic toxicity) and **bioaccumulation tests** which measure a phenomenon (e.g., the uptake of contaminants into tissues).

Bioavailable: Can affect organisms.

Bioconcentration: Uptake of a substance from water.

Biomagnification: Bioaccumulation up the food chain, e.g., the route of accumulation is solely through food. Organisms at higher trophic levels will have higher body burdens than those at lower trophic levels.

Biota sediment accumulation factor: Relative concentration of a substance in the tissues of an organism compared to the concentration of the same substance in the sediment.

Bulk sediment chemistry: Results of chemical analyses of whole sediments (in terms of wet or dry weight), without normalization (e.g., to organic carbon, grain-size, acid volatile sulfide).

Can: Is used to mean "is able to".

Chronic: Involving a stimulus that is lingering or which continues for a long time.

Chronic toxicity: See **sublethal/chronic toxicity**.

Comparability: The confidence with which one data set can be compared to others and the expression of results consistent with other organizations reporting similar data. Comparability of procedures also implies using methodologies that produce results comparable in terms of precision and bias.

Completeness: A measure of the amount of valid data *obtained* versus the amount of data originally *intended* to be collected.

Confined disposal: A disposal method that isolates the dredged material from the environment. Confined disposal is placement of dredged material within diked confined disposal facilities via pipeline or other means.

Confined disposal facility (CDF): A diked area, either in-water or upland, used to contain dredged material. The terms confined disposal facility (CDF), dredged material containment area, diked disposal facility, and confined disposal area are used interchangeably.

Constituents: Chemical substances, solids, liquids, organic matter, and organisms associated with or contained in or on dredged material.

***Contaminant:** A chemical or biological substance in a form that can be incorporated into, onto or be ingested by and that harms aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment, and includes but is not limited to the substances on the 307(a)(1) list of toxic pollutants promulgated on January 31, 1978 (43 FR 4109). [Note: A contaminant that causes actual harm is technically referred to as a pollutant, but the regulatory definition of a "pollutant" in the Guidelines is different, reflecting the intent of the CWA.]

Contaminant of concern: A contaminant present in a given sediment thought to have the potential for unacceptable adverse environmental impact due to a proposed discharge.

Control sediment: A sediment essentially free of contaminants and which is used routinely to assess the acceptability of a test. Control sediment may be the sediment from which the test organisms are collected or a laboratory sediment, provided the organisms meet control standards. Test procedures are conducted with the control sediment in the same way as the reference sediment and dredged material. The purpose of the control sediment is to confirm the biological acceptability of the test conditions and to help verify the health of the organisms during the test. Excessive mortality in

the control sediment indicates a problem with the test conditions or organisms, and can invalidate the results of the corresponding dredged material test.

Data quality indicators: Quantitative statistics and qualitative descriptors which are used to interpret the degree of acceptability or utility of data to the user; include bias (systematic error), precision, accuracy, comparability, completeness, representativeness, detectability and statistical confidence.

Data quality objectives (DQOs): Qualitative and quantitative statements of the overall uncertainty that a decision maker is willing to accept in results or decisions derived from environmental data. DQOs provide the framework for planning environmental data operations consistent with the data user's needs.

Discharge of dredged material: Any addition of dredged material into waters of the United States. [Dredged material discharges include: open water discharges; discharges resulting from unconfined disposal operations (such as beach nourishment or other beneficial uses); discharges from confined disposal facilities which enter waters of the United States (such as effluent, surface runoff, or leachate); and, overflow from dredge hoppers, scows, or other transport vessels]. Material resuspended during normal dredging operations is considered "de minimus" and is not regulated under Section 404 as a dredged material discharge. See 33 CFR 323.2 for a detailed definition. The potential impact of resuspension due to dredging can be addressed under NEPA.

***Disposal site:** That portion of the "waters of the United States" where specific disposal activities are permitted and consist of a bottom surface area and any overlying volume of water. In the case of wetlands on which surface water is not present, the disposal site consists of the wetland surface area. [Note: upland locations, although not mentioned in this definition in the Regulations, can also be disposal sites].

District: A USACE administrative area.

***Dredged material:** Material that is excavated or dredged from waters of the United States. [A general discussion of the nature of dredged material is provided by Engler et al. (1991a)].

EC_{50}: The median effective concentration. The concentration of a substance that causes a specified effect (generally sublethal rather than acutely lethal) in 50% of the organisms tested in a laboratory toxicity test of specified duration.

Elutriate: Material prepared from the sediment dilution water and used for chemical analyses and toxicity testing. Different types of elutriates are prepared for two different procedures as noted in this manual.

Evaluation: The process of judging data in order to reach a decision.

***Factual determination**: A determination in writing of the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical and biological components of the aquatic environment in light of Subparts C-F of the Guidelines.

Federal Standard: The dredged material disposal alternative(s) identified by the U.S. Army Corps of Engineers that represent the least costly, environmentally acceptable alternative(s) consistent with sound engineering practices and which meet the environmental standards established by the 404(b)(1) evaluation process. [See Engler et al. (1988) and 33 CFR 335-338].

***Fill material:** Any material used for the primary purpose of replacing an aquatic area with dry land or changing the bottom elevation of a water body for any purpose. The term does not include any pollutant discharged into the water primarily to dispose of waste, as that activity is regulated under Section 402 of the Clean Water Act. [Note: dredged material can be used as fill material].

Grain-size effects: Mortality or other effects in laboratory toxicity tests due to sediment granulometry, not chemical toxicity. [It is clearly best to use test organisms which are not likely to react to grain-size but, if this is not reasonably possible, then testing must account for any grain-size effects.]

Guidelines: Substantive environmental criteria by which proposed discharges of dredged material are evaluated. CWA Section 404(b)(1) final rule (40 CFR 230) promulgated December 24, 1980.

LC_{50}: The median lethal concentration. The concentration of a substance that kills 50% of the organisms tested in a laboratory toxicity test of specified duration.

Leachate: Water or any other liquid that may contain dissolved (leached) soluble materials, such as organic salts and mineral salts, derived from a solid material.

Lethal: Causing death.

Loading density: The ratio of organism biomass or numbers to the volume of test solution in an exposure chamber.

Management actions: Those actions considered necessary to rapidly render harmless the material proposed for discharge (e.g., non-toxic, non-bioaccumulative) and which may include containment in or out of the waters of the U.S. (see 40 CFR Subpart H). Management actions are employed to reduce adverse impacts of proposed discharges of dredged material.

Management unit: A manageable, dredgeable unit of sediment which can be differentiated by sampling and which can be separately dredged and disposed within a larger dredging area. Management units are not differentiated solely on physical or other measures or tests but are also based on site- and project-specific considerations.

May: Is used to mean "is allowed to".

Method detection limit (MDL): The minimum concentration of a substance which can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

Might: Is used to mean "could possibly."

***Mixing zone:** A limited volume of water serving as a zone of initial dilution in the immediate vicinity of a discharge point where receiving water quality may not meet quality standards or other requirements otherwise applicable to the receiving water. [The mixing zone may be defined by the volume and/or the surface area of the disposal site or specific mixing zone definitions in State water quality standards].

Must: In this manual refers to requirements that have to be addressed in the context of compliance with the Guidelines.

Open water disposal: Placement of dredged material in rivers, lakes or estuaries via pipeline or surface release from hopper dredges or barges.

Pathway: In the case of bioavailable contaminants, the route of exposure (e.g., water, food).

***Pollution:** The man-made or man-induced alteration of the chemical, physical, biological or radiological integrity of an aquatic ecosystem. [See definition of **contaminant**].

***Practicable:** Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Practical quantitation limit (PQL): The lowest concentration that can be reliably quantified with specified limits of precision and accuracy during routine laboratory operating conditions.

Precision: The ability to replicate a value; the degree to which observations or measurements of the same property, usually obtained under similar conditions, conform to themselves. Usually expressed as standard deviation, variance or range.

QA: Quality assurance, the total integrated program for assuring the reliability of data. A system for integrating the quality planning, quality control, quality assessment, and quality improvement efforts to meet user requirements and defined standards of quality with a stated level of confidence.

QC: Quality control, the overall system of technical activities for obtaining prescribed standards of performance in the monitoring and measurement process to meet user requirements.

Reason to believe: Subpart G of the 404(b) (1) guidelines requires the use of available information to make a preliminary determination concerning the need for testing of the material proposed for dredging. This principle is commonly known as "reason to believe", and is contained in Tier I of the tiered testing framework. The decision to not perform additional testing based on prior information must be documented, in order to provide a "reasonable assurance that the proposed discharge material is not a carrier of contaminants" (230.60(b)).

Reference sediment: Point of comparison for evaluating test sediment. Testing requirements in the Section 404(b)(1) Guidelines regarding the point of comparison for evaluating proposed discharges of dredged material are being updated to provide for comparison to a "reference sediment" as opposed to sediment from the disposal site. Because subsequent discharges at a disposal site could adversely impact the point of comparison, adoption of a reference sediment that is unimpacted by previous discharges of dredged material will result in a more scientifically sound evaluation of potential individual and cumulative contaminant-related impacts. This change to the Guidelines was proposed in the Federal Register in January 1995, public comments have been received, and a final rule Notice is being prepared. It is expected that the final rule will be published prior to July 1, 1998, and as a result the reference sediment approach will be implemented in the ITM.

Reference site: The location from which **reference sediment** is obtained.

Region: An EPA administrative area.

region: A geographical area.

Regulations: Procedures and concepts published in the Code of Federal Regulations for evaluating the discharge of dredged material into waters of the United States.

Representativeness: The degree to which sample data depict an existing environmental condition; a measure of the total variability associated with sampling and measuring that includes the two major error components: systematic error (bias) and random error. Sampling representativeness is accomplished through proper selection of sampling locations and sampling techniques, collection of sufficient number of samples, and use of appropriate subsampling and handling techniques.

Sediment: Material, such as sand, silt, or clay, suspended in or settled on the bottom of a water body.

Should: Is used to state that the specified condition is recommended and ought to be met unless there are clear and definite reasons not to do so.

Standard operating procedure (SOP): A written document which details an operation, analysis, or action whose mechanisms are thoroughly prescribed and which is commonly accepted as the method for performing certain routine or repetitive tasks.

Standardized: In the case of methodology, a published procedure which has been peer reviewed (e.g., journal, technical report), and generally accepted by the relevant technical community of experts.

Sublethal: Not directly causing death; producing less obvious effects on behavior, biochemical and/or physiological function, histology of organisms.

Sublethal/chronic toxicity: Biological tests which use such factors as abnormal development, growth and reproduction, rather than solely lethality, as end-points. These tests involve all or at least an important, sensitive portion of an organism's life-history. A sublethal endpoint may result either from short-term or long-term (chronic) exposures.

Target detection limit: A performance goal set by consensus between the lowest, technically feasible, detection limit for routine analytical methods and available regulatory criteria or guidelines for evaluating dredged material. The target detection limit is, therefore, equal to or greater than the lowest amount of a chemical that can be reliably detected based on the variability of the blank response of routine analytical methods. However, the reliability of a chemical measurement generally increases as the concentration increases. Analytical costs may also be lower at higher detection limits. For these reasons, a target detection limit is typically set at not less than 10 times lower than available dredged material guidelines.

Tests/testing: Specific procedures which generate biological, chemical, and/or physical data to be used in evaluations. The data are usually quantitative but may be qualitative (e.g., taste, odor, organism behavior). Testing for discharges of dredged material in waters of the United States is specified at 40 CFR 230.60 and 230.61 and is implemented through the procedures in this manual.

Tiered approach: A structured, hierarchical procedure for determining data needs relative to decision-making, which involves a series of tiers or levels of intensity of investigation. Typically, tiered testing involves decreased uncertainty and increased available information with increasing tiers. This approach is intended to ensure the maintenance and protection of environmental quality, as well as the optimal use of resources. Specifically, least effort is required in situations where clear determinations can be made of whether (or not) unacceptable adverse impacts are likely to occur based on available information. Most effort is required where clear determinations cannot be made with available information.

Toxicity: see **Acute toxicity**; **Sublethal/chronic toxicity**, **Toxicity test**.

Toxicity test: A **bioassay** which measures an effect (e.g., acute toxicity, sublethal/chronic toxicity). Not a **bioaccumulation test** (see definition of **bioassay**).

Water quality certification: A state certification, pursuant to Section 401 of the Clean Water Act, that the proposed discharge of dredged material will comply with the applicable provisions of Sections 301, 303, 306 and 307 of the Clean Water Act and relevant State laws. Typically this certification is provided by the affected State. In instances where the State lacks jurisdiction (e.g., Tribal Lands), such certification is provided by EPA or the Tribe (with an approved certification program).

Water quality standard: A law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an anti-degradation statement.

Waters of the U.S.: In general, all waters landward of the baseline of the territorial sea and the territorial sea. Specifically, all waters defined in Section 230.3 (s) of the Guidelines. [See Appendix A].

Whole sediment: The sediment and interstitial waters of the proposed dredged material or reference sediment that have had minimal manipulation. For purposes of this manual, press-sieving to remove organisms from test sediments, homogenization of test sediments, compositing of sediment samples, and additions of small amounts of water to facilitate homogenizing or compositing sediments may be necessary to conducting bioassay tests. These procedures are considered unlikely to substantially alter chemical or toxicological properties of the respective whole sediments except in the case of AVS (acid volatile sulfide) measurements (EPA, 1991a) which are not presently required. Alternatively, wet sieving, elutriation, or freezing and thawing of sediments may alter chemical and/or toxicological properties, and sediment so processed should not be considered as whole sediment for bioassay purposes.

LIST OF ACRONYMS

AAS - Atomic Absorption Spectrometry
AF - Application Factor
AVS - Acid Volatile Sulfide
BAF - Bioaccumulation Factor
BCF - Bioconcentration Factor
BSAF - Biota Sediment Accumulation Factor
CDF - Confined Disposal Facility
CFR - Code of Federal Regulations
CLP - Contract Laboratory Program
CWA - Clean Water Act
ECD - Electron Capture Detection
EO - Executive Orders
EPA - Environmental Protection Agency
FDA - Food and Drug Administration
FR - Federal Register
GC - Gas Chromatography
GFAAS - Graphite Furnace Atomic Absorption Spectrometry
IAEA - International Atomic Energy Agency
ICP - Inductively Coupled Plasma
ITM - Inland Testing Manual
LBP - Lipid Bioaccumulation Potential
MPRSA - Marine Protection, Research and Sanctuaries Act
MS - Mass Spectrometry
NBS - National Bureau of Standards
NEPA - National Environmental Policy Act
NIST - National Institute for Standards and Technology
NOAA - National Oceanic Atmospheric Administration
NPDES - National Pollutant Discharge Elimination System
NRC - National Research Council of Canada
PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyl
QA - Quality Assurance

QC - Quality Control
QSAR - Quantitative Structure Activity Relationship
RHA - Rivers and Harbors Act of 1899
SAB - Science Advisory Board
SIM - Selected Ion Monitoring
SOP - Standard Operating Procedure
SQC - Sediment Quality Criteria
SQS - Sediment Quality Standards
SRM - Standard Reference Material
TBP - Theoretical Bioaccumulation Potential
TDL - Target Detection Limit
TEF - Toxicity Equivalency Factor
TOC - Total Organic Carbon
TIE - Toxicity Identification Evaluation
USACE - U.S. Army Corps of Engineers
USCS - Unified Soil Classification System
WQC - Water Quality Criteria
WQS - Water Quality Standards

CONVERSIONS

METRIC TO IMPERIAL	IMPERIAL TO METRIC
WEIGHT:	
1Kg = 1000g = 2.205lb	1lb = 16 oz = 0.4536Kg
1g = 1000mg = 2.205 x 10^{-3}lb	
1 mg = 1000μg = 2.205 x 10^{-6}lb	
LENGTH:	
1m = 100cm = 3.28 ft. = 39.370in	1 foot (ft) = 12in = 0.3048m
1cm = 10mm = 0.3937in	
1mm = 1000μg = 0.03937in	
CONCENTRATION:	
1ppm = 1mg/L = 1mg/Kg =1μg/g = 1mL/m^3	1 lb/gal = 7.481lb/ft^3 = 0.120g/cc = 119.826g/L = 119.826Kg/m^3
1g/cc = 1Kg/L = 8.3454 lb/gallon (US)	
1g/m^3 = 1mg/L = 6.243 x 10^{-5}lb/ft^3	1 oz/gal = 7.489Kg/m^3
VOLUME:	
1L = 1000mL	1yd^3 = 27ft^3 = 764.555 L = 0.7646m^3
1mL = 1000μL	1 acre-ft = 1233.482m^3
1cc = $10^{-6}m^3$	1 gallon (US) = 3785cc
	1 ft^3 = 0.0283m^3= 28.3168 L
FLOW:	
1m/s = 196.850 ft/min = 3.281 ft/s	1 ft^3/s = 1699.011 L/min = 28.317 L/s
1 m^3/s = 35.7 ft^3/s	1 ft^2/hr = 2.778 x 10^{-4} ft^2/s = 2.581 x $10^{-5}m^2$/s
	1 ft/s = 0.03048m/s
	1 yd^3/min = 0.45ft^3/s
	yd^3/s = 3.366 gal/s = 12.743 L/s
AREA:	
1 m^2 = 10.764ft^2	1 ft^2 = 0.0929m^2
1 hectare (ha) = 10000m^2 = 2.471 acres	1 acre = 4046.856m^2 = 0.405 ha

PART I - GENERAL CONSIDERATIONS

1.0 INTRODUCTION

1.1 Background

The "Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual", commonly referred to as the Inland Testing Manual, updates and replaces "Ecological Evaluation of Proposed Discharge of Dredged or Fill Material into Navigable Waters" (USACE, 1976). This updated manual contains technical guidance for determining the potential for contaminant-related impacts associated with the discharge of dredged material in waters regulated under Section 404 of the CWA (inland waters, near coastal waters, and surrounding environs) through chemical, physical, and biological evaluations. The technical guidance in the manual is intended for use by Army Corps of Engineers (USACE) and Environmental Protection Agency (EPA) personnel, state regulatory personnel, as well as dredging permit applicants and others (e.g., scientists, managers, and other involved or concerned individuals). The results obtained will be utilized within the context of regulatory requirements (discussed in the following sections), to facilitate decision-making with regard to the management of dredged material.

Key changes to the 1976 testing protocol include a tiered testing approach, accommodation for sediment quality standards (SQS), 28-d bioaccumulation testing, comparison of benthic test results with those of the reference sediment, improved statistics, improved model applications, and new test organisms. Because this manual is national in scope, the guidance provided is generic and may need to be modified in certain instances. Application of this guidance in some site- and case-specific situations will require best professional judgment, appropriately documented. Permit applicants and others are strongly encouraged to consult with their appropriate Regional and District experts for additional guidance.

1.2 Statutory/Regulatory Overview

The following sections provide a discussion of the statutory and regulatory framework of the Federal programs within which decisions regarding the management of dredged material discharge activities are made.

1.2.1 Statutory Overview

The USACE and EPA share the Federal responsibility for regulating the discharge of dredged material. The Clean Water Act (CWA) governs discharges of dredged material into "waters of the United States",

including all waters landward of the baseline of the territorial sea. The Marine Protection, Research, and Sanctuaries Act (MPRSA) governs the transportation of dredged material seaward of the baseline (in ocean waters) for the purpose of disposal. In addition, all activities regulated by these statutes must comply with the applicable requirements of the National Environmental Policy Act (NEPA), as well as other Federal laws, regulations and Executive Orders which apply to activities involving the discharge of dredged material.

The CWA was enacted by Congress to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA created three permit programs, under Section 401 (as a certification), Section 402 and Section 404, to regulate the point-source discharge of pollutants into waters of the U.S. EPA administers Section 402 which established the National Pollutant Discharge Elimination System (NPDES) Program to regulate discharges of chemicals, heavy metals, and biological wastes, primarily in waste water from industrial processes, publicly owned sewage treatment works, and stormwater discharges. The Section 402 program may be delegated by EPA to the States to administer. EPA and USACE each administer specific aspects of Section 404 which established a permit program and technical guidelines to regulate discharges of dredged or fill material (dredged material and fill material disposal sites must be "specified"). States may assume (and most of them have) the program administered by EPA under Section 401 and must grant, deny, or waive certification for activities permitted or conducted by USACE based on the potential impacts to water quality which may result from a discharge of dredged or fill material to waters of the U.S.

The USACE also administers a regulatory program under Section 10 of the Rivers and Harbors Act of 1899 (RHA) which regulates dredging and other construction activities in navigable waters. The USACE also operates a Federal Civil Works navigation program in conjunction with the CWA and with requirements established within Congressional authorization and appropriation statutes, which involves extensive dredging and dredged material discharge activities. These USACE programs are operated in accordance with NEPA which requires, among other things, the analysis and documentation of potential primary and secondary impacts, including those associated with dredging and dredged material discharges.

1.2.2 Section 404 Regulatory Overview

The USACE has the primary responsibility for the Section 404 regulatory permit program [the USACE regulatory program also administers Section 10 RHA, as well as Section 103 of the MPRSA (for the transport of dredged material to the ocean for the purpose of disposal)] and is authorized, after notice and opportunity for public comment, to issue permits specifying sites for the discharge of dredged or fill material. EPA has the primary role in developing the environmental guidelines, in conjunction with

USACE [the Section 404(b)(1) Guidelines (Guidelines)], by which permit applications must be evaluated. EPA is also responsible for commenting on proposed USACE permits, prohibiting discharges with unacceptable adverse aquatic environmental impacts, approving and overseeing State assumption of the program, establishing jurisdiction, and interpreting exemptions. Both USACE and EPA share enforcement authority.

The USACE regulates the discharge of dredged material, resulting from navigation dredging, into waters of the United States. The USACE also regulates the discharge of dredged material and incidental discharges of dredged material resulting from mechanized landclearing, ditching, channelization, and other excavation activities. The Inland Testing Manual has been developed to facilitate testing in conjunction with proposed dredged material discharges resulting from navigation dredging. The testing protocols are not designed or intended to be applied to discharge of dredged material and incidental discharges of dredged material resulting from mechanized landclearing, ditching, channelization, and other excavation activities, except where excavation and subsequent discharge activities are of essentially the same character as those associated with navigation dredging and disposal (e.g., open water discharges of dredged material excavated from a soft-bottom flood control channel or reservoir).

The USACE's evaluation of a Section 404 permit application involves determining whether the proposed project complies with the Guidelines (40 CFR 230) and USACE permit regulations (33 CFR 320-330) which require a public interest review of the project. [Public interest factors (listed in 33 CFR 320.4) considered with respect to dredged material contaminant-related impacts include water quality, water supply and conservation, safety, and fish and wildlife impacts]. A permit is issued provided the proposed project complies with the Guidelines and is not contrary to the public interest. The USACE issues individual permits and general permits. Individual permits are issued on a project-by-project basis after the Guidelines compliance and public interest determinations are made for the specific project at issue. General permits, on the other hand, are issued for classes of activities after the USACE conducts the Guidelines compliance and public interest reviews and determines that issuance of the general permit will not result in more than minimal adverse impacts to the aquatic environment from either a site-specific or cumulative standpoint. General permits require little or no reporting, analysis, or paperwork.

There are three types of general permits issued by the USACE, nationwide permits, regional general permits and programmatic general permits. Nationwide permits are issued by the Chief of Engineers and apply nationwide. Regional permits are issued by District and Division Engineers and are applicable on district or State-wide basis. Programmatic permits are issued (by the Chief of Engineers, as well as District and Division Engineers) to other federal, State or local agencies with the intention of providing the appropriate level of environmental protection and avoiding unnecessary duplication of effort with the agency regulatory activities at issue.

There are currently four nationwide permits that pertain to dredging and the discharge of dredged material. One authorizes the discharge and return water from confined disposal areas (provided the associated dredging is authorized pursuant to Section 10 of the River and Harbor Act of 1899); two other nationwide permits authorize the dredging and discharge, respectively, of up to 25 cubic yards of material; and a fourth authorizes maintenance dredging of existing marina basins (provided that the dredged material is deposited on uplands; return water from a confined disposal area requires separate authorization pursuant to Section 404 of the Clean Water Act). The USACE depends on its districts' knowledge of potentially contaminated areas and on the discretionary authority of District and Division Engineers to develop special conditions and/or require individual permits where contaminated sediments are present. General permits are not intended to apply to projects involving the dredging or the discharge of contaminated materials.

USACE Civil Works activities are conducted in accordance with the Guidelines and the USACE operation and maintenance regulations (33 CFR 335-338). The USACE specifies sites for the discharge of dredged material in conjunction with its regulatory and civil works responsibilities. (Permits are not actually issued in conjunction with USACE discharge activities).

1.2.2.1 The Section 404(b)(1) Guidelines

The Guidelines provide the substantive environmental criteria used in evaluating proposed discharges of dredged or fill material into waters of the United States. Fundamental to these Guidelines is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern.

For proposed discharges of dredged material to comply with the Guidelines, they must satisfy four requirements found in Section 230.10 as follows. Section 230.10(a) addresses those impacts associated with the loss of aquatic site functions and values of the proposed discharge site, by requiring that the discharge site represent the least environmentally damaging, practicable alternative. Section 230.10(b) requires compliance with established legal standards (e.g., issuance or waiver of a State water quality certification). Section 230.10(c) requires that discharge of dredged material not result in significant degradation of the aquatic ecosystem. Section 230.10(d) requires that all practicable means be utilized to minimize for adverse environmental impacts.

Testing as described in this manual is part of the larger evaluation of a proposed discharge activity to

determine its compliance with the Guidelines. Sections 230.60 and 230.61 of the Guidelines provide the basis for certain factual determinations with regard to dredged material discharge activities. Section 230.60 provides for a general evaluation of the material and establishes a framework to determine, based on existing information on the proposed dredging and discharge sites, whether the material at issue requires further testing. If the conditions at 230.60 cannot be met or are not applicable, the testing requirements of Section 230.61 must be applied. This manual details the testing procedures outlined in 230.60 and 230.61. Conclusions reached utilizing this manual will be used to make factual determinations of the potential effects of a proposed discharge of dredged or fill material on the physical, chemical and biological components of the aquatic environment. Such factual determinations are used to make findings of compliance or noncompliance with relevant parts of Sections 230.10(b) (including compliance with established water quality standards) and 230.10(c) (determinations of potential contaminant-related impacts to aquatic resources). All specifications of discharge sites must also comply with Section 230.10 (a) and Section 230.10(d). Site monitoring and/or management activities developed following the use of this manual may be said to contribute to satisfying the aforementioned requirements of Section 230.10(d).

Once compliance with the Guidelines is established, information developed utilizing the manual will also be factored into the USACE public interest determination which is required by its regulatory permit regulations for proposed non-Federal dredged material discharge activities, or its determinations required by the operation and maintenance regulations pertaining to Federal Civil Works activities. In making determinations with regard to its regulatory and civil works responsibilities, the USACE considers a continuum of discharge options, on a project-specific basis, including alternative sites, mitigation and specific site management and monitoring conditions. Determination of whether a material, which would not otherwise comply with the Guidelines or with other USACE regulatory and civil works requirements, could be brought into compliance through appropriate management actions or other discharge methods, is beyond the scope of this manual.

1.2.2.2 Particulars of Sections 230.60 and 230.61

Reason to Believe - Subpart G of the 404(b)(1) guidelines requires the use of available information to make a preliminary determination concerning the need for testing of the material proposed for dredging. This principle is commonly known as "reason to believe". The decision to not perform testing based on prior information must be documented in order to provide a "reasonable assurance that the proposed discharge material is not a carrier of contaminants" (by virtue of the fact that it is sufficiently removed from sources of pollution) [230.60(b)]. The reason to believe that no testing is required is based on the type of material to be dredged and/or its potential to be contaminated. For example, dredged material is most likely to be free of contaminants if the material is composed primarily of sand, gravel, or other

inert material and is found in areas of high current or wave energy [230.60(a)]. In addition, knowledge of the proposed dredging site proximity to other sources of contamination, as well as that gained from previous testing or through experience and knowledge of the area to be dredged, may be utilized to conclude that there is no reason to believe that contaminants are present [230.60(b)] and, therefore, no need for testing. This general evaluation comprises procedures found in Tier I of the manual's tiered-testing framework. Tier I is a comprehensive analysis of all existing and readily available information on the proposed dredging project, including all previously collected physical, chemical, and biological data for both the proposed dredging and discharge sites. A more complete discussion of technical factors to consider with respect to Sections 230.60(a) and (b) in Tier I is provided in Section 4.0.

Exclusions From Testing - Sections 230.60(c) and (d) provide for specific circumstances in which the discharge of dredged material which is suspected to be contaminated may be conducted without further testing. Section 230.60(c) provides that where the proposed discharge and dredging sites are adjacent and are comprised of similar materials and subject to the same source(s) of contaminants, disposal may be conducted without further testing because the discharge is not likely to result in degradation of the discharge site, as long as the potential spread of contaminants to less contaminated areas can be prevented. Section 230.60(d) provides that the discharge of contaminated dredged material may be conducted without further testing if constraints, acceptable to USACE and EPA, are available to reduce contamination to acceptable levels within the discharge site, and to prevent contaminants from being transported beyond the proposed discharge site boundaries.

Conclusions reached with regard to dredged material discharges without testing, in accordance with Section 230.60, must be described in the appropriate factual determination. Even though material may be excluded from testing under the manual the water quality certifying agency may require testing to demonstrate compliance with state laws. Even in cases where the discharge site is adjacent to the dredging site, potential differences in contaminant bioavailability may occur.

Reference Sediment - The manual requires comparison of testing results between the proposed dredged material and a reference sediment (see previous Definitions section). The USACE and EPA believe that the use of a reference sediment provides an accurate information base for predicting cumulative bioaccumulation and benthic impacts resulting from the discharge of dredged material.

1.2.3 Relationship to Section 401 CWA Water Quality Certification

Section 401 of the CWA requires that all Federal permits and licenses, including those for the discharge of dredged material into waters of the United States, authorized pursuant to Section 404 of the CWA,

must be certified as complying with applicable State water quality standards (WQS). The Guidelines at 40 CFR 230.10(b) state in part that "No discharge of dredged or fill material shall be permitted if it: (1) Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard." This applies at the edge of a State designated mixing zone.

The process for adoption of State WQS is prescribed at 40 CFR 131. States must issue, condition, deny, or waive a Water Quality Certification for activities permitted or conducted by USACE, certifying that no adverse water quality impacts will occur based on determinations of compliance with applicable State WQS which have been adopted in accordance with the above regulation. State water quality standards consist of designated uses, narrative and numeric criteria designed to support those uses, and anti-degradation provisions. This testing manual is intended to provide guidance for the dredged material testing necessary to determine compliance with such State WQS.

States may, at their discretion, include in their State standards policies generally affecting their application and implementation, e.g. mixing zones (40 CFR 131.13). A mixing zone is a limited volume of water serving as a zone of initial dilution in the immediate vicinity of a discharge point where receiving water may not meet quality standards or other requirements otherwise applicable to the receiving water (40 CFR 230.3). Where mixing zone provisions are part of the State standards, the State should describe the procedures for defining mixing zones.

According to EPA (1991b), mixing zone concentrations should not exceed acute water quality standards and, considering likely pathways of exposure, there should be no significant human health risks. For dredged material discharges which only occur periodically, water quality standard compliance in the mixing zone is generally focused on aquatic life, not on human health, which is based on long-term exposures to contaminants. (Long-term exposures resulting from accumulations of dredged material at the disposal site can be evaluated by such means as bioaccumulation tests). Acute or chronic standards may be appropriate, depending on the duration of discharge and characteristics of the discharge site.

Many States have statutory or regulatory requirements for use of State-owned lands, including aquatic (marine and freshwater) bedlands. For discharges of dredged or fill materials into waters of the U.S. which are also waters of State or State-owned lands, specific requirements (including testing) for "use" of State lands may exist which need to be considered. The responsible State land-management agency may be different from the agency which normally issues the WQS or coastal zone certification. At a minimum, coordination with the responsible State agency should occur to avoid conflicts with or impacts to existing and/or future uses of State lands. In parts of the country, cooperative State-federal dredged material or sediment management ventures are in place or are being pursued to identify disposal sites, develop consistent regional management standards, and to monitor maintenance of those standards [e.g.,

the Puget Sound Dredged Material Disposal Analysis (State of Washington) and San Francisco Long-Term Management Strategy (LTMS - State of California)]. These programs are intended to streamline the regulatory process associated with dredging and dredged material disposal.

2.0 SCOPE AND APPLICABILITY

This manual is directed towards evaluation of proposed discharges of dredged material (associated with navigational dredging or dredging activities of essentially the same character as navigational dredging) in open water. It utilizes both chemical and biological analyses as necessary, to provide effects-based conclusions within a tiered framework with regard to the potential for contaminant-related water column, benthic toxicity and benthic bioaccumulation impacts. The tiered-testing procedure detailed in Section 3.1 is comprised of four levels (tiers) of increasing investigative intensity which generate information to assist in making contaminant-related determinations. Tiers I and II use existing or easily acquired information and apply relatively inexpensive and rapid tests to predict environmental effects. Tiers III and IV contain biological evaluations which are more intensive and require field sampling, laboratory testing, and rigorous data analysis.

2.1 This Manual is Intended to Address:

- contaminant-related impacts associated with discharges of dredged material (resulting from navigational dredging or dredging activities of essentially the same character as navigation dredging, such as open water discharges of dredged material excavated from a soft-bottom flood control channel or reservoir) in open water disposal areas, including wetlands.

- contaminant-related impacts to waters of the U.S. associated with dredged material runoff from confined disposal areas. Guidance on evaluation of such discharges is provided in Appendix B.

2.2 This Manual is Not Intended to Address:

- impacts associated with the dredging activity itself.

- impacts associated with dredged material discharges associated with excavation of drainage ditches and landclearing.

- impacts associated with the discharge of fill material. However, where dredged material associated with navigational dredging will be discharged in open water as fill, the procedures of this manual are applicable.

- microbiological impacts except for impacts in conjunction with the State designated use of a waterbody and human health considerations. The manual provides a list of applicable references, as the technology for analyzing other potential impacts from microorganisms (e.g., modeling potential pathways of contamination) is in various stages of development. Although scientifically accepted mechanisms for predicting the degree of potential microbiological impacts are not yet available, site management techniques are available (but are beyond the scope of this manual) to address potential impacts (e.g., aerating dredged material to kill anaerobic organisms).

2.3 Dredged Material Discharge for Beneficial Uses

The testing procedures in this manual should also be applied when navigational dredged material is proposed for certain beneficial uses. To the extent that dredged material will be discharged into open water in conjunction with a beneficial use and the evaluation of its suitability requires analysis of contaminant-related impacts listed in 2.1, the testing protocols of this manual should be applied. However, other evaluations may be necessary, in addition to those in this manual, to assess the potential for contaminant-related impacts through pathways other than those provided by open water. For example, contaminants in dredged material proposed for wetlands creation which will not adversely affect the open water environment, may be taken up by wetlands vegetation, thereby requiring evaluations that are not detailed in this manual.

This manual may also apply to dredged material used for beach nourishment. Beach nourishment normally involves hydraulic or mechanical placement of uncontaminated materials near a shoreline. As with other beneficial uses, dredged material proposed for beach nourishment often can be excluded from chemical or biological testing; the focus is on analysis to determine physical compatibility as measured by grain size and total organic carbon (see Section 9.1). However, if there is a reason to believe that contaminants are present, further evaluation should be performed.

2.4 The Role of Biological Evaluations (Toxicity and/or Bioaccumulation Tests) in the Manual

As noted in Section 230.61 of the Guidelines, the evaluation process will usually entail investigation of potential biological effects, rather than merely chemical presence, of the possible contaminants. Biological evaluations serve to integrate the chemical and biological interactions of the suite of contaminants which may be present in a dredged material sample, including their availability for biological uptake, by

measuring their effects on test organisms. Within the constraints of experimental conditions and the end-points of effects measured, biological evaluations provide for a quantitative comparison of the potential effects of a dredged material when compared to reference sediments. Thus, a specified level of change compared to reference conditions and a statistically significant result in this comparison indicate that the discharge of the dredged material in question may cause a direct and specific biological effect under test conditions and, therefore, has the potential to cause an ecologically undesirable impact. Guidance for the conduct of biological tests is given in Sections 11 and 12.

Dredged material potentially contains a myriad of chemical contaminants which may adversely impact aquatic organisms. The literature is replete with examples where aquatic organism sensitivity varies with the type of contaminant (e.g., see Rand and Petrocelli, 1985) and, as a result, a suite of aquatic species are routinely recommended to fully assess the impact of contaminants on a biological community. In this manual, three sensitive species are recommended for the water column and whole sediment toxicity tests. In the case of the latter, two species can be used, provided they cover three functional characteristics: filter feeder, deposit feeder, burrower. In both cases, at least one of these species must be a sensitive "benchmark" species. For assessing bioaccumulation, adequate tissue biomass and the ability to ingest sediments is more important than taxon sensitivity. Where possible, two species should be used to assess potential bioaccumulation unless adequate regional data are available to justify single species testing.

It is important to recognize that dredged material bioassays (toxicity and bioaccumulation tests) are subject to interpretation and are not precise predictors of environmental effects. This manual does not provide quantitative guidance on interpreting the ecological meaning of such effects (e.g., the ecological consequences of a given tissue concentration of a bioaccumulated contaminant or the consequences of that body burden to the animal). Rather, the manual considers statistically significant increases above certain levels compared to the reference sediment as potentially undesirable. Because a statistically significant difference is not a quantitative prediction that an ecologically important impact would occur in the field or vice versa, this manual discusses additional factors to be weighed in evaluating potential ecological impact. This is more likely to result in environmentally sound evaluations than is reliance on statistical significance alone.

Bioaccumulation evaluations indicate biological availability of contaminants in dredged material, which may bioaccumulate and bioconcentrate in (or, for a few chemicals, biomagnify up) aquatic food webs to levels which might be harmful to consumers, including human beings, without killing the intermediate organisms. To use bioaccumulation data, it is necessary to predict whether there will be a cause-and-effect relationship between the animal's exposure to dredged material and a meaningful adverse elevation of body burden of contaminants above that of similar animals not exposed to the dredged material.

2.5 The Role of Water and Sediment Chemical Evaluations in the Manual

Chemical evaluations of water and sediments are conducted for the following reasons:

- to determine contaminant concentrations in the dredged material
- to determine contaminant concentrations in the discharge or reference sites
- to determine compliance with water quality standards (WQS).

Chemical evaluations may be made on the basis of previous chemical inventories, when there is a reason to believe that the dredged material contains no new contaminants, or that there is no difference between contaminants in the dredged material and the disposal site [Tier I; Section 230.60(a)-(c) of the Guidelines]. The latter may be the case where the discharge site is adjacent to the dredging site, and potential differences in contaminant bioavailability are considered unlikely. There may, however, be concern with potential water column effects which would warrant evaluation of such potential effects (Tier II; Section 2.6). In particular, it must be shown that unacceptable levels of dissolved and suspended contaminants from the discharge either will not be released and transported to less contaminated areas, or can be managed.

Initial evaluation of water column chemistry may be carried out through the use of a numerical dispersion model based on bulk sediment chemistry (Section 5.1.1). If this model indicates the potential for adverse effects, a chemical evaluation of potential water column effects may be conducted through the use of elutriate tests [Tier II; Section 230.61(b)(2) of the Guidelines]. In this procedure an aqueous extract (i.e., an elutriate) is prepared from the material to be discharged, and the dissolved contaminants are compared to water quality standards with consideration of mixing. This comparison requires that dissolved contaminants in reference water (ambient condition) also be analyzed.

The above elutriate test is used to determine compliance with WQS with consideration of mixing. The elutriate test provides an indirect evaluation of potential biological effects, because WQS are derived from toxicity tests of solutions of various contaminants. Even if WQS are met, biological evaluations (see Section 2.4) must be considered.

2.6 Water Column Effects

The dredged material impact in the water column must be within the available WQS for all contaminants of concern outside of the mixing zone. If disposal operations result in long-term exposures, compliance with chronic aquatic and/or human health standards should be evaluated. Wildlife standards, if available, should also be considered. Water column toxicity tests are used to provide information on the toxicity

of contaminants not included in water quality standards, and also to indicate possible interactive effects of multiple contaminants.

2.7 Mixing

Appendix C describes the method to be used for estimating the effect of mixing for water column evaluations. 40 CFR 230.11(f)(2) describes the factors to be considered in defining mixing zones; States may use additional factors in such definition. This method is applied in evaluating the potential for impacts of the portion of dredged material that remains in the water column; all water quality and water column toxicity data must be interpreted in light of mixing [Section 230.61 (b)(2)(ii) of the Guidelines]. This is necessary because biological effects (which are the basis for WQS) are a function of the biologically available contaminant concentration and exposure time of the organisms. Laboratory toxicity tests expose organisms to specific concentrations for fixed periods of time, whereas in the field both concentration and exposure time to contaminants change continuously due to mixing and dilution. Both factors interact to control the degree of biological impact. Thus, it is necessary to incorporate the mixing expected at the discharge site into the interpretation of data.

2.8 Benthic Effects

Generally, the greatest potential for environmental effects from dredged material discharge lies in the benthic environment. Deposited dredged material is not mixed and dispersed as rapidly or as greatly as the portion of the material that may remain in the water column, and bottom dwelling animals living and feeding on deposited material for extended periods represent the most likely pathways by which adverse effects to aquatic biota can occur. Therefore, the major evaluative effort must be placed on deposited material and the benthic environment, unless there is a compelling reason to do otherwise. The approach in this manual is conservative (i.e., protective) as it uses whole-sediment bioassays (toxicity and bioaccumulation tests) to evaluate the solid phase of the dredged material. Sediment chemical analyses currently cannot be used to directly evaluate the biological effects of any contaminants which may be present in dredged material because such potential effects are a function of bioavailability. However, as noted in Section 2.5, there are circumstances where it may be reasonably assumed that bioavailability in the dredged material and the discharge site are similar. When decisions cannot be made using evaluations in Section 230.60 of the Guidelines, bioaccumulation tests should be used to directly determine the bioavailability of potential contaminants.

2.9 Management Options

Some dredged material evaluated in accordance with technical procedures in this manual may demonstrate

a potential for unacceptable environmental impacts or not meet Federally approved State WQS. If so, a careful case-by-case evaluation of management options (e.g., alternative dredging and discharge methods, alternative discharge sites, confined disposal, capping, site controls such as covers and/or liners) will be necessary to determine whether the proposed discharge can be made acceptable or can be brought into compliance with the Guidelines and State WQS. As previously noted, it is beyond the scope of this manual to determine whether a material which would not otherwise comply with the Guidelines, could be brought into compliance through appropriate management actions or other discharge methods.

2.10 The Relationship of the Inland Testing Manual to Other USACE/EPA Dredged Material Management Efforts

2.10.1 Relationship of the Manual to the USACE/EPA Framework Document

EPA and USACE have long recognized the need for a consistent technical framework for decision-making regarding the discharge of dredged material in ocean, near coastal, and inland waters (e.g., see Francingues et al., 1985; Wright and Saunders, 1990). This manual is one of a series of guidance documents jointly developed by EPA and the USACE in response to that recognition. This series of guidance documents includes the "Evaluating Environmental Effects of Dredged Material Management Alternatives - A Technical Framework" (USACE/EPA, 1992) which articulates those factors (including the potential for and degree of contaminant-related impacts) to be considered in identifying the environmental effects of dredged material management alternatives on a continuum from uplands to oceans, and which meet the substantive and procedural requirements of NEPA, CWA and MPRSA. The companion testing manual for ocean disposal, the Green Book (EPA/USACE, 1991) is included in the series. Application of the testing guidance in this manual within the context of the Framework Document will allow for consistency in decision-making with respect to technical considerations, across statutory boundaries and with consideration of the continuum of dredged material discharge options.

2.10.2 Relationship of the Manual to the EPA/USACE Green Book

Although the Ocean Dumping and the CWA programs carry out their functions under different mandates and different environments (estuarine, lake and riverine *versus* ocean), there is a considerable overlap in terms of practical application. The Guidelines are statutorily directed to be based upon criteria comparable to those developed under Section 403(c) for the territorial seas, contiguous zone, and ocean. Additionally, in previous guidance both EPA and USACE have acknowledged the ecological similarity of all aquatic areas and the need for a consistent technological analysis framework, particularly when the waters of the

United States under consideration for a discharge are near-coastal. While details of this manual are necessarily different from one addressing only ocean waters, the tiered testing framework and concepts of the Green Book are an appropriate paradigm. The Inland Testing Manual also utilizes the Green Book's reference site approach which provides a more accurate data base for cumulative impact analysis.

Dredged material transported for purposes of dumping or disposal seaward of the baseline of the territorial sea will continue to be regulated under the MPRSA (commonly referred to as the Ocean Dumping Act). MPRSA-regulated dredged material disposal will be tested in accordance with procedures outlined in the Green Book (EPA/USACE, 1991). As previously discussed, dredged material used as fill within the territorial sea, such as for beach nourishment, is regulated under the CWA and will be tested in accordance with this manual.

2.10.3 Relationship of the Manual to EPA's Contaminated Sediment Strategy and Sediment Quality Criteria

EPA is developing a Contaminated Sediment Management Strategy (Strategy; Southerland et al., 1992) which is a multi-program effort to address contaminated aquatic sediments in the United States. The Strategy is intended to improve the understanding of the extent and severity of sediment contamination and to propose prevention, control, and remediation programs. The Strategy describes the policy framework and specific actions EPA could take to promote the consideration of and reduction of ecological and human health risks posed by sediment contamination. The Strategy also recommends a comprehensive research program and outreach activities with other agencies and the general public.

One component of the Strategy is the development of Sediment Quality Criteria (SQC), which are derived numerical values representing the concentration of chemicals in sediment which are determined to adversely affect benthic organisms. SQC are included in EPA's approach to defining contamination in sediments, and are envisioned to play a range of roles in all programs, from assessment to remediation. When finalized, SQC likely will be incorporated into the Inland Testing Manual in Tier II. SQC could also form the basis for State SQS. The Inland Testing Manual is structured such that evolving science may be readily merged into the document.

PART II - EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACT

3.0 OVERVIEW OF TESTING AND EVALUATION

As noted in Section 1.2.2.1, conclusions reached utilizing this manual will be used to make factual determinations of the potential effects of a proposed discharge of dredged material on the physical, chemical and biological components of the aquatic environment. Such factual determinations are used to make findings of compliance or noncompliance with relevant parts of Sections 230.10(b) (including compliance with established water quality standards) and 230.10(c) (determinations of potential contaminant-related impacts to aquatic resources).

3.1 Tiered Testing and Evaluation

The tiered approach to testing used in this manual must be initiated at Tier I. It is designed to aid in generating physical, chemical, toxicity and bioaccumulation information, but not more information than is necessary to make factual determinations. This allows optimal use of resources by focusing the least effort on disposal operations where the potential (or lack thereof) for unacceptable adverse impact is clear, and expending the most effort on operations requiring more extensive investigation to determine the potential (or lack thereof) for impact. To achieve this objective, the procedures in this manual are arranged in a series of tiers, or levels of intensity (and cost) of investigation. Tiered testing results in environmental protection in the context of more efficient completion of necessary evaluations and reduced costs, especially to low-risk operations. Disposal operations that obviously have low environmental impact generally should not require intensive investigation to make factual determinations. Evaluation at successive tiers is based on more extensive and specific information about the potential impact of the dredged material, that may be more time-consuming and expensive to generate, but that allows more and more comprehensive evaluations of the potential for environmental effects. At any tier except for Tier IV, failure to satisfactorily determine the potential for unacceptable aquatic environmental impact, or to develop sufficient information to make factual determinations, results in additional testing at a subsequent, more complex tier unless a decision is made to seek other disposal alternatives (thereby avoiding the potential for unacceptable aquatic environmental impacts).

It is necessary to proceed through the tiers only until information sufficient to make factual determinations has been obtained. For example, if the available information is sufficient to make factual determinations, no further testing is required.

The initial tier (Tier I) uses readily available, existing information (including all previous testing). For certain dredged materials with readily apparent potential for environmental impact (or lack thereof), information collected in Tier I may be sufficient for making factual determinations. However, more

extensive evaluation (Tiers II, III and IV) may be needed for other materials with less clear potential for impact or for which Tier I information is inadequate.

Tier II is concerned solely with sediment and water chemistry. Tier III is concerned with well-defined, nationally accepted toxicity and bioaccumulation testing procedures. Tier IV allows for case-specific laboratory and field testing, and is intended for use in unusual circumstances.

The approach is to enter Tier I and proceed as far as necessary to make factual determinations. Although it is not always necessary that all dredged material be evaluated through all tiers, there must be enough information available to make determinations on all aspects of the Guidelines relating to water column impact, benthic toxicity and benthic bioaccumulation. It is acceptable to carry water-column and benthic evaluations, or toxicity and bioaccumulation evaluations, to different tiers to generate the information necessary and sufficient to make these determinations.

Prior to initiating testing, it is essential that the informational requirements of preceding tiers be thoroughly understood and that the information necessary for interpreting results at the advanced tier be assembled. For example, it is always appropriate to gather all relevant available information and identify the chemicals of concern for the dredged material in question even though it may be clear without formal Tier I evaluation that further assessment will be necessary.

The tests in this manual reflect the present state-of-the-art procedures for dredged material evaluation. However, it is recognized that the evaluation of dredged material is an evolving field. It is anticipated that, as new methods of evaluation are developed and accepted, they will be integrated into the tiered framework. The tiered approach will be maintained because of the efficiency afforded by its hierarchical design.

The tiered approach used in the manual is summarized in Figure 3-1, and additional detail on water column and benthic evaluation is presented in Figures 3-2 and 3-3. These flowcharts should be used in conjunction with a careful reading of the corresponding guidance presented in this manual, in particular Sections 4, 5, 6 and 7. The sections or figures in the manual that present the technical guidance shown by the flowcharts are indicated in the boxes on the figures.

3.2 Control and Reference Sediments

It is important to clearly distinguish between control and reference sediments in the context of testing for benthic impacts. In general, control sediment is that within which the organisms resided prior to

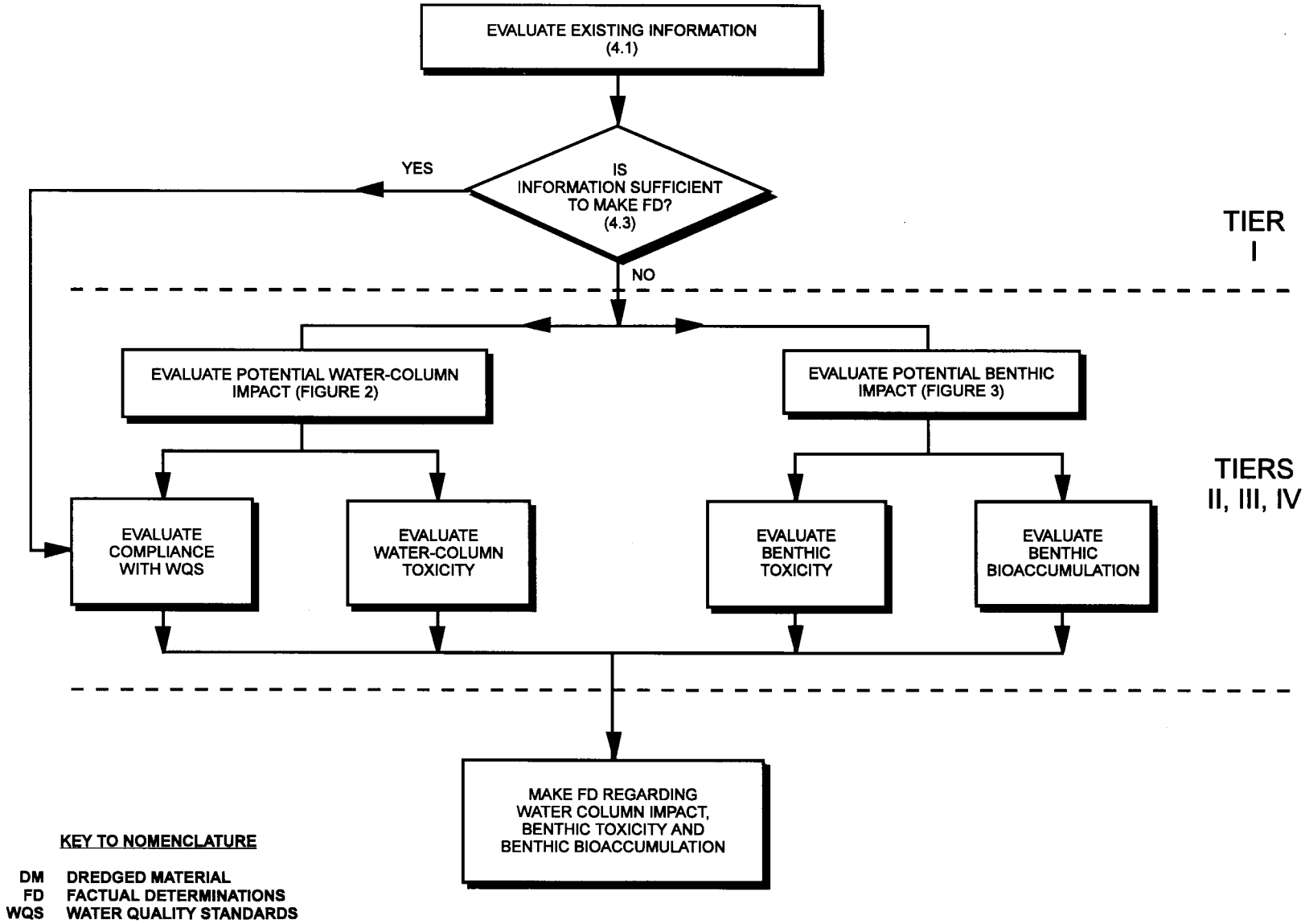


Figure 3-1. Simplified Overview of Tiered Approach to Evaluating Potential Impact of Aquatic Disposal of Dredged Material.

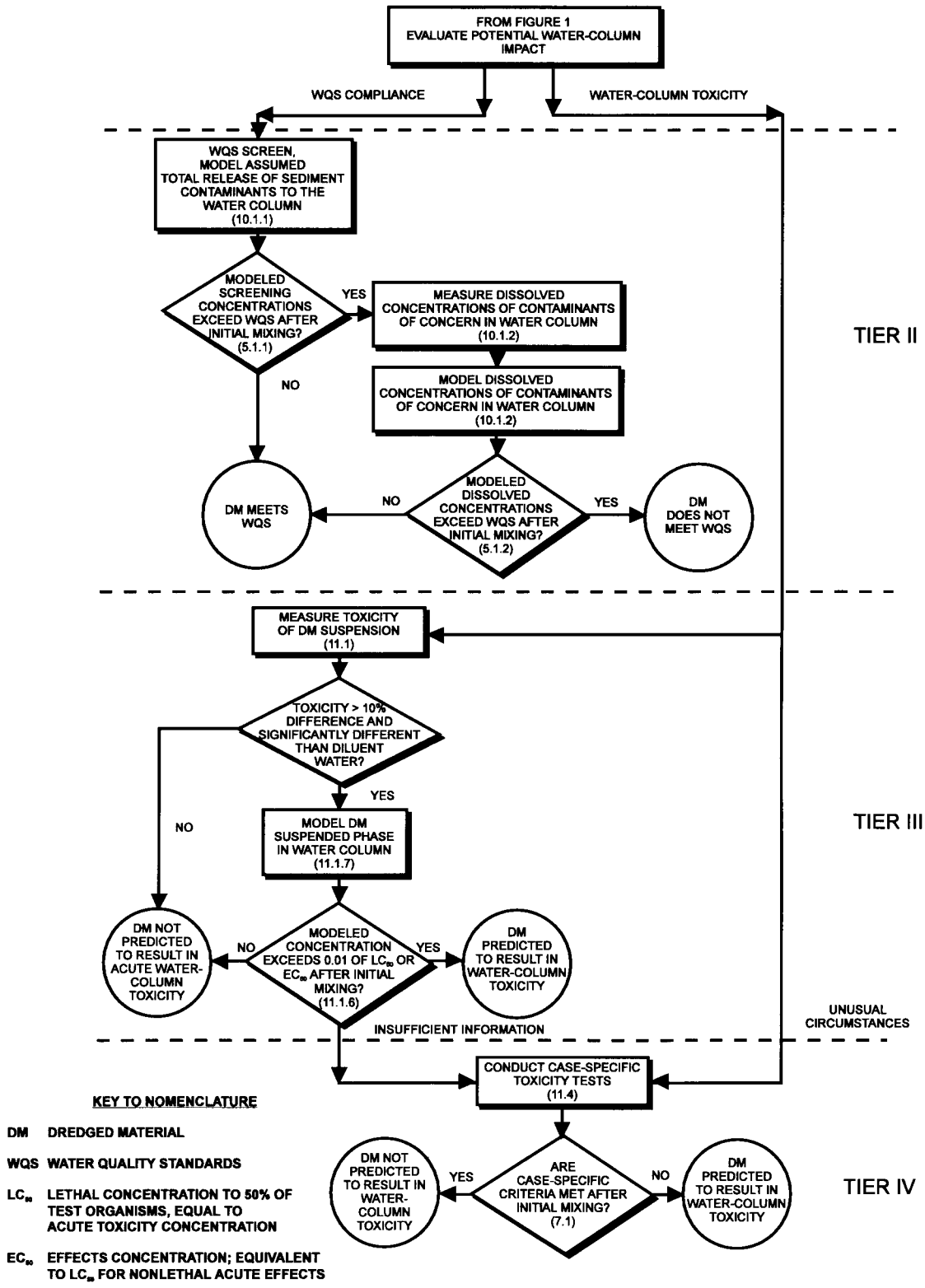


Figure 3-2. Illustration of Tiered Approach to Evaluating Potential Water Column Impacts of Dredged Material.

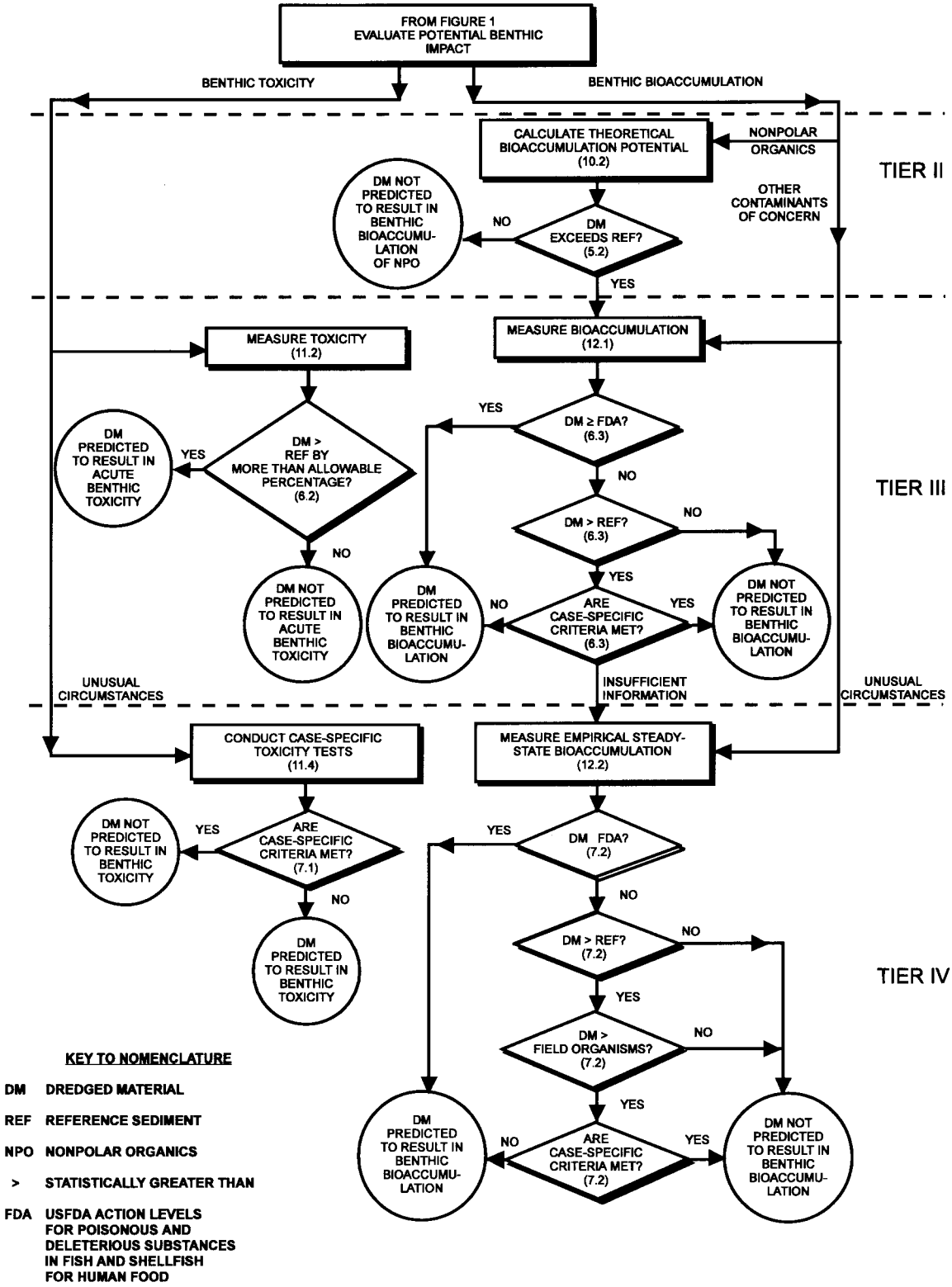


Figure 3-3. Illustration of Tiered Approach to Evaluating Potential Benthic Impacts of Deposited Dredged Material.

collection in the field or is that within which they were cultured in the laboratory, and serves to confirm the health of the test animals and the acceptability of the test conditions. Generic control sediments are also possible and consist of field-collected or laboratory prepared sediment. Reference sediment is the key to the evaluation of dredged material. Results of tests using reference sediment provide the point of comparison (reference point) to which benthic effects of dredged material are compared.

In some cases, it may be appropriate to use more than one reference sediment for a single dredging project. This could occur when the dredged material or the disposal site has a wide range of grain-sizes or TOC, when management needs suggest that disposal of different dredged materials at different locations in the disposal site is desirable, or when discharge at more than one site is being considered. One reference site can serve more than one disposal site.

3.2.1 Reference Sediment Sampling

Reference sediment is the point of comparison for evaluating test sediment. Testing requirements in the Section 404(b)(1) Guidelines regarding the point of comparison for evaluating proposed discharges of dredged material are being updated to provide for comparison to a "reference sediment" as opposed to sediment from the disposal site. Because subsequent discharges at a disposal site could adversely impact the point of comparison, adoption of a reference sediment that is unimpacted by previous discharges of dredged material will result in a more scientifically sound evaluation of potential individual and cumulative contaminant-related impacts. This change to the Guidelines was proposed in the Federal Register in January 1995, public comments have been received, and a final rule Notice is being prepared. It is expected that the final rule will be published prior to July 1, 1998, and as a result the reference sediment approach will be implemented in the ITM.

Reference sediment is generally collected outside the influence of previous disposal operations at a dredged material disposal site, but near enough to the disposal site that the reference sediment is subject to all the same influences (except previously disposed dredged material) as the disposal site. If there is a potential for sediment migration or there is a reason to believe that previously disposed sediment has migrated, reference sediment should be collected from an area that is not expected to be influenced by test material. There are four potential reference sampling approaches as discussed below. We recommend the first two reference approaches because they allow statistically valid comparisons.

Reference Point Approach: This approach is used when the disposal site is known to be sufficiently homogeneous that a single reference location is representative of the disposal site. A single reference location is sampled and the sediment is tested concurrently with the dredged material. The bioassay results from the reference sediment are statistically compared to those obtained from benthic toxicity and bioaccumulation tests of the material to be dredged.

Reference Area Approach: This approach is used when the disposal site is known to be heterogeneous and more than one reference location must be sampled to adequately characterize the disposal site. Several reference locations are sampled and a composite of all of the sediments are tested concurrently with the dredged material. The bioassay results from the reference sediment composite are statistically compared to those obtained from benthic toxicity and bioaccumulation tests of the material to be dredged.

Periodic Reference Point Approach: This approach could, theoretically, be used when it is not desirable or possible to sample the reference location each time that dredged material is to be tested. Values from the homogeneous reference location collected over a period of time are used to develop decision guidance values which are compared to those obtained from benthic toxicity and bioaccumulation tests of the material to be dredged.

Periodic Reference Area Approach: This approach could, theoretically, be used when it is not desirable or possible to sample the heterogeneous reference locations each time that dredged material is to be tested. Values from heterogeneous reference locations collected over a period of time are used to develop decision guidance values which are compared to those obtained from benthic toxicity and bioaccumulation tests of the material to be dredged.

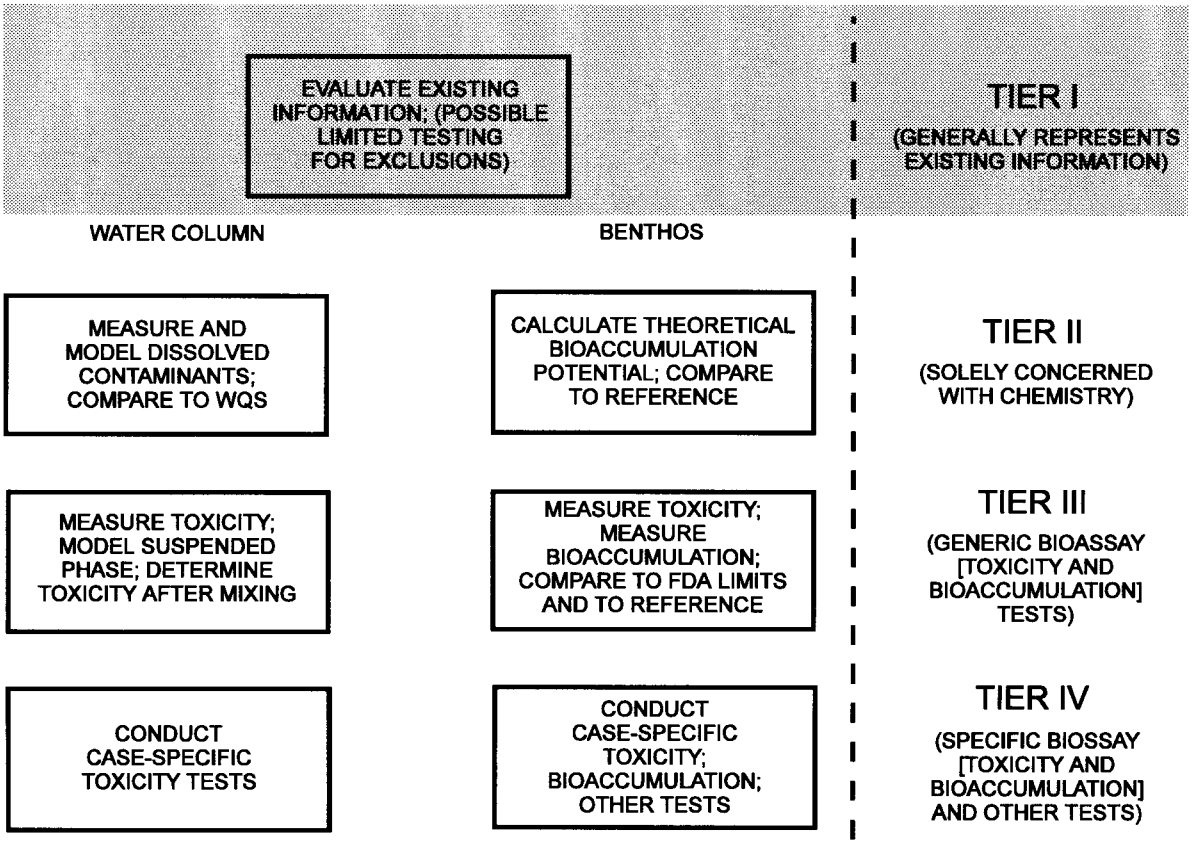
Appendix D, Statistical Methods, provides guidance for conducting statistical comparisons for the reference point and reference area approaches. It does not provide guidance for the use of either of the "periodic" approaches.

3.2.2 Reference Sediment Sampling Plan

The importance of thoughtful selection of the reference sampling approach cannot be overemphasized. To ensure that an appropriate approach is used, information gathered during the site specification process or other studies should be consulted for both the disposal and the reference sites. In some instances there are differences in the statistical methods used in comparing results from the various reference sampling methods to those obtained from the dredged material being

evaluated. There may also be differences in costs among the approaches. Prior to selecting an approach, it is imperative that Appendix D be consulted to determine which approach best fits specific concerns and conditions, including feasibility, technical validity, and cost.

A well-designed sampling plan is essential to the collection, preservation, and storage of samples so that potential toxicity and bioaccumulation can be accurately assessed (Section 8). The implementation of such a plan is equally essential for dredged material, control sediment, and reference sediment.


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
(GENERALLY REPRESENTS EXISTING INFORMATION)
WATER COLUMN
BENTHOS
MEASURE AND MODEL DISSOLVED CONTAMINANTS; COMPARE TO WQS
CALCULATE THEORETICAL BIOACCUMULATION POTENTIAL; COMPARE TO REFERENCE
TIER II
(SOLELY CONCERNED WITH CHEMISTRY)
MEASURE TOXICITY; MODEL SUSPENDED PHASE; DETERMINE TOXICITY AFTER MIXING
MEASURE TOXICITY; MEASURE BIOACCUMULATION; COMPARE TO FDA LIMITS AND TO REFERENCE
TIER III
(GENERIC BIOASSAY [TOXICITY AND BIOACCUMULATION] TESTS)
CONDUCT CASE-SPECIFIC TOXICITY TESTS
CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
TIER IV
(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

4.0 TIER I EVALUATION

One of the purposes of Tier I is to determine whether factual determinations can be made on the basis of existing information. Tier I is a comprehensive analysis of all existing and readily available, assembled, and interpreted information on the proposed dredging project, including all previously collected physical, chemical, and biological monitoring data and testing for both the dredged material excavation site and the proposed disposal site. Only limited testing, to determine the applicability of exclusions, may be necessary in this tier.

If the information set compiled in Tier I is adequate to meet the exclusions or is complete and comparable to that which would satisfy Tier II, III, or IV, as appropriate, factual determinations can be made without proceeding into the higher tiers (Figure 3-1). For an evaluation to be completed within Tier I, the burden of evidence of the collected information must be adequate to make factual determinations.

The initial focus of the Tier I evaluation is on information relevant to Sections 230.60 (a), (b), (c), and (d) of the Guidelines and the potential for contaminant-associated impacts upon discharge. These four sections of the Guidelines fully define the exclusions from testing, which are summarized below.

If an evaluation of the dredging site indicates that the dredged material is not a "carrier of contaminants", testing may not be necessary. Such situations are most likely to arise if: the dredged material is composed primarily of sand, gravel and/or inert materials; the sediments are from locations far removed from sources of contaminants; the sediments are from depths deposited in preindustrial times and not exposed to modern sources of pollution. However, potential impacts from natural mineral deposits must also be considered.

Testing may also not be necessary "where the discharge site is adjacent to the excavation site and subject to the same sources of contaminants, and materials at the two sites are substantially similar "(Section 230.60 (c)). However, some physical and chemical testing may be necessary to confirm that the two sites are "substantially similar". The rationale behind this exclusion from testing is that when 1) the discharge and excavation sites are adjacent, 2) the concentration of contaminants in the two sites are not substantially different, and 3) the geochemical environments are similar, then the bioavailability of contaminants at the two sites are likely to be similar. This exclusion can apply even if the dredged material is a carrier of contaminants, providing that "dissolved materials and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas".

Section 230.60 (d) states that testing may not be necessary with material likely to be a carrier of contaminants if constraints acceptable to the USACE District Engineer and EPA Regional Administrator

are available to "reduce contamination to acceptable levels within the disposal site and to prevent contaminants from being transported beyond the boundaries of the disposal site". Such constraints may involve technologies such as capping and underwater containment. Design and monitoring requirements for such constraints should be determined by the Regional Administrator and District Engineer on a case-by-case basis.

If the exclusionary criteria are satisfied, factual determinations for the dredged material can be made and no further evaluation is necessary. If the exclusionary criteria are not met, the material is evaluated based on all existing information. This information should include chemical information and, if appropriate, existing data on the toxicity and bioaccumulation potential of the dredged material and of the reference sediment. The information must be sufficient to determine if water quality standards are met and, if appropriate, whether 1% of the LC_{50} or EC_{50} of each tested species will or will not be exceeded in the water column following mixing. If adequate information is not available for a Tier I evaluation, the process moves to Tier II.

Even if factual determinations cannot be made on the basis of Tier I information, the information collected can be put to use in later tier analyses. Another purpose of Tier I is to identify the contaminants of concern (if any) in the dredged material. This information is used to select analyses in Tiers II, III, and IV. Similarly, other information collected in Tier I may be used to satisfy all or portions of evaluations in other tiers. It is necessary to proceed through the tiers only until a factual determination is reached. Rigorous information collection and assessment in Tier I inevitably saves time and resources in making final determinations.

Annual or episodic dredging, undertaken to maintain existing navigation improvements, may warrant a periodic Tier I reevaluation. The general recommendation of EPA and USACE is that the interval between reevaluation of Tier I data for these projects not exceed three years or the dredging cycle, whichever is longest. If there is reason to believe that conditions have changed, then the time interval for reevaluation may be less than three years. As a minimum, this reevaluation should include a technical reassessment of all new and previously evaluated physical, chemical and biological data, changes in sediment composition or deposition (e.g., industrial development in the watershed), improvements in analytical methods and contaminant detectability, quality assurance considerations and any regulatory changes.

4.1 Compilation of Existing Information

The potential for contaminants to have been introduced to the dredged material, evaluated with consideration of the physical nature of the dredged material, and the proposed disposal site, allows case-by-case determinations of whether the proposed discharge of dredged material may result in contamination, bioaccumulation or toxicity above reference levels. Section 230.60 (b) of the Guidelines lists a number of factors which should be considered when evaluating the potential for contamination at the dredging (i.e., extraction) site. These factors represent sources of contamination, pathways of contaminant transport, and naturally occurring substances which may be harmful to aquatic biota:

- urban and agricultural runoff
- sewer overflows/bypassing
- industrial and municipal wastewater discharges
- previous dredged or fill discharges
- landfill leachate/groundwater discharge
- spills of oil or chemicals
- releases from Superfund and other hazardous waste sites
- illegal discharges
- air deposition
- biological production (detritus)
- mineral deposits.

The information gathering phase of Tier I evaluations has to be as complete as is reasonably possible, including existing information from all reasonably available sources. This will increase the likelihood that determinations concerning the impact of dredged material may be made at initial tiers. Sources of available information include the following, without limitation:

- Results of prior physical, chemical, and biological tests and monitoring of the material proposed to be disposed.
- Information describing the source of the material to be disposed which would be relevant to the identification of potential contaminants of concern.
- Existing data contained in files of agencies such as EPA or USACE or otherwise available from public or private sources. Examples of sources from which relevant information might be obtained include:
    - Selected Chemical Spill Listing (EPA)
    - Pesticide Spill Reporting System (EPA)
    - Pollution Incident Reporting System (United States Coast Guard)

- Identification of In-Place Pollutants and Priorities for Removal (EPA)
- Hazardous waste sites and management facilities reports (EPA)
- USACE studies of sediment pollution and sediments
- Federal STORET, BIOS, CETIS, and ODES databases (EPA)
- Water and sediment data on major tributaries (Geological Survey)
- NPDES permit records
- Agencies with contaminant or related information, for instance, Fish and Wildlife Service (FWS), National Oceanic and Atmospheric Administration (NOAA), regional planning commissions, state resource/survey agencies
- CWA 404(b)(1) evaluations
- Pertinent and applicable research reports
- MPRSA 103 evaluations
- Port and marina authorities
- Colleges/Universities
- Records of State agencies, (e.g., environmental, water survey, transportation, health)
- Superfund sites, hazardous waste sites
- Published scientific literature.

Sources may contribute differing types and quantities of contaminants to sediments. For example, a matrix of potential correlations between industrial sources and specific contaminants is provided in Table 4-1. This matrix is, however, not all inclusive and makes no accounting for current pollution control practices.

There are also a number of factors which influence the pathways between contaminant sources and the dredging and disposal sites, including:

- bathymetry
- water current patterns
- tributary flows
- watershed hydrology and land uses
- sediment and soil types
- sediment deposition rates.

More detailed site-specific guidance for reaching administrative decisions concerning the impact of a dredged material discharge may be developed by particular EPA Regions and USACE Districts by considering available scientific information and locally important concerns. In evaluating the likelihood

Table 4-1. Industries Associated with Sediment Contaminants. Data derived from Eckenfelder (1980), EPA (1987a), Merck (1989), WDNR/USGS (1992), EPA (1987b), NOAA (1991). Table developed by U.S. EPA Region 5, Water Division.

CONTAMINANTS / INDUSTRIES	Aluminum	Ammunitions	Antifouling Paints	Automobile	Batteries	Chemical Manufacturing	Commercial Farming	Corrosion Metallurgy	Dairy	Detergents/Surfactants	Dye	Electrical	Explosives	Flat Glass	Fruits and Vegetables	Leather/Tanning	Meat Products	Metal Finishing Refining	Metallurgical Processes	Nitric Acid Manufacturing	Oxide Manufacturing	Perfume	Pesticides/Fertilizers	Petroleum Refining	Phosphate Mining	Phosphorus	Photographic	Pigments/Inks	Plastics	Printing Plates	Pulp and Paper Mills	Rubber	Steam Power	Steel/Iron	Sulfuric Acid	Textiles	Utilities	Valuable Mineral Mining	Waste Water Treatment Plants	Potential Nonpoint Sources	Boat Manufacturing/Boat Repair	Boat Refueling
Acenaphthene							●				●												●						●													
Aldrin							●																●																			
Ammonia						●	●		●				●		●		●				●			●	●				●					●	●	●	●			●			
Aniline											●			●				●				●							●					●									
Arsenic				●														●	●							●	●						●	●								
Benzo(a)anthracene																		●															●	●						●		
Benzo(a)pyrene				●														●																●						●	●	●
Cadmium	●			●		●						●						●															●	●		●				●	●	●
Chlordane																																	●					●				
Chlorpyrifos																																											
Chromium	●			●		●		●								●		●			●							●					●						●	●	●	
Copper		●	●	●				●				●	●					●			●												●						●	●	●	
Cyanide								●										●															●						●	●	●	
DDE																																		●						●			
DDT							●																																	●			
Dieldrin							●																●																				
Endrin																							●																				
Ethyl Parathion																							●																				
Fluoranthene																																								●	●	●	
Heptachlor																							●																				
HCB																							●																				
HCBD																																											
HCCPD					●													●																										
Lead			●		●			●				●						●						●				●	●				●	●				●	●	●		
Mercury			●			●						●																●									●		●	●	●		
2-Methylnaphthalene						●																															●		●	●	●		
Nickel	●							●				●						●	●														●						●	●		
Oil and Grease				●		●												●	●															●						●	●	●	●
Organotin/Tin			●																																							
PCBs				●								●																													●		
Phenanthrene																																									●		
Phosphorus		●					●		●	●					●								●		●	●	●			●							●		●	●	●	●
Pyrene																																					●		●	●	●		
Selenium						●						●		●										●			●	●				●					●		●	●	●	●	
TCDD																								●							●											
TCDF																								●							●											
Toxaphene						●	●																●																			
Zinc		●		●				●		●		●						●	●		●								●		●			●		●	●	●	●	●	

that discharge of a dredged material may cause contaminant associated impacts, concern decreases with the increase of factors such as:

- isolation of the dredging operation from known existing and historical sources of contamination
- time since historical sources of contamination have been remediated
- number and frequency of maintenance dredging operations since abatement of the source of contamination
- mixing and dilution occurring between the contamination source and the dredging site
- transport and potential deposition of sediment in the dredging area from sources other than those potentially affected by contamination
- grain size of the dredged material.

Concern regarding contaminant associated impacts increases with the increase of factors such as the number, amount, and toxicological importance of contaminants:

- known to have been introduced to the dredging site
- suspected to have been introduced to the dredging site
- included in continuing input from existing sources
- included in historical sources.

These and other considerations are complexly interrelated; i.e., the acceptable degree of isolation from sources of contamination depends on the number, amount, and toxicological importance of the contaminants as well as on all other factors. These considerations have to be evaluated for all dredged material. Even so, it is desirable that local guidance be developed, based on technical evaluations, that describes the emphasis on factors deemed appropriate in each area. In all cases, the decisions that are based on these factors must be compatible with the Guidelines.

4.2 Identification of Contaminants of Concern

In the Tier I decision sequence (Figure 3-1), the first possibility is that more information is required to make a factual determination. A critical prerequisite to generating this information and one which is crucial to the success of the testing program is deciding, on a case-by-case basis, which contaminants are of concern, particularly for 401 certification, in the dredged material being evaluated. To determine the contaminants of concern, it may be necessary to supplement available information with additional chemical analyses of the dredged material. Contaminants of concern are not restricted to compounds

which inhibit organisms but also those which promote undesirable organisms or growth (e.g., nutrients such as phosphorous - Nakaniski et al., 1986). However note that in at least some cases nutrient releases may be minimal and of no environmental concern (e.g., Tavolaro and Mansky, 1985).

4.2.1 Microbial Contamination

As noted in Section 2.2, this manual only addresses microbiological concerns to the extent that they address State 401 certification requirements. To this end, major areas of concern and pertinent sources of information addressing these and other relevant microbiological issues are provided below.

If sediments are suspected to have high levels of microbial contamination and dredging or disposal sites are close to shellfish beds, swimming beaches or drinking water intakes, then microbial sediment analyses may be required. Useful references include: EPA (1978); Gerba et al. (1979); Dutka et al. (1988) and Helmer et al. (1991). Appropriate state health and water quality agencies should be consulted for guidance and appropriate methods for measuring microbial contamination.

There are three major areas of concern for microbiological contamination and effects related to dredged sediments: (1) contamination of harvestable shellfish (e.g., Hood et al., 1983; Bruckhardt et al., 1992; Martinez-Manzanares et al., 1992); (2) body contact, generally related to swimming beaches (e.g., Fleisher, 1991; Helmer et al., 1991) ; (3) contamination of drinking water (e.g., Geldreich, 1991; Helmer et al., 1991). As noted in the Guidelines (e.g., 230.21, Suspended Particulates, and elsewhere), the ultimate concern is that "...pathogens and viruses...may be biologically available".

Sediments generally contain higher concentrations of indicators of fecal contamination and pathogens, such as *Salmonella* and viruses, than occur in the water column (e.g., Chen et al., 1979; Gerba et al., 1979; LaBelle et al., 1980). Further, these microorganisms survive longer in the sediments than in the water column (e.g., DeFlora et al., 1975; Smith et al., 1978; Borrego et al., 1983; Rao et al., 1984). Sediments have been shown to be a source of microorganisms released to the water column (e.g., VanDonsel and Geldreich, 1971; Shiharis et al., 1987; Hardina and Fujioka, 1991). More specifically, dredging and disposal have been shown to release these microorganisms (e.g., Grimes, 1975; Babinchak et al., 1977).

4.2.2 Chemical Contamination

Nationally, it is difficult to specify a single set of contaminants that adequately addresses all environmental concerns. However, regions may develop their own general contaminants of concern list for routine permitting purposes. In some dredged materials, there may be no contaminants of concern. Different disposal operations may have their own set of contaminants of environmental concern that should be adequately evaluated for each operation.

Identifying specific contaminants that are of concern in a particular dredged material is dependent on the information collected for Tier I. In some instances, it may be sufficient to perform confirmatory analyses for specific contaminants of concern identified in Tier I. In other cases, where the initial evaluation indicates that a variety of contaminants of concern may be present, chemical analysis of the dredged material could provide a useful inventory, and bulk sediment chemistry analysis conducted according to the guidance in Section 9.3 may be appropriate and, in fact, would be necessary to conduct the Tier II water quality screen and the theoretical bioaccumulation potential determination. Contaminants always of interest, if present, are those for which there are FDA limits or state fish advisories and where WQS exceedances exist. Other contaminants that should be included are those that might reasonably be expected to cause an unacceptable adverse impact if the dredged material is discharged.

The contaminants of concern in each dredged material should be identified on the basis of the following, keeping in mind the discussion in Sections 9.3, 9.4, and 9.5:

- presence in the dredged material
- presence in the dredged material relative to the concentration in the reference sediment
- toxicological importance
- persistence in the environment
- propensity to bioaccumulate from sediments.

  The major chemical properties controlling the propensity to bioaccumulate are:

  Hydrophobicity

  Literally, "fear of water"; the property of neutral (i.e., uncharged) organic molecules that causes them to associate with surfaces or organic solvents rather than to be in aqueous solution. The presence of a neutral surface such as an uncharged organic molecule causes water molecules to become structured around the intruding entity. This structuring is energetically unfavorable, and the neutral organic molecule tends to be partitioned to a less energetic phase if one is available. In an operational sense, hydrophobicity is the reverse of aqueous solu-

bility. The octanol/water partition coefficient (K_{ow}, log K_{ow}, or log P) is a measure of hydrophobicity. The tendency for organic chemicals to bioaccumulate is related to their hydrophobicity. Bioaccumulation factors increase with increasing hydrophobicity up to a log K_{ow} of about 6.00. At hydrophobicities greater than about log K_{ow} = 6.00, bioaccumulation factors tend not to increase due, most likely, to reduced bioavailability.

Aqueous Solubility

Chemicals such as acids, bases, and salts that speciate (dissociate) as charged entities tend to be water-soluble and those that do not speciate (neutral and nonpolar organic compounds) tend to be insoluble, or nearly so. Solubility favors rapid uptake of chemicals by organisms, but at the same time favors rapid elimination, with the result that soluble chemicals generally do not bioaccumulate to a great extent. The soluble free ions of certain heavy metals are exceptional in that they bind with tissues and thus are actively bioaccumulated by organisms.

Stability

For chemicals to bioaccumulate, they must be stable, conservative, and resistant to degradation (although some contaminants degrade to other contaminants which do bioaccumulate). Organic compounds with structures that protect them from the catalytic action of enzymes or from nonenzymatic hydrolysis tend to bioaccumulate. Phosphate ester pesticides do not bioaccumulate because they are easily hydrolyzed. Unsubstituted polynuclear aromatic hydrocarbons (PAH) can be broken down by oxidative metabolism and subsequent conjugation with polar molecules. The presence of electron-withdrawing substituents tends to stabilize an organic molecule. Chlorines, for example, are bulky, highly electronegative atoms that tend to protect the nucleus of an organic molecule against chemical attack. Chlorinated organic compounds tend to bioaccumulate to high levels because they are easily taken up by organisms, and, once in the body, they cannot be readily broken down and eliminated.

Stereochemistry

The spatial configuration (i.e., stereochemistry) of a neutral molecule affects its tendency to bioaccumulate. Molecules that are planar tend to be more lipid-soluble (lipophilic) than do globular molecules of similar molecular weight. For neutral organic molecules, planarity can correlate with higher bioaccumulation unless the molecule is easily metabolized by an organism.

4.3 Tier I Conclusions

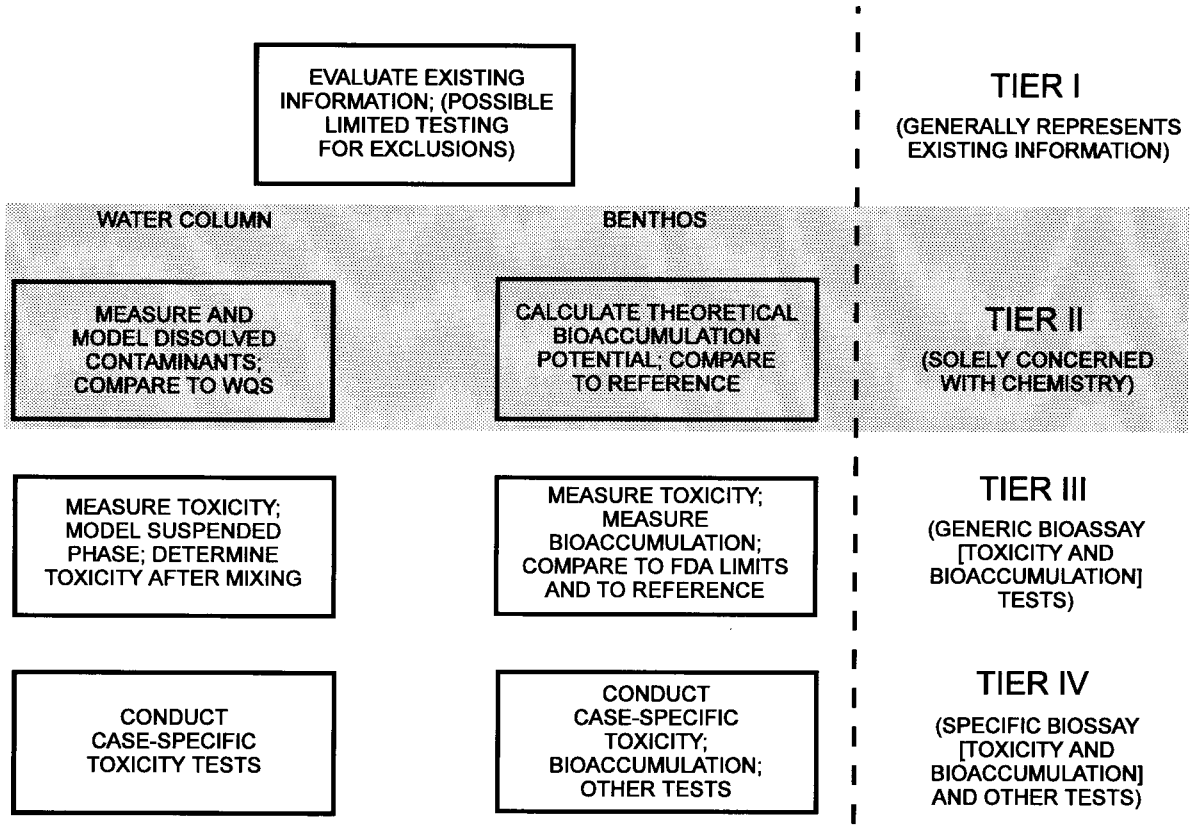
After consideration of all available information, one of the following conclusions is reached (Figure 3-1):

- Existing information does not provide a sufficient basis for making factual determinations. In this case, further evaluation in higher tiers is appropriate.

- Existing information provides a sufficient basis for making factual determinations. In this case, one of the following decisions is reached (Figure 3-1):

    - The material meets the exclusion criteria.

    - The material does not meet the exclusion criteria but information concerning the potential impact of the material is sufficient to make factual determinations.


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
(GENERALLY REPRESENTS EXISTING INFORMATION)
WATER COLUMN
BENTHOS
MEASURE AND MODEL DISSOLVED CONTAMINANTS; COMPARE TO WQS
CALCULATE THEORETICAL BIOACCUMULATION POTENTIAL; COMPARE TO REFERENCE
TIER II
(SOLELY CONCERNED WITH CHEMISTRY)
MEASURE TOXICITY; MODEL SUSPENDED PHASE; DETERMINE TOXICITY AFTER MIXING
MEASURE TOXICITY; MEASURE BIOACCUMULATION; COMPARE TO FDA LIMITS AND TO REFERENCE
TIER III
(GENERIC BIOASSAY [TOXICITY AND BIOACCUMULATION] TESTS)
CONDUCT CASE-SPECIFIC TOXICITY TESTS
CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
TIER IV
(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

5.0 TIER II EVALUATION

Tier II provides useful information through screening tools, but not all possible determinations can be reached at this tier. It consists of evaluation of State water quality standard (WQS) compliance using a numerical mixing model of the disposal site conditions (Figure 3-2 and Appendix C) and an evaluation of the potential for benthic impact using calculations of theoretical bioaccumulation potential (TBP) (Figure 3-3 and Section 10.2).

Tier II is ultimately expected to provide a reliable, rapid screen to determine potential dredged material contaminant effects. The dredged material discharge must meet applicable WQS for all contaminants of concern outside the mixing zone. Water column impact must also be evaluated by toxicity testing in Tier III (Figure 3-2) when there are contaminants of concern for which applicable WQS are not available or where interactive effects are of concern.

When national sediment quality criteria (SQC) are proposed and finalized they are expected to provide a basis for State sediment quality standards (SQS). State SQS will be incorporated into Tier II benthic impact evaluations. The incorporation of these standards into Tier II will be implemented in this testing manual and regional manuals as appropriate.

At present, only the bioaccumulation impact of nonpolar organic compounds in dredged material on benthic organisms can be evaluated in Tier II (Figure 3-3). The approved procedure calculates the TBP for a test organism by factoring the concentration of the nonpolar organic chemical(s), the total organic carbon in the sediment, and the percent lipid concentration in the organism. This calculation predicts the magnitude of bioaccumulation likely to be associated with nonpolar organic contaminants in the dredged material. Additional guidance for identifying potential bioaccumulating contaminants is provided by EPA (1994a).

5.1 Water Column Impact

Program experience (primarily in marine, near coastal and estuarine waters) has shown that in most cases the existing data are sufficient to make water column determinations. However, Tier I evaluation may show that the existing information is insufficient to make a determination. If a WQS determination cannot be made in Tier I, Tier II evaluation is necessary to determine whether the discharge complies with 230.10(b)(1) (Figure 3-2). The discharge of dredged material cannot cause the WQS to be exceeded outside the mixing zone unless the State provides a variance to the standard.

There are two approaches for the Tier II water column evaluation for WQS compliance. One approach is to use the numerical models provided in Appendix C as a screen, assuming that all of the contaminants in the dredged material are released into the water column during the disposal process. The other approach applies the same model with results from chemical analysis of the elutriate test.

5.1.1 Screen Relative To WQS

The assumption that all of the contaminants in the dredged material are completely released into the water column during the discharge operation is conservative because, in virtually all cases, most of the contaminants remain within the dredged material. If the numerical model (Appendix C) predicts that the concentrations of all contaminants of concern after consideration of mixing are less than the available, applicable WQS, the dredged material complies with WQS. If the screen/model, as applied indicates that the WQS is exceeded, the elutriate analysis approach (Section 5.1.2) should be employed.

5.1.2 Elutriate Analysis Relative To WQS

For an elutriate analysis, the numerical mixing model (Appendix C) is run with chemical data obtained from an elutriate test conducted on the dredged material. The standard elutriate analysis is described in Section 10.1.2.1 and the analytical procedures for measuring constituents in the water are provided in Section 9.4.2. The model is, in effect, using data that more accurately represent the contaminant concentrations that will be present in the water column after consideration of mixing. If the numerical model (Appendix C) predicts that the concentration of all contaminants of concern at the edge of the mixing zone is less than the available, applicable WQS, the dredged material complies with WQS. Otherwise, it does not.

5.2 Benthic Impact

The currently available Tier II procedure for evaluating potential benthic impact consists of evaluating the TBP, calculated according to the guidance in Section 10.2. A comparison is made between the TBP calculated for the nonpolar organic contaminants of concern in dredged material and for the same constituents in the reference sediment. At present, this calculation can be performed for nonpolar organic compounds, but not for polar organic compounds, organometals, or metals. If such constituents are contaminants of concern in a dredged material requiring bioaccumulation evaluation, further evaluation has to take place in Tier III.

Even if the dredged material contains other contaminants of concern than nonpolar organic contaminants, it is still useful to calculate the TBP. The TBP provides an indication of the magnitude of bioaccumulation of nonpolar organics that may be encountered in actual testing (Tiers III and/or IV). Additionally, the calculation may eliminate the need for further evaluation of nonpolar organics and thereby reduce efforts in higher tiers.

5.3 Tier II Conclusions

One of two possible conclusions is reached regarding the potential water column impact of the proposed dredged material:

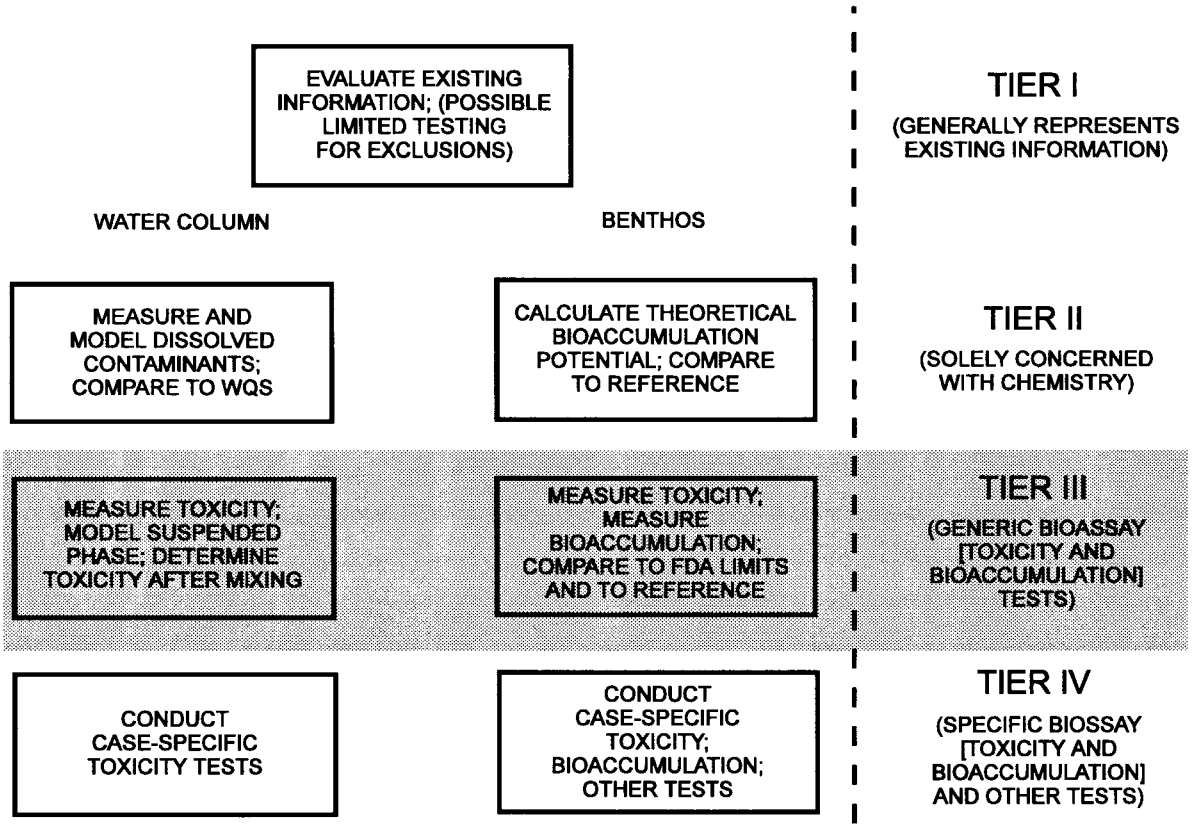
- The available WQS requirements are met. Further information on water column toxicity must be evaluated in Tier III when there are contaminants of concern for which applicable WQS are not available or where interactive effects are of concern.

- Concentrations of one or more of the dissolved contaminants of concern, after allowance for mixing, exceed available WQS beyond the boundaries of the mixing zone. In this case, the proposed discharge of dredged material does not comply with WQS.

For nonpolar organics, one of the following conclusions is reached based on comparison between the TBP for the dredged material and for the same contaminants in the reference sediment:

- The TBP for the nonpolar organic contaminants of concern in the dredged material does not exceed the TBP for the reference sediment and, therefore, the dredged material is predicted not to result in benthic bioaccumulation of the measured non-polar organic compounds. However, further evaluation of biological effects in Tier III is necessary to furnish information to make determinations under the Guidelines.

- The TBP for the nonpolar organic contaminants of concern in the dredged material exceeds the TBP for the reference sediment. In this case, the information is not sufficient to predict whether the dredged material will result in benthic bioaccumulation of the measured non-polar organic compounds, and further evaluation of bioaccumulation in Tier III is necessary to furnish information to make determinations under the Guidelines.


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
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TIER III
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CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
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(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

6.0 TIER III EVALUATION

Tier III testing assesses the impact of contaminants in the dredged material on appropriately sensitive and benchmark organisms to determine if there is the potential for an unacceptable (toxicity or bioaccumulation) impact at the disposal site. Lists of candidate test species (Sections 11 and 12: Tables 11-1 through 12-1) include consideration of: (1) appropriate sensitivity such that testing should not occur with insensitive organisms; (2) allowing appropriate Regional flexibility based on the list provided in this manual or the approved regional implementation manual; (3) providing some benchmark species for comparing (where appropriate) the sensitivity of regional species not widely used for such testing.

The Tier III assessment methods are bioassays (toxicity and bioaccumulation tests) (Figures 3-1 through 3-3). Generic guidance provided in this manual may have to be modified for specific species. Where possible and appropriate, organisms representative of the water column and benthic biota and conditions at the disposal site or the appropriate reference area should be used. Also, exposure routes must be appropriate (e.g., benthic test species must be truly benthic, that is, living on or in the sediment).

Presently, Tier III toxicity tests primarily use lethality as the endpoint. Chronic/sublethal tests for sediments are under development; none are considered to be currently suitable for wide-spread national use and hence are not included in this manual although regional use is allowed (cf. Section 11.2.3). New, appropriate benthic and water column tests, including sediment chronic/sublethal tests, will be included in future revisions of this manual as appropriate.

The recommended procedures for water-column toxicity tests (Figure 3-2) use appropriate sensitive water column organisms (Section 11.1.1, Table 11-1). The assay for benthic impact (Figure 3-3) uses deposited sediment and appropriately sensitive benthic organisms (Section 11.2.1, Table 11-2).

Bioaccumulation also has to be considered to fully evaluate potential benthic impact (Figure 3-3). The results of bioaccumulation tests are used to predict the potential for uptake of dredged-material contaminants by organisms (Kay, 1984).

Tier III information is usually sufficient for making factual determinations. Only in unusual cases is further information on toxicity or bioaccumulation (or both) necessary to make determinations under the Guidelines.

6.1 Water Column Toxicity Tests

Tier III (Figure 3-2) considers the effects on water column organisms, after allowance for mixing, of dissolved contaminants plus those associated with suspended particulates. The toxicity and mixing data results are generated as described in Section 11.1.

After considering the tests and considering mixing, one of the following conclusions is reached:

- If the 100% dredged material elutriate toxicity is not statistically higher than the dilution water (see Section 8.0, Table 8-1), the dredged material is not predicted to be acutely toxic to water column organisms.

- The concentration of dissolved plus suspended contaminants, after allowance for mixing, does not exceed 0.01 of the toxic (LC_{50} or EC_{50}) concentration beyond the boundaries of the mixing zone. Therefore the dredged material is predicted not to be acutely toxic to water column organisms. However, benthic impact has to be considered. If the information warrants, it is acceptable to determine water column effects at Tier III and benthic effects at another tier.

- The concentration of dissolved plus suspended contaminants, after allowance for mixing, exceeds 0.01 of the toxic (LC_{50} or EC_{50}) concentration beyond the boundaries of the mixing zone. Therefore, the dredged material is predicted to be acutely toxic to water column organisms.

6.2 Benthic Toxicity Tests

Evaluation of benthic (i.e., sediment) toxicity tests in Tier III (Figure 3-3) is based on data generated according to the guidance in Section 11.2. Dredged material is predicted to be acutely toxic to benthic organisms when mean test organism mortality:

- is statistically greater than in the reference sediment, and

- exceeds mortality (or other appropriate end point) in the reference sediment by at least 10% (the 10% value should be used unless a different value has been developed for specific test species and end-points for regulatory use, and is technically defensible; e.g.,

a 20% value for lethality can be used for the amphipods *Ampelisca abdita, Rhepoxynius abronius* and *Eohaustorius estuarius* (Swartz et al., 1985; Mearns et al., 1986; SAIC, 1992a,b)).

However, even if there is a certain level of toxicity (e.g., marginal mortalities for a single non-benchmark species), the preponderance of evidence could suggest that the sediment is not acutely toxic to benthic organisms. Acute toxicity testing of contaminants in the dredged material in Tier III will result in one of the following possible conclusions:

- Mortality (or other appropriate endpoint) in the dredged material is not statistically greater than in the reference sediment, or does not exceed mortality (or other appropriate endpoint) in the reference sediment by at least 10%. Therefore, the dredged material is predicted not to be acutely toxic to benthic organisms. However, bioaccumulation of contaminants also has to be considered. If the information warrants, it is acceptable to determine benthic toxicity at Tier III and bioaccumulation at another tier.

- Mortality (or other appropriate endpoint) in the dredged material is statistically greater than in the reference sediment and exceeds mortality (or other appropriate endpoint) in the reference sediment by at least 10%. In this case, the dredged material is predicted to be acutely toxic to benthic organisms.

6.3 Benthic Bioaccumulation

Body burdens of chemicals are of concern for both ecological and human health reasons. The Tier III benthic bioaccumulation tests (Section 12.1) are conducted for a subset of the contaminant of concern list based on the contaminant bioaccumulation properties discussed in Sections 4.2 and 10.2. These tests provide for the determination of bioavailability through 28-day exposure tests. For purposes of comparison with an action or tolerance level such as from Food and Drug Administration (FDA) as described below (or when conducting a Tier IV risk assessment), the duration of a bioaccumulation test should be sufficient for organisms to reach steady-state tissue residues for all compounds. However, the time to reach or approach steady-state varies among different compounds and, to a lesser extent, among species. Test designs that assure that steady-state has been attained require a large number of samples and substantial expense. As a cost-effective compromise, it is recommended that a 28 day exposure be used for the "standard" bedded sediment bioaccumulation test for neutral organics and metals.

Where it is desirable to know the steady-state concentration of neutral organic compounds as, for example, comparison to an FDA action level, fish advisory, or similar numerical values, the following procedure is recommended. The log Kow of the neutral organic compound of concern should be determined from Section 9.5.1 (Table 9-5). This should be compared with the log Kow in Figure 6-1 and will indicate the proportion of steady-state concentration (Css) expected in 28 days. This will allow estimation of the steady-state value from the 28-day laboratory exposure data through the use of a steady-state correction factor. The correction factor is the reciprocal of the decimal fraction indicating the proportion of Css expected in 28 days.

Bioaccumulation of most compounds, if it occurs, will be detectable after the 28-day exposure period, even though steady state may not have been reached. Thus, Tier III bioaccumulation tests provide useful information about the potential for bioaccumulation (i.e., bioavailability), even when steady-state tissue residues are not determined, e.g. when comparing to a reference sediment.

Concentrations of contaminants of concern in tissues of benthic organisms following dredged material exposure are compared to applicable Food and Drug Administration (FDA) Action or Tolerance Levels for Poisonous or Deleterious Substances in Fish and Shellfish for Human Food, when such levels (i.e., limits) have been set for the contaminants. The FDA levels (Table 6-1) are based on human-health as well as economic considerations (21 CFR 109 and 509), but do not indicate the potential for environmental impact on the contaminated organisms or the potential for biomagnification. Because contamination of food in excess of FDA levels is considered a threat to human health, EPA and USACE consider concentrations in excess of such levels in any test species to be predictive of benthic bioaccumulation of contaminants. This guidance applies even though the test species may not be a typical human food item partly because certain contaminants can be transferred through aquatic food webs, but mainly because uptake to FDA levels in relatively short term tests with one species may indicate the potential for accumulation in other species.

Based on tissue comparisons with FDA levels, one of the following conclusions is reached:

- Tissue concentrations of one or more contaminants are not statistically less than the FDA levels. Therefore, the dredged material is predicted to result in benthic bioaccumulation of contaminants.

- Tissue concentrations of all contaminants either are statistically less than FDA levels or there are no FDA levels for the contaminants. In this case, the information is insufficient to reach a conclusion with respect to benthic bioaccumulation of contaminants. The

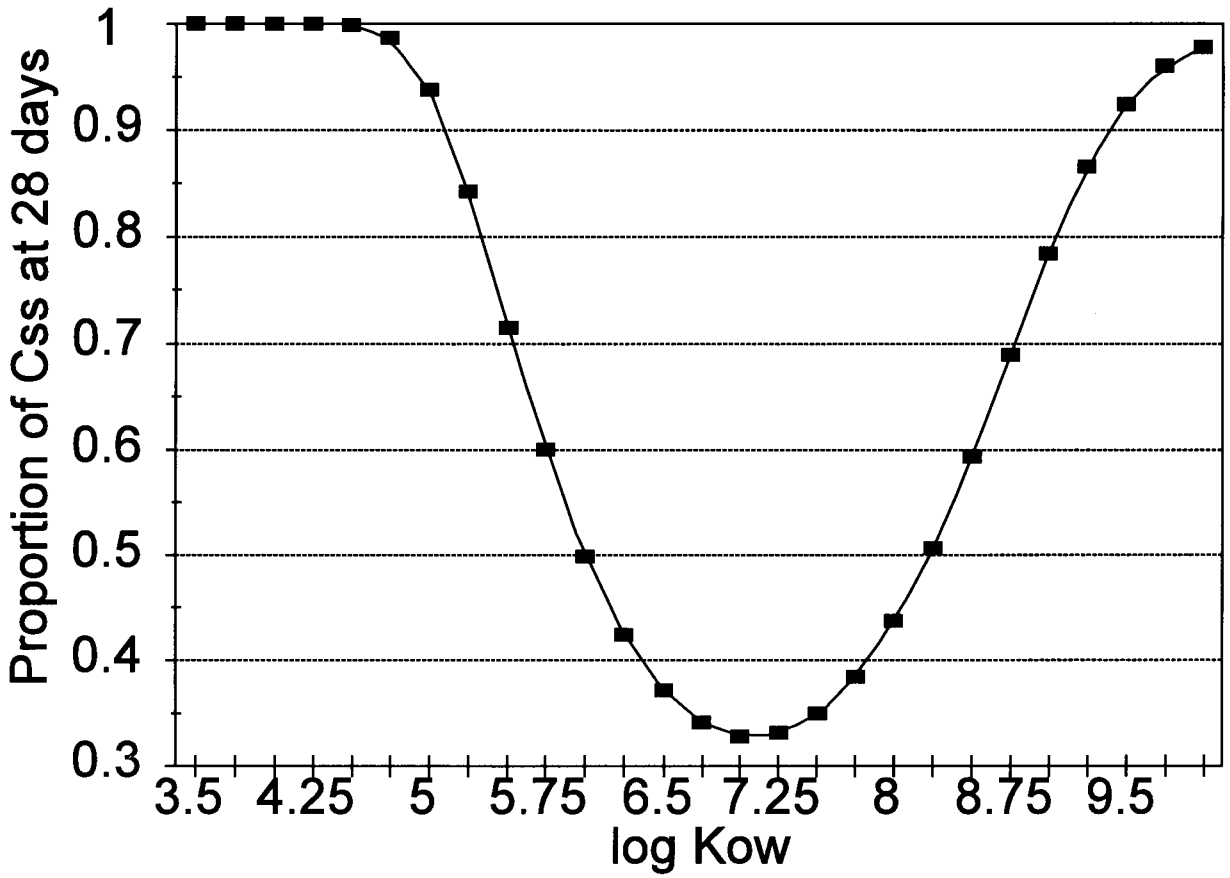


Figure 6-1. Expected proportion of steady-state concentration (Css) of neutral organic compounds reached in 28-day laboratory exposures. The proportion is a function of the log Kow of the compound of interest. Consult Section 9.5.1 (Table 9-5) for appropriate log Kow values. Figure adapted from McFarland (1994).

Table 6-1. Food and Drug Administration (FDA) Action Levels for Poisonous and Deleterious Substances in Fish and Shellfish for Human Food.[a]

Substance	Action Level[b]
Metals	
Methyl Mercury	1.0 ppm
Pesticides	
Chlordane	0.3 ppm
Chlordecone (Kepone)	0.3 ppm
DDT + DDE	5.0 ppm
Dieldrin + Aldrin	0.3 ppm
Heptachlor + Heptachlor Epoxide	0.3 ppm
Mirex	0.1 ppm
Industrial Chemicals	
PCBs[c]	(2.0 ppm)

[a] Action levels are established, revised, and revoked through notices published in the Federal Register. It is the responsibility of the users of the list to keep up to date on any amendments to this list. For further information on current action levels, users may contact the Food and Drug Administration, Center for Food Safety and Applied Nutrition, Industry Programs Branch [HFF-326, 200 C Street, S.W., Washington, DC 10204; (202) 205-5251].

[b] Action levels are reported in wet weight.

[c] There is no FDA action level for PCBs as a tolerance level has now been established (21 CFR part 109.30), which is equal to the previous action level.

dredged material needs to be further evaluated in Tier III as described below for bioaccumulation potential to furnish information to make determinations under the Guidelines.

Tissue contaminant concentrations following exposure to dredged material which are statistically less than FDA levels, or for which there are no such levels, are compared to tissue contaminant concentrations for organisms similarly exposed to reference sediment. One of the following conclusions is reached based on this comparison:

- Tissue concentrations of contaminants of concern in organisms exposed to dredged material do not statistically exceed those of organisms exposed to the reference sediment; therefore, the dredged material is predicted not to result in benthic bioaccumulation of contaminants. However, benthic toxicity effects also have to be considered.

- Tissue concentrations of contaminants of concern in organisms exposed to dredged material statistically exceed those of organisms exposed to the reference material. In this case, the final conclusion regarding benthic bioaccumulation of contaminants would be based upon technical evaluations that emphasize the various factors deemed appropriate in a particular region (see last paragraph in this section). Additional testing (Tier IV) may be required.

One other possibility exists: tissue concentrations are above FDA limits but are not statistically different from the reference (or disposal) site. This situation represents an exceptional case which can only be dealt with at the regional level.

The above comparisons to FDA values address human health concerns, and follow from EPA/USACE (1991). Other approaches which should be considered in addition to the use of FDA values include comparisons to state fish advisories, cancer and non-cancer risk models, existing ambient fish concentration data. State fish advisories exist for the following chemicals for which EPA risk-based screening values are being developed: (carcinogens) chlordane, DDT, dieldrin, hexachlorobenzene, lindane, toxaphene, PAH, PCBs, 2,3,7,8-TCDD; (noncarcinogens) endosulfan, mirex, cadmium, mercury, selenium, endrin. Methods to calculate carcinogenic and non-carcinogenic health risks are summarized in EPA (1989a). "Computerized Risk and Bioaccumulation System", an expert system for PC computers, is available to predict tissue residues in sediment-dwelling shellfish and the associated excess cancer risk (Lee et al., 1990). Note that this program does not calculate risks associated with mobile invertebrates or fishes, and that it should be used only to supplement data derived from other methods.

Reference comparisons are made for the protection of aquatic life as well as human health because bioaccumulation is both undesirable and an indicator of bioavailability (Figure 3-3). It is recognized that residue effects information does not exist to fully interpret bioaccumulation data; the approach followed in this manual is the best presently available.

When the bioaccumulation of contaminants in dredged-material tests statistically exceeds that in reference-material tests, five factors should be assessed. Where available, regional guidance should be consulted regarding the relative importance of these factors:

- What is the toxicological importance of the contaminants (e.g., Do they biomagnify? Do they have effects at low concentrations?) whose bioaccumulation from the dredged material statistically exceeds that from the reference material?

- By what magnitude does bioaccumulation from the dredged material exceed bioaccumulation from the reference material?

- What is the propensity for the contaminants with statistically significant bioaccumulation to biomagnify within aquatic food webs (Kay, 1984)? Contaminants which biomagnify appear to be few in number but widespread, and include DDT, PCB, methylmercury and, possibly, dioxins and furans.

- What is the magnitude by which contaminants whose bioaccumulation from the dredged material exceeds that from the reference material also exceeds the concentrations found in comparable species living in the vicinity of the proposed disposal site?

- For how many contaminants is bioaccumulation from the dredged material statistically greater than bioaccumulation from the reference material?

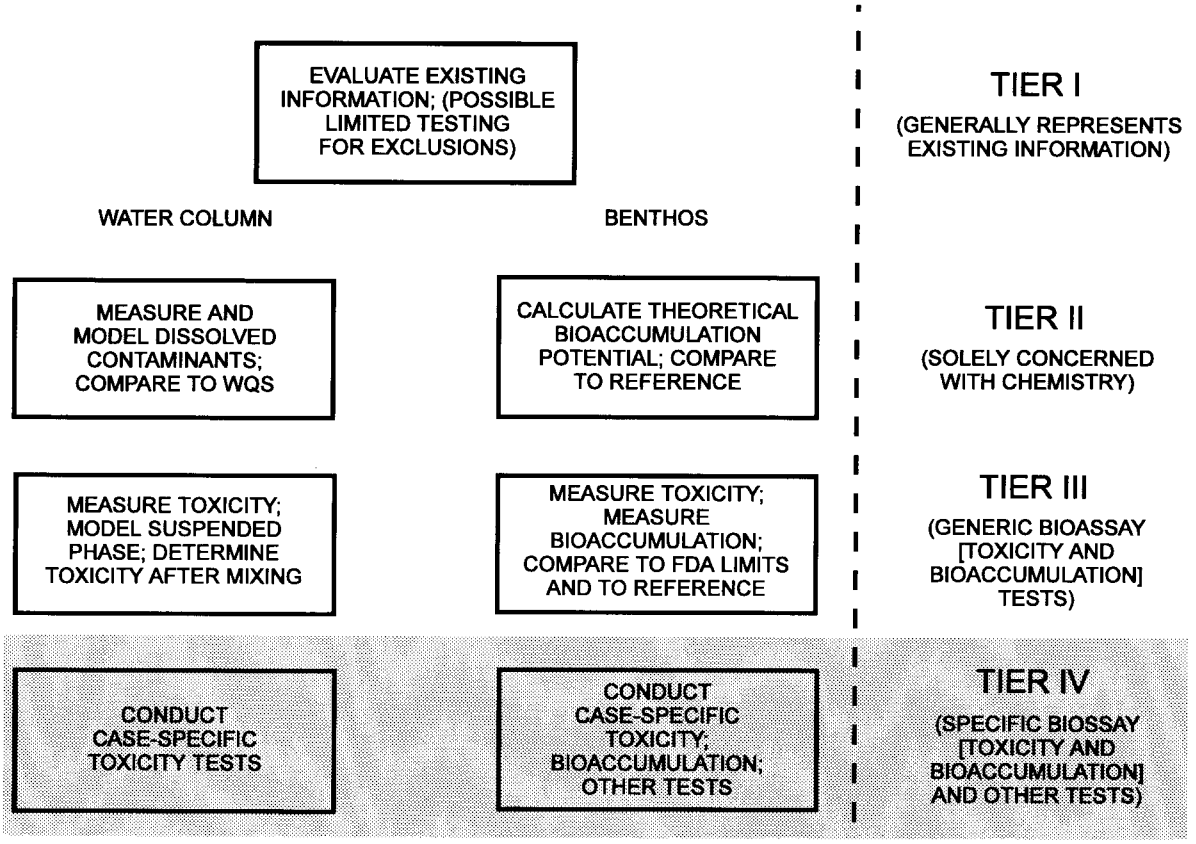
6.4 Tier III Conclusions

The above five factors and perhaps other factors are complexly interrelated; i.e., the importance of each factor depends on its interaction with all other factors. These factors have to be considered in case-specific determinations (if needed) for dredged material assessed for bioaccumulation in the final step of Tier III. After considering these factors, one of the following Tier III conclusions is reached:

- Discharge of the dredged material is predicted not to result in above-reference toxicity or benthic bioaccumulation of contaminants.

- Discharge of the dredged material is predicted to result in above-reference toxicity or bioaccumulation of contaminants.

- Further information is needed to make factual determinations, specifically in Tier IV.


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
(GENERALLY REPRESENTS EXISTING INFORMATION)
WATER COLUMN
BENTHOS
MEASURE AND MODEL DISSOLVED CONTAMINANTS; COMPARE TO WQS
CALCULATE THEORETICAL BIOACCUMULATION POTENTIAL; COMPARE TO REFERENCE
TIER II
(SOLELY CONCERNED WITH CHEMISTRY)
MEASURE TOXICITY; MODEL SUSPENDED PHASE; DETERMINE TOXICITY AFTER MIXING
MEASURE TOXICITY; MEASURE BIOACCUMULATION; COMPARE TO FDA LIMITS AND TO REFERENCE
TIER III
(GENERIC BIOASSAY [TOXICITY AND BIOACCUMULATION] TESTS)
CONDUCT CASE-SPECIFIC TOXICITY TESTS
CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
TIER IV
(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

7.0 TIER IV EVALUATION

Tier IV involves case-specific, state-of-the-art testing for toxicity and/or bioaccumulation and is to be used on a case-by-case basis only when lower tiered testing is judged to be insufficient to make complete factual determinations. Insufficient information for a determination may include: inability to reach a clear conclusion based on existing data; statistical differences are inconclusive; evidence is conflicting. Experience to date suggests that Tier IV should only be used in a very few cases. When methods are suitable for wide-spread national use, sediment chronic/sublethal testing will be part of Tier III. Until such time as sediment chronic/sublethal tests are approved for national use in Tier III, they should only be used in Tier IV. However, regional testing manuals may apply appropriate sediment chronic/sublethal tests in Tier III in advance of their inclusion in this national manual provided this is done with a benchmark species (Section 11.2.1) or *in addition to* the testing presently required in Tier III.

Tier IV tests may be conducted for water column evaluations (Figure 3-2) or benthic evaluations (Figure 3-3). In both cases, tests should be carefully selected to address the specific issues relevant to the case in question. Tier IV can further consider human and ecological health concerns, including risk assessment. Case-specific evaluative criteria for Tier IV tests must be:

- agreed upon by EPA and USACE and, where appropriate, the State
- adequate to make factual determinations.

7.1 Toxicity Tests

Tier IV toxicity tests (Figure 3-2) should measure end-points of clear ecological importance, for example survival, growth and reproduction. Differences from Tier III tests may include:

- longer duration of exposure
- different species
- different end-points
- exposure in the disposal site environs.

Toxicity determinations in this tier can involve laboratory or field testing or field assessments of resident benthic communities. Field assessments can be difficult to interpret but can yield valuable information on responses of resident organisms to in-place contaminants at the dredging site as compared to a disposal site or site environs as appropriate.

Toxicity identification evaluation procedures (e.g., Ankley et al., 1992a) can also be used in this tier. Such procedures can be applied to sediments when ammonia or hydrogen sulfide could be responsible for toxicity.

7.2 Benthic Bioaccumulation

Tier IV bioaccumulation tests (Figure 3-3) differ from Tier III tests in that steady-state tissue concentrations of contaminants of concern are always determined. Such determinations can be made by: longer laboratory exposures than used in Tier III, collecting tissue samples from the field (Section 12.2.2), or *in situ* exposures using transplanted organisms.

Tissue concentrations determined in Tier IV are subject to the same comparisons as in Tier III, specifically to FDA action limits, and to comparisons with organisms exposed to reference sediment. Conclusions possible from such comparisons and evaluative factors which should be assessed are detailed in Section 6.3 and can include risk assessments and no effects levels for aquatic life, rather than solely the first two comparisons.

Prediction of the movement of contaminants from sediment into and through pelagic food webs is technically challenging and should only be dealt with if a Tier IV evaluation is necessary. One approach is bioenergetic-based toxicokinetic modeling. These models have been successfully applied to marine (Connolly and Tonelli, 1985) and freshwater (Norstrom et al., 1976) fishes, theoretical food chains (Thomann, 1989), and more recently to sediment organisms (Boese et al., 1990). These models are very data intensive to apply on a chemical and site-specific basis. It is possible to use values determined through QSAR (EPA, 1994a), though the default values may substantially overestimate tissue residues in metabolizable compounds, such as PAH. Another general approach is to bracket likely concentrations of specific contaminants at different trophic levels based on an empirical model derived from a variety of marine food webs (Young, 1988).

PART III - SAMPLING AND ANALYSIS

8.0 SAMPLING

When testing is necessary, samples of dredged material, reference sediment, control sediment, organisms, and water will be needed for physical evaluations, chemical analysis, and for bioassay tests. This section provides general guidance for the development of a sampling plan including collection, handling and storage.

Sampling is the foundation upon which all testing rests but there are so many case-specific factors that influence sampling needs that detailed guidance of National scope is impractical. Some regions of the country have developed specific technical requirements and agency review/approvals of sampling and analysis plans. Regional guidance from local EPA and USACE offices should be sought for developing project-specific sampling plans as for information gathered at Tier I. The type of samples that may be required to complete the evaluations of Tiers II, III, and IV are outlined in Table 8-1. This manual provides general guidance on items of major importance to consider when designing a sampling plan. Additional guidance is provided by EPA (1995).

8.1 Preparation For Sampling

A well-designed sampling plan is essential when evaluating the potential impact of dredged material discharge upon the aquatic environment. Before any sampling is initiated, the sampling plan has to be tailored to meet clearly defined objectives for individual dredging operations. Factors such as the availability and content of historical data, the degree of sediment heterogeneity, the dredging depth, the number and geographical distribution of sample-collection sites, the procedures for collection, preservation, storage, and tracking of samples, and the necessity for adequate quality assurance and quality control (Appendix G; EPA, 1995) must be carefully considered. The magnitude of the dredging operation and its time and budgetary constraints should also be considered.

It is recommended that a written plan for sediment sampling and analyses be prepared and provided to the appropriate Federal and State agencies for coordination prior to sampling, where practicable. The Tier I evaluation would be a logical attachment to the sampling and analysis plan for agency review and comment. This coordination can reduce the chance of having to repeat costly procedures and can assist in keeping projects on schedule. An adequate amount of sediment and water should be collected to conduct planned evaluations and allow for any contingencies. Maximum allowable and recommended sample and organism holding times as well as the exigencies of resampling should be given careful consideration.

Table 8-1. Type of Samples Which May Be Required Following Tier I to Conduct Dredged-Material Evaluation Tests. Actual sampling requirements are project-specific and are determined during the development of the project plan. Sampling from the disposal site may also be conducted as necessary and appropriate, to verify the applicability of exclusion 230.60 (C) (see Sections 4.0 and 9.1.)

Tests	Water Samples			Sediment Samples			Biota Samples	
	Disposal Site	Dredging Site	Control[a]	Dredging Site	Reference Site	Control[a]	Dredging Site	Reference Site
Tier II								
Water column								
Screen	●[c]			●				
Elutriate	●[c]	●		●				
Tier II								
Benthic				●	●			
Tier III								
Water column	●[b]	●	●	●				
Tier III								
Benthic				●	●	●		
Tier IV								
Water column	●	●	●	●			●	●
Tier IV								
Benthic				●	●	●	●	●

[a]May or may not have to be field-collected.

[b]Dilution water for water column toxicity tests. Artificial or clean seawater or clean freshwater may also be used.

[c]Disposal site water is required for WQS comparison. Elutriate samples are prepared with dredging site water.

The importance of sampling is underscored by the fact that any evaluation is only as complete and reliable as the sampling (and sample handling and storage) upon which it is based. Thus, inadequacies or biases in sampling will limit the accuracy and/or the usefulness of the study results.

The primary objective of sediment and water collection is to obtain samples to adequately and accurately characterize the dredging and reference area. Sample size should be large enough to attain the appropriate detection limits but small enough to be conveniently handled and transported within the requirements for all planned analyses. The quality of the information obtained through the testing process is impacted by the following four factors:

- collecting representative samples
- collecting an appropriate number of samples
- using appropriate sampling techniques
- protecting or preserving the samples until they are tested.

Ideally, the importance of each of these three factors will be fully understood and appropriately implemented. In practice, however, this is not always the case. There may be occasions when study needs, time, costs or other resource constraints will limit the amount of information that should or can be gathered. When this is the case, the relative importance of each of these factors has to be carefully considered in light of the specific study purposes.

An important component of any field sampling program is a preproject meeting with all concerned personnel. Personnel involved may include management, field personnel, laboratory personnel, data management/analysis personnel, and representatives of regulatory agencies, the permit applicant, and the dredging company. To assure sampling quality, at least one individual familiar with the study area should be included in the preproject meeting. The purposes of the meeting include:

- defining the objectives of the sampling program
- ensuring communication among participating groups
- ensuring agreement on methods, QA/QC details and contingency plans.

The more explicitly the objectives of a testing program can be stated, the easier it will be to design an appropriate sampling plan. A complete sampling plan will result in a level of detail such that all sampling procedures and locations are clearly defined, sample volumes are clearly established, all logistical concerns are fully addressed, and target analytes are identified to class of compound.

8.2 Components Of A Sampling Plan

The following steps will help to ensure that all essential sampling plan information is provided:

- Review the plan for the proposed dredging operation, including the dimensions of the dredging area, the dredging depth(s), side-slopes, the volume of sediment for disposal, and the type of dredge equipment (e.g., clamshell, hydraulic) for determining composite sampling or delineating representative project segments.
- Evaluate the prior history and the existing database for the area, in particular, information gathered in Tier I. Identify relevant data and the need for additional data. Identify areas of potential environmental concern within the confines of the dredging operation.
- If appropriate, subdivide the dredging area into project segments on the basis of an assessment of level of environmental concern within the dredging area. This may be an iterative process that starts before sampling, using available information, and that is refined after sampling, based on new data.
- Determine the number of samples to be collected and select sampling locations. Choose methods and equipment for positioning vessels at established stations.
- Determine what sampling methods will be used.
- Define procedures for sample handling, preservation, storage, and (if applicable) field or shipboard analysis.
- Identify logistical considerations and safety precautions.

The subsections that follow discuss each of these steps and provide general guidance for their conduct. An essential step, preparation of a quality assurance/quality control (QA/QC) project plan, is discussed in detail in Appendix G and EPA (1995) and must be integral to the project. The QA/QC plan is essential to ensure that there will be sufficient and appropriate data of known and documented quality to make decisions with confidence and to defend those decisions. Properly prepared, a QA/QC plan expedites project coordination.

8.2.1 Review of Dredging Plan

A review of the plan for the dredging operation provides a basis for determining the sampling strategy. The volume of material to be dredged and the method of dredging are two important factors which will help to determine the number of samples required. The number of samples required is generally a judgement which considers the cost, resolution, and the risk of an incorrect decision regarding the volume of material to be dredged. Knowledge of the depth and physical characteristics of the material to be

dredged will help to determine the kind of sampling equipment that is required. The boundaries of the dredging area have to be known to ensure that the number and location of samples are appropriate. Sampling should generally be to the project depth (including overdredging) unless the sediments are known to be vertically homogeneous.

8.2.2 Historical Data

All information relevant to the dredging site should be reviewed. Using pertinent available information to determine project segments and station locations within the dredging area is both cost and technically effective. If a review of historical data identifies possible sources of contamination, skewing the sampling effort toward these areas may be justified for thorough characterization of these areas, but can lead to an incomplete assessment of contamination in the whole area. In areas of unequally distributed contamination, the total sampling effort should be increased to ensure representative, but not necessarily equal, sampling of the entire site. Sediment sampling techniques are detailed in Mudroch and MacKnight (1991). The information gathered for the Tier I evaluation (discussed in Section 4.1) should be reviewed for assistance in designing the sampling plan, in particular the following:

- **Geotechnical and hydrodynamic data**
  The grain size, specific gravity, water or solids content, total organic carbon (TOC) and identification of sediment horizons are helpful in making operational decisions. Areas of high currents and high wave energy tend to have larger grain-sized sediments than do quieter areas. Many contaminants have a greater affinity for clay and silt than for sand. Horizontal and vertical gradients may exist within the sediment. Local groundwater quality and movement should be determined if groundwater is a potential source of contamination.

- **Quality and age of available data**
  The value of the available data should be critically weighed. Existing high-quality data might lower costs by reducing the number of analytes measured or tests required for the proposed dredging operation. Existing data that do not meet all quality assurance/quality control (QA/QC) standards may still be useful if appropriate calibration and documentation are available; they are less useful if older methods with higher detection limits were used. Information from such studies might be helpful in identifying areas of contamination, but not in accurately assessing the degree of contamination.

- **Known distribution of contaminants**
  All evidence regarding contaminants within or near the dredging area, including spill data, may be an important consideration in identifying locations for sampling and/or determining sampling intensity.

- **Dredging history**
  Knowledge of prior dredging may dramatically affect sampling plans. If the area is frequently dredged (every 1-2 years) or if the sediments are subject to frequent mixing by wave action, currents, or ship traffic, the sediments are likely to be relatively homogeneous. Assuming that there is no major contaminant input, the sampling effort may be minimal. However, if there is information regarding possible contamination or heterogeneity is possible, a more extensive sampling effort may be indicated. New excavations of material unaffected by anthropogenic input may require less intensive sampling than maintenance dredging.

8.2.3 Subdivision of Dredging Area

Sediment characteristics are likely to vary substantially within the limits of the area to be dredged as a result of geographical and hydrological features. Areas of low hydrodynamic energy will be characterized by fine sediments that have a greater tendency to accumulate contaminants than do coarser-grained sediments. (However note that contaminants, if present in coarse-grained sediments, may be more bioavailable than if present in fine-grained sediments). Sediments in and downstream of heavily urbanized or industrialized areas are more likely to accumulate contaminants than sediments farther removed from direct contaminant input.

Many dredging operations can be subdivided into project segments (horizontal and/or vertical) which can be treated as separate management units. A project segment is an area expected to have relatively consistent characteristics that differ substantially from the characteristics of adjacent segments. Project segments may be sampled with various intensities and, if warranted by the study objectives and test results, the dredged material from various project segments can be managed differently during dredging and disposal to limit environmental impact. When the sampling plan is developed, project segments can be designated, based on factors including but not limited to: historical data, sediment characteristics, geographical configuration, anticipated method of dredging, depth of cut, sampling- or dredging-equipment limitations, results of pilot studies, and known or suspected contaminant concentrations. Surface sediments might be considered separately from subsurface sediments at the same location if vertical stratification of contamination is expected or encountered. Large dredging operations located

within industrialized areas might require subdivision into several project segments horizontally and into one or more segments vertically. A dredging operation characterized by relatively uniform distribution of sediment type in a nonindustrialized location might be considered as a single project segment. Vertical subdivisions usually are not appropriate in areas of rapid shoaling or in areas of high sediment mixing by ship scour, which are likely to be relatively homogenous vertically. Vertical subdivisions smaller than about 1 m are usually impractical because dredge operators generally cannot reliably control excavation with any finer precision; vertical subdivisions should reflect the actual removal precision to be employed during the dredging operation. If analytical data and test results for two or more project segments prove to be similar, these segments may be treated as one larger segment when considering disposal options. If the analytical and test results demonstrate important differences between project segments, alternative disposal options may be necessary for portions of the total sediment volume.

Any established sampling program should be sufficiently flexible to allow changes based on field observations; however, any deviations from the sampling plan must be documented, along with the rationale for such deviations. Certain characteristics of the sediments, such as color or texture, can be an indication of patchiness. The greater the patchiness, the larger the number of samples that will be required to adequately characterize the area. The project manager can refine a sampling program based on historical data and/or a preliminary sampling survey of the dredging area.

8.2.4 Selection of Sampling Locations and Number of Samples

Generally a single sampling strategy will be adequate for most circumstances. However, in some cases, two sampling strategies may be required. For instance, when sampling involves both uncontaminated and highly contaminated sediments with interfaces between the two, a single sampling strategy may not be sufficient to adequately characterize these sediments, which will probably be treated differently.

The method of dredging, the volume of sediment to be removed, the areal extent of the dredging project, and the horizontal and vertical heterogeneity of the sediment are key to determining station locations and the number of samples to be collected for the total dredging operation and for each project segment. When appropriate to testing objectives, samples may be composited prior to analysis (with attention to the discussion later in this section). The appropriate number of samples and the proper use of compositing should be determined for each operation on a case-by-case basis. Note that the following detailed discussion is not appropriate to all dredging operations. Sampling a number of small, isolated shoals is very different than sampling a large, contiguous open area.

Factors to Consider:

The following factors, many of which follow from information gathered in Tier I, should be among those considered in sampling station and pattern selection:

- objectives of the testing program
- bathymetry
- area of the dredging project
- accessibility
- flows (currents, tides)
- mixing (hydrology)
- sediment heterogeneity
- contaminant source locations
- land use activities
- available resources
- other physical characteristics.

Station Locations:

Station locations within the dredging area should include locations downstream from major point sources and in quiescent areas, such as turning basins, side channels, and inside channel bends, where fine-grained sediments are most likely to settle. Characteristics which help to define the representativeness of station(s) within a segment include:

- The distribution of sediments to be dredged is clearly defined.
- The project segment being sampled is clearly defined.
- The sampling locations are distributed appropriately within each project segment.
- Multiple samples should be collected if sample variability is suspected.
- When sediment variability is unknown, it may be necessary to conduct a preliminary survey of the dredging area to better define the final sampling program.

Sample Replication:

Within a station, samples may be collected for replicate testing. For this manual, laboratory replicates are generally recommended as opposed to field replicates, depending on site-specific issues. The former (subsamples of a composite sample of the replicates) involves pseudo-replication compared to separate samples for each replicate, but is more appropriate for dredged material evaluations where sediments will

be homogenized by the dredging and discharge process. The latter involves true replication but is more appropriate for field investigations of the extent and degree (or not) of homogeneity of sediment toxicity.

Depth Considerations:

Sediment composition can vary vertically as well as horizontally. Samples should be collected over the entire dredging depth (including over-dredging), unless the sediments are known to be vertically homogeneous or there are adequate data to demonstrate that contamination does not extend throughout the depth to be excavated. Separate analyses of defined sediment horizons may be useful to determine the vertical distribution of contamination if warranted by the study objectives. A major consideration of vertical compositing is the anticipated depth of dredging. For example, even though sediments in a 1 m shoal may vary in composition, the material would be mixed as a result of the dredging process.

Sampling Bias:

Ideally, the composition of an area and the composition of the samples obtained from that area will be the same. However, in practice, there often are differences due to bias in the sampling program, including disproportionate intensity of sampling in different parts of the dredging area and equipment limitations.

In some cases, to minimize bias, it may be useful to develop a sampling grid for each project segment. The horizontal dimensions of each project segment may be subdivided into grid cells of equal size, which are numbered sequentially. Cells are then selected for sampling either randomly or in an stratified random manner. It can be important to collect more than the minimum number of samples required, especially in areas suspected of having high or highly variable contamination. In some cases, although additional costs and logistic considerations will apply, extra samples may be archived (for long time periods in the case of physical characterization or chemical analyses and for short time periods in the case of biological tests), should reexamination of particular project segment(s) be warranted.

In other cases, a sampling grid may not be desirable. This is particularly the case where dredging sites are not continuous open areas, but are rather a series of separate humps, bumps, reaches and pockets with varying depths and surface areas. In these latter cases, sample distribution is commonly biased with intent.

Level of Effort:

In some cases, it may be advisable to consider varying the level of sampling effort. Project segments suspected or known to be contaminated may be targeted for an increased level of effort so that the

boundaries and characteristics of the contamination can be identified. A weighting approach can be applied whereby project segments are ranked in increasing order of concern, and level of concern can then be used as a factor when determining the number of samples within each project segment relative to other project segments.

Number of Samples:

In general, the number of samples that should be collected within each project segment is inversely proportional to the amount of known information, and is proportional to the level of confidence that is desired in the results and the suspected level of contamination. No specific guidance can be provided, but the following factors should be considered:

- the greater the number of samples collected, the better the areal and/or vertical definition
- single measurements are inadequate to describe variability
- the means of several measurements at each station within a project segment generally are less variable than individual measurements at each station.

Time and Funding Constraints:

In all cases, the ultimate objective is to obtain sufficient information to evaluate the environmental impact of a dredged material disposal operation. The realities of time and funding constraints have to be recognized, although such do not justify inadequate environmental evaluation. Possible responses to cost constraints have been discussed by Higgins (1988). If the original sampling design does not seem to fit time or funding constraints, several options are available, all of which increase the risk of an incorrect determination:

- Reduce the number of project segments into which the project is divided, but maintain the same total number of samples.
- Maintain (or even increase) the number of stations sampled, and composite multiple samples from within a project segment so that a lower number of analyses are performed per project segment.

Project Segments:

Regardless of the final decision on project segments and the number of sample stations and replicates per project segment, expected or known degree of contamination will be the dominant factor in initially describing the proposed project segments. If variation in potential dredged material impact within a project segment is likely, where possible it may be advisable either to use a stratified random-sampling approach or to redefine project-segment boundaries. Once sampling data are available, it is advisable to reconsider the boundaries of the project segments to be used in the actual dredging in order to maximize homogeneity within segments.

Sample Compositing:

The objective of obtaining an accurate representation and definition of the dredging area and method has to be satisfied when compositing samples. Compositing provides a way to control cost while still analyzing sediments from a large number of stations. Compositing results in a less detailed description of variability within the area sampled than would individual analysis at each station. However if, for example, five analyses can be performed to characterize a project segment, the increased coverage afforded by collecting 15 individual samples and combining sets of three into five composite samples for analysis may justify the increased time and cost of collecting the extra 10 samples. Compositing can also provide the large sample volumes required for some biological tests. Composite samples represent the "average" of the characteristics of the individual samples making up the composite and are generally appropriate for logistic and other reasons; however, composite samples which serve to "dilute" a highly toxic but localized sediment "hot spot" are not recommended. Further, composite samples are not recommended for stations with very different sediment grain size characteristics.

Sample Definition:

When a sediment sample is collected, a decision has to be made as to whether the entire sediment volume is to be considered as the sample or whether the sediment volume represents separate samples. For instance, based on observed stratification, the top 1 m of a core might be considered to be a separate sample from the remainder of the core. After the sediment to be considered as a sample is identified, it should be thoroughly homogenized. Samples may be split before compositing, with a portion of the original sediment archived for possible later analysis, and the remainder combined with parts of other samples. These are then thoroughly homogenized (using clean instruments until color and textural homogeneity are achieved), producing the composite sample.

8.2.5 Sample Collection Methods

Sample collection requires an adequately trained crew, an adequate vessel equipped with navigational and supporting equipment appropriate to the site and the study, and noncontaminating sampling apparatus capable of obtaining representative samples. Divers may also be used in some cases to collect some samples; in such cases divers must be certified and approved diver safety management plans must be in place. To assure sampling quality, at least one individual familiar with the study area should be present during the sampling activities. Sampling effort for a proposed dredging operation is primarily oriented toward collection of sediment samples for physical and chemical characterization and for biological tests. Collection of water samples is also required to evaluate potential water column impact. Collection of organisms near the disposal site might be necessary if there is a need to characterize indigenous populations or to assess concentrations of contaminants in tissues. Organisms for use in toxicity and bioaccumulation tests may also be field-collected.

In general, a hierarchy for sample collection should be established to prevent contamination from the previous sample, especially when using the same sampling apparatus to collect samples for different analyses. Where possible, the known, or expected, least contaminated stations should be sampled first. At a station where water and sediment are to be collected, water samples should be collected prior to sediment samples. The vessel should ideally be positioned downwind or downcurrent of the sampling device. When raising or lowering sampling devices, care should be taken to avoid visible surface slicks and the vessel's exhaust. The deck and sample handling area should be kept clean to help reduce the possibility of contamination.

8.2.5.1 Sediment Sample Collection

Mudroch and MacKnight (1991) provide useful reference information. Higgins and Lee (1987) provide a perspective on sediment collection and analysis as commonly practiced in USACE Districts. ASTM (1994a) and Burton (1991) provide guidelines for collecting sediments for toxicological testing. Guidance provided in these publications may be followed on all points that do not conflict with this manual.

Care should be taken to avoid contamination of sediment samples during collection and handling. A detailed procedure for handling sampling equipment and sample containers should be clearly stated in the sampling plan associated with a specific project. This may be accomplished by using standard operating procedures (SOPs). For example, samples designated for trace metal analysis should not come into contact with metal surfaces (except stainless steel, unless specifically prohibited for a project), and samples designated for organic analysis should not come into contact with plastic surfaces. Samples for

biological tests may be stored in clean polypropylene containers. Subsamples for particular groups of analytes may be removed from areas of the sample not in physical contact with the collecting instrument.

A coring device with appropriate liners is recommended whenever sampling to depth is required. The choice of corer design depends upon factors including the objectives of the sampling program, sediment volumes required for testing, sediment type, water depth, sediment depth, and currents or tides. A gravity corer may be limited to cores of 1-2 m in depth, depending upon sediment grain size, degree of sediment compactness, and velocity of the drop. For penetration greater than 2 m, a vibratory corer or a piston corer is generally preferable. These types of coring devices are generally limited to soft, unconsolidated sediments. A split-spoon core may be used for more compacted sediment. The length of core that can be collected is usually limited to 10 core diameters in sand substrate and 20 core diameters in clay substrate. Longer cores can be obtained, but substantial sample disturbance results from internal friction between the sample and the core liner.

Freefall cores can cause compaction of the vertical structure of sediment samples. Therefore, if the vertical stratification in a core sample is of interest, a piston or vibra corer should be used. Piston corers use both gravity and hydrostatic pressure. As the cutting edge penetrates the sediments, an internal piston remains at the level of the sediment/water interface, preventing sediment compression and overcoming internal friction. A vibra corer is a more complex piece of equipment but is capable of obtaining 3- to 7-m cores in a wide range of sediment types by vibrating a large diameter core barrel through the sediment column with little compaction. If the samples will not be sectioned prior to analysis, compaction is not a problem, and noncontaminating freefall corers are a suitable alternative.

Corers are the samplers of preference in most cases because of the variation in contamination with depth that can occur in sediment deposits. Substantial variation with depth is less likely in shallow channel areas without major direct contaminant inputs, that have frequent ship traffic, and from which sediments are dredged at short intervals. Generally, in these situations, accumulating sediments are resuspended and mixed semicontinuously by ship scour and turbulence, effectively preventing stratification. In such cases, surface grab samples can be representative of the mixed sediment column, and corers should be necessary only if excavation of infrequently disturbed sediments below the mixed layer is planned.

Grab samplers are also appropriate for collecting surficial samples of reference or control sediments. A grab can be Teflon-coated to prevent potential contamination of trace metal samples. The sampling device should at least be rinsed with clean water between samples and possibly also solvent-rinsed.

8.2.5.2 Water Sample Collection

If water samples are necessary, representative samples should be collected with either a noncontaminating pump or a discrete water sampler. When sampling with a pump, the potential for contamination can be minimized by using a peristaltic or a magnetically coupled impeller-design pump. The system should be flushed with the equivalent of 10 times the volume of the collection tubing. Also, any components within several meters of the sample intake should be noncontaminating (i.e., sheathed in polypropylene or epoxy-coated). Potential sample contamination must be avoided, including vessel emissions and other sampling apparatus.

A discrete water sampler should be of the close/open/close type so that only the target water sample comes into contact with internal sampler surfaces. Seals should be Teflon-coated whenever possible. Water sampling devices should be acid-rinsed (1:1 nitric acid) prior to use for collection of trace-metal samples, and solvent-rinsed prior to collection of samples for organic analyses.

8.2.5.3 Organism Collection

Benthic organism collection methods may be species specific and can include, but are not restricted to, bottom trawling, grabs or cores. If organisms are to be maintained alive, they should be transferred immediately to containers with clean, well-oxygenated water, and sediment as appropriate. Care must be taken to prevent organisms from coming into contact with potentially contaminated areas or fuels, oils, natural rubber, trace metals, or other contaminants.

8.2.6 Sample Handling, Preservation, and Storage

Detailed procedures for sample handling, preservation, and storage should be part of the standard operating procedures and protocols developed for each sampling operation. Samples are subject to chemical, biological, and physical changes as soon as they are collected. Sample handling, preservation, and storage techniques have to be designed to minimize any changes in composition of the sample by retarding chemical and/or biological activity and by avoiding contamination. Collection methods, volume requirements, container specifications, preservation techniques, storage conditions and holding times (from the time of sample collection) for sediment, water, and tissue samples are discussed below and summarized in Table 8-2.

8.2.6.1 Sample Handling

Sufficient sample volume must be collected to:

Table 8-2. Summary of Recommended Procedures for Sample Collection, Preservation, and Storage.[a]

Analyses	Collection Method[b]	Amount Required[c]	Container[d]	Preservation Technique	Storage Conditions	Holding times[e]
SEDIMENT						
Chemical/Physical Analyses						
Metals	Grab/corer	100 g	Precleaned polyethylene jar[f]	Dry ice[f] or freezer storage for extended storages; otherwise refrigerate	≤ 4°C	Hg - 28 days Others - 6 months[g]
Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons)	Grab/corer	250 g	Solvent-rinsed glass jar with Teflon lid[f]	Dry ice[f] or freezer storage for extended storages; otherwise refrigerate	≤ 4°C[f]/dark[g]	14 days[h]
Particle size	Grab/corer	100 g	Whirl-pac bag[f]	Refrigerate	< 4°C	Undetermined
Total Organic Carbon (TOC)	Grab/corer	50 g	Heat treated glass vial with Teflon-lined lid[f]	Dry ice[f] or freezer storage for extended storages; otherwise refrigerate	≤ 4°C[f]	14 days
Total solids/ specific gravity	Grab/corer	50 g	Whirl-pac bag	Refrigerate	< 4°C	Undetermined
Miscellaneous	Grab/corer	≥ 50g	Whirl-pac bag	Refrigerate	< 4°C	Undetermined

Table 8-2 *(continued)*

Analyses	Collection Method[b]	Amount Required[c]	Container[d]	Preservation Technique	Storage Conditions	Holding times[e]
SEDIMENT (continued)						
Sediment from which elutriate is prepared	Grab/corer	Depends on tests being performed	Glass with Teflon-lined lid	Completely fill and refrigerate	4°C/dark/airtight	14 days
Biological Tests						
Dredged material	Grab/corer	12-15 L per sample	Plastic bag or container[i]	Completely fill and refrigerate; sieve	4°C/dark/airtight	14 days[j]
Reference sediment	Grab/corer	45-50 L per test	Plastic bag or container[i]	Completely fill and refrigerate; sieve	4°C/dark/airtight	14 days[j]
Control Sediment	Grab/corer	21-25 L per test	Plastic bag or container[i]	Completely fill and refrigerate; sieve	4°C/dark/airtight	14 days[j]
WATER AND ELUTRIATE						
Chemical/Physical Analyses						
Particulate analysis	Discrete sampler or pump	500 - 2000 mL	Plastic or glass	Lugols solution and refrigerate	4°C	Undetermined
Metals	Discrete sampler or pump	1 L	Acid-rinsed polyethylene or glass jar[k]	pH <2 with HNO_3[k]; refrigerate	4°C 2°C[k]	Hg - 14 days Others - 6 months[l]
Total Kjeldahl nitrogen (TKN)	Discrete sampler or pump	100 - 200 mL	Plastic or glass[l]	H_2SO_4 to pH <2; refrigerate	4°C[l]	24 h[l]
Chemical oxygen demand (COD)	Discrete sampler or pump	200 mL	Plastic or glass[l]	H_2SO_4 to pH <2; refrigerate	4°C[l]	7 days[l]

Table 8-2 *(continued)*

Analyses	Collection Method[b]	Amount Required[c]	Container[d]	Preservation Technique	Storage Conditions	Holding times[e]
WATER AND ELUTRIATE (continued)						
Total organic carbon (TOC)	Discrete sampler or pump	100 mL	Plastic or glass[l]	H_2SO_4 to pH <2; refrigerate	4°C[l]	<48 h[l]
Total inorganic carbon (TIC)	Discrete sampler or pump	100 mL	Plastic or glass[l]	Airtight seal; refrigerate[h]	4°C[l]	6 months[l]
Phenolic compounds	Discrete sampler or pump	1 L	Glass[l]	0.1 - 1.0 g $CuSO_4$; H_2SO_4 to pH <2; refrigerate	4°C[l]	24 h[l]
Soluble reactive phosphates	Discrete sampler or pump	-	Plastic or glass[l]	Filter; refrigerate[h]	4°C[l]	24 h[l]
Extractable organic compounds (e.g., semivolatiles)	Discrete sampler or pump	4 L	Amber glass bottle[k]	pH < 2, 6N HCl; airtight seal; refrigerate	4°C[k]	7 days for extraction; 40 days for extract analysis[k]
Volatile organic compounds	Discrete sampler or pump	80 mL	Glass vial[k]	pH < 2 with 1:1 HCL; refrigerate in airtight, completely filled container[k]	4°C[k]	14 days for sample analysis if preserved[m]
Total phosphorus	Discrete sampler or pump	-	Plastic or glass[i]	H_2SO_4 to pH < 2; refrigerate	4°C[l]	7 days[l]
Total solids	Discrete sampler or pump	200 mL	Plastic or glass[l]	Refrigerate	4°C[l]	7 days[l]

Table 8-2 *(continued)*

Analyses	Collection Method[b]	Amount Required[c]	Container[d]	Preservation Technique	Storage Conditions	Holding times[e]
WATER AND ELUTRIATE (continued)						
Volatile solids	Discrete sampler or pump	200 mL	Plastic or glass[l]	Refrigerate	4°C[l]	7 days[l]
Sulfides	Discrete sampler or pump	-	Plastic or glass[l]	pH > 9 NaOH (ZnAc); refrigerate	4°C[l]	24 h[l]
Biological Tests						
Site water	Grab	Depends on tests being performed	Plastic carboy	Refrigerate	< 4°C	14 days
Dilution water	Grab or makeup	Depends on tests being performed	Plastic carboy	Refrigerate	<4°C	14 days
TISSUE						
Metals	Trawl/Teflon-coated grab	5-10 g	Double Ziploc[f]	Handle with nonmetallic forceps; plastic gloves; dry ice[f]	≤ -20°C[f] or freezer storage	Hg - 28 days Others - 6 months[n]
PCBs and chlorinated pesticides	Trawl/Teflon-coated grab	10-25 g	Hexane-rinsed double aluminum foil and double Ziploc[f]	Handle with hexane-rinsed stainless steel forceps; dry ice[f]	≤ -20°C[f] or freezer storage	14 days[h]
Volatile organic compounds	Trawl/Teflon-coated grab	10-25 g	Heat-cleaned aluminum foil and watertight plastic bag[m]	Covered ice chest[g]	≤ -20°C[h] or freezer storage	14 days[n]

Table 8-2 *(continued)*

Analyses	Collection Method[b]	Amount Required[c]	Container[d]	Preservation Technique	Storage Conditions	Holding times[e]
TISSUE (continued)						
Semivolatile organic compounds (e.g, PAH)	Trawl/Teflon-coated grab	10-25 g	Hexane-rinsed double aluminum foil and double Ziploc[f]	Handle with hexane-rinsed stainless steel forceps; dry ice[f]	≤ -20°C[f] or freezer storage	14 days[h]
Lipids	Trawl/Teflon-coated grab	part of organic analyses	Hexane-rinsed aluminum foil	Handle with hexane-rinsed stainless steel forceps; quick freeze	≤ -20°C or freezer storage	14 days[h]

[a] This table contains only a summary of collection, preservation, and storage procedures for samples. The cited references should be consulted for a more detailed description of these procedures.

[b] Collection method should include appropriate liners.

[c] Amount of sample required by the laboratory to perform the analysis (wet weight or volume provided, as appropriate). Miscellaneous sample size for sediment should be increased if auxiliary analytes that cannot be included as part of the organic or metal analyses are added to the list. The amounts shown are not intended as firm values; more or less tissue may be required depending on the analytes, matrices, detection limits and particular analytical laboratory.

[d] All containers should be certified as clean according to EPA (1990a).

[e] These holding times are for sediment, water, and tissue based on guidance that is sometimes administrative rather than technical in nature. There are no promulgated, scientifically based holding time criteria for sediments, tissues or elutriates. References should be consulted if holding times for sample extracts are desired. Holding times are from the time of sample collection.

[f] NOAA (1989)

[g] Tetra Tech (1986a)

[h] Sample may be held for up to one year if ≤ -20°C.

[i] Polypropylene should be used if phthalate bioaccumulation is of concern.

[j] Two weeks is recommended; sediments must not be held for longer than 8 weeks prior to biological testing.

[k] EPA (1987c); 40 CFR Part 136, Table III

[l] Plumb (1981)

[m] If samples are not preserved to pH<2, then aromatic compounds must be analyzed within 7 days.

[n] Tetra Tech (1986b)

- perform the necessary analyses
- partition the samples, either in the field or as soon as possible after sampling, for respective storage and/or analytical requirements (e.g., freezing for trace metal analysis, refrigeration for bioassays)
- provide sample for replicate or QA analyses, if specified
- archive portions of the sample for possible later analysis.

Sample handling is project and analysis specific as well as being based on what is practical and possible. Generally, samples to be analyzed for trace metals should not come into contact with metals, and samples to be analyzed for organic compounds should not come into contact with plastics. All sample containers should be appropriately cleaned (acid-rinsed for analysis of metals; solvent-rinsed for analysis of organic compounds).

For analysis of volatile compounds, samples should completely fill the storage container, leaving no air-space. These samples should be refrigerated but never frozen or the containers will crack. Samples for other kinds of chemical analysis are sometimes frozen. If the sample is to be frozen, sufficient air space should be allowed for expansion to take place. Container labels have to withstand soaking, drying, and freezing without becoming detached or illegible. The labelling system should be tested prior to use in the field.

Sediment samples for biological testing should have at least the larger living organisms removed from the sediment prior to testing. This may be accomplished by press-sieving the sediments through a 1-mm-mesh screen. Other matter retained on the screen with the organisms, such as shell fragments, gravel, and debris, should be recorded and discarded. Prior to use in bioassays, individual test sediments should be thoroughly homogenized with clean instruments (until color and textural homogeneity is achieved).

8.2.6.2 Sample Preservation

Preservation steps should be taken immediately upon sediment collection. There is no universal preservation or storage technique although storage in the dark at 4°C is generally used for all samples held for any length of time prior to partitioning, and for some samples after partitioning. A technique for one group of analyses may interfere with other analyses. This problem can be overcome by collecting sufficient sample volume to utilize specific preservation or storage techniques for specific analytes or

tests. Preservation, whether by refrigeration, freezing, or addition of chemicals, should be accomplished onboard the collecting vessel whenever possible. If final preservation techniques cannot be implemented in the field, the sample should be temporarily preserved in a manner that retains its integrity.

Onboard refrigeration is generally accomplished with coolers and ice; however, samples should be segregated from melting ice or cooling water. Samples which are to be frozen on board may be stored in an onboard freezer or may simply be placed in a cooler with dry ice or blue ice. Sediment samples for biological analysis should be preserved at 4°C, never frozen or dried. Additional guidance on sample preservation is given in Table 8-2.

8.2.6.3 Sample Storage

The elapsed time between sample collection and analysis should be as short as possible. Sample holding times for chemical evaluations are analysis-specific (Table 8-2). Sediments for bioassay (toxicity and/or bioaccumulation) testing *should* be tested as soon as possible, preferably within 2 weeks of collection. Studies to date suggest that sediment storage time should not exceed 8 weeks (at 4°C, in the dark, excluding air) (Becker and Ginn, 1990; Tatem et al., 1991). Toxicity may change with storage time. Sample storage conditions (e.g., temperature, location of samples) should be documented.

8.2.7 Logistical Considerations and Safety Precautions

A number of frustrations in sample collection and handling can be minimized by carefully thinking through the process and requirements before going to the field (e.g., see EPA, 1995). Contingency plans are essential. Well-trained, qualified, and experienced field crews should be used. Backup equipment and sampling gear, and appropriate repair parts, are advisable. A surplus of sampling containers and field data sheets should be available. Sufficient ice and adequate ice-chest capacity should be provided, and the necessity of replenishing ice before reaching the laboratory should be considered. A vessel with adequate deck space is safer and allows for more efficient work than an overcrowded vessel. Unforeseeable circumstances (e.g., weather delays) are to be expected during field sampling, and time to adequately accomodate the unforeseen has to be included in sampling schedules.

Appropriate safety and health precautions must be observed during field sampling activities. EPA (1984) should be used as a guidance document to prepare a site-specific health and safety plan. The health and safety plan should be prepared as a separate document from the QA project plan. Requirements set forth in the Occupational Safety and Health Administration 29 CFR § 1910.120 (Federal Register, Vol. 54, No. 43) should be met for medical surveillance, personal protection, respirator fit testing (if applicable),

and hazardous waste operations training (if applicable) by all personnel working in contaminated areas or working with contaminated media.

The procedures and practices established in the site-specific health and safety plan must be observed by all individuals participating in the field activities. Safety requirements should also be met by all observers present during field audits and inspections. The plan should include the following information:

- site location and history
- scope of work
- site control
- hazard assessment (chemical and physical hazards)
- levels of protection and required safety equipment
- field monitoring requirements
- decontamination
- training and medical monitoring requirements
- emergency planning and emergency contacts.

Samples must be properly disposed when no longer needed. Ordinary sample-disposal methods are usually acceptable, and special precautions are seldom appropriate. Under Federal law [40 CFR 261.5(a)], where highly contaminated wastes are involved, if the waste generated is less than 100 Kg per month, the generator is conditionally exempt as a small-quantity generator and may accumulate up to 1,000 Kg of waste on the property without being subject to the requirements of Federal hazardous waste regulations. However, State and local regulations may require special handling and disposal of contaminated samples. When samples have to be shipped, 49 CFR 100-177 should be consulted for current Department of Transportation regulations on packing and shipping.

8.2.8 Non-Indigenous Test Species

Over the last few years, there has been a growing awareness of the ecological and economic damage caused by introduced species. Because both east and west coast species are often used in bioaccumulation

tests, there is a real potential of introducing bioaccumulation test species or associated fauna and flora (e.g., pathogens, algae used in transporting the worms). It is the responsibility of the persons conducting the bioaccumulation or toxicity tests to assure that no non-indigenous species are released.

The general procedures to contain non-indigenous species are to collect and then poison all water, sediment, organisms and associated packing materials (e.g., algae, sediment) before disposal. Chlorine bleach can be used as the poison. A double containment system is used to keep any spillage from going down the drain. Guidance on procedures used in toxicity tests can be found in Appendix B of DeWitt et al. (1992a). Flow-through tests can generate large quantities of water, and researchers should plan on having sufficient storage facilities.

9.0 PHYSICAL ANALYSIS OF SEDIMENT AND CHEMICAL ANALYSIS OF SEDIMENT, WATER, AND TISSUE SAMPLES

This section provides guidance on the selection of chemical and physical analyses to aid in the evaluation of dredged material for proposed disposal, and on the methods used to analyze these parameters. QA/QC guidance is provided in Appendix G and EPA (1995).

The methods cited in this section may be used to develop the required chemical information. However, other methods may provide similar results, and the final choice of analytical procedures depends upon the needs of each evaluation. In all cases, proven, state-of-the-art methods should be used.

Any dredged material from estuarine or marine areas contains salt. The salt can interfere with the results obtained from some analytical methods. *Any methods proposed for the analysis of sediment and water from estuarine or marine environments must explicitly address steps taken to control salt interference.*

9.1 Physical Analysis of Sediment

Physical characteristics of the dredged material must be determined to help assess the impact of disposal on the benthic environment and the water column at the disposal site. This is the first step in the overall process of sediment characterization, and also helps to identify appropriate control and reference sediments for biological tests. In addition, physical analyses can be helpful in evaluating the results of analyses and tests conducted later in the characterization process.

The general analyses may include (1) grain size, (2) total solids and (3) specific gravity.

Grain-size analysis defines the frequency distribution of the size ranges of the particles that make up the project sediment (e.g., Plumb, 1981; Folk, 1980). The general size classes of gravel, sand, silt, and clay are the most useful in describing the size distribution of particles in dredged-material samples. Use of the Unified Soil Classification System (USCS) for physical characterization is recommended for the purpose of consistency with USACE engineering evaluations (ASTM, 1992).

Total solids is a gravimetric determination of the organic and inorganic material remaining in a sample after it has been dried at a specified temperature. The total solids values generally are used to convert concentrations of contaminants from a wet weight to a dry weight basis.

The specific gravity of a sample is the ratio of the mass of a given volume of material to an equal volume of distilled water at the same temperature (Plumb, 1981). The specific gravity of a dredged-material sample helps to predict the behavior (i.e., dispersal and settling characteristics) of dredged material after disposal.

Other physical/engineering properties (e.g., Atterburg limits, hydrometer analysis, settling properties, etc.) may be needed to evaluate the quality of any effluent discharged from confined disposal facilities. Guidance in this regard is provided in Appendix B.

9.2 Target Detection Limits

The selection of appropriate target detection limits (TDLs) is vital (e.g., TetraTech, 1986a; EPA, 1986a). TDLs should be lower than the appropriate values against which the data are to be compared for interpretation. Different analytical methods are capable of detecting different concentrations of a chemical in a sample. For example, a highly sensitive technique can detect a much lower chemical concentration than can a screening technique for the same chemical. The accuracy of measurements also differs among analytical techniques. In general, as the sensitivity and accuracy of a technique increases, so does the cost. Recommended TDLs that are judged to be feasible, cost effective, and to meet the requirements for dredged material evaluations are summarized in EPA (1995), along with example analytical methods that are capable of meeting those TDLs. However, any method that can achieve those TDLs is acceptable, provided that the appropriate documentation of the method performance is generated for the project.

The TDL is a performance goal set between the lowest, technically feasible detection limit for routine analytical methods and available regulatory criteria or guidelines for evaluating dredged material. The TDL is, therefore, equal to or greater than the lowest amount of a chemical that can be reliably detected based on the variability of the blank response of routine analytical methods (see EPA [1995] for discussion of method blank response). However, the reliability of a chemical measurement generally increases as the concentration increases. Analytical costs may also be lower at higher detection limits. For these reasons, the TDLs in EPA (1995) have been set at not less than 10 times lower than available regional or international dredged material guidelines for potential biological effects associated with sediment chemical contamination.

All data generated for dredged material evaluation should meet the TDLs in EPA (1995) unless prevented by sample-specific interferences. Any sample-specific interferences must be well documented by the laboratory. If significantly higher or lower TDLs are required to meet rigorously defined data quality

objectives (e.g., for human health risk assessments) for a specific project then, on a project-specific basis, modification to existing analytical procedures may be necessary. Such modifications must be documented in the QA project plan. An experienced analytical chemist should be consulted so the most appropriate method modifications can be assessed, the appropriate coordination with the analytical laboratory can be implemented, and the data quality objectives can be met. A more detailed discussion of method modifications is provided in EPA (1995).

9.3 Chemical Analysis of Sediment

9.3.1 Target Analytes

Chemical analysis provides information about the chemicals present in the dredged material that, if biologically available, could cause toxicity and/or be bioaccumulated. This information is valuable for exposure assessment and for deciding which of the contaminants present in the dredged material to measure in tissue samples.

If the historical review conducted in Tier I (Section 4.1) establishes a reason to believe that sediment contaminants may be present, but fails to produce sufficient information to develop a definitive list of potential contaminants, a list of target analytes has to be compiled. Target analytes should be selected from, but not necessarily limited to, the compounds in Table 9-1 and from the historical review information. The target list should include contaminants that historical information or commercial and/or agricultural applications suggest could be present at a specific dredging site — for example, tributyltin near shipyards, berthing areas, and marinas where these compounds have been applied. Analysis of polynuclear aromatic hydrocarbons (PAH) in dredged material should focus on those PAH compounds that are on the priority pollutant list (Clarke and Gibson, 1987).

All PCB analyses should be made using congener-specific methods. The sum of the concentrations of specific congeners is an appropriate measure of total PCBs (NOAA, 1989).

Sediments should be analyzed for total organic carbon (TOC). This is particularly important if there are hydrophobic organics on the contaminant of concern list developed in Tier I. The TOC content of sediment is a measure of the total amount of oxidizable organic material in a sample and also affects contaminant bioaccumulation by, and effects to, organisms (e.g., Di Toro et al., 1991; DeWitt et al., 1992b).

Table 9-1. Potential Contaminants of Concern Listed According to Structural Compound Class.

Structural Compound Class	Contaminant
Phenols	phenol
	2,4-dimethylphenol
	2-methylphenol
	4-methylphenol
Substituted Phenols	2,4,6-trichlorophenol
	para-chloro-meta-cresol
	2-chlorophenol
	2,4-dichlorophenol
	2-nitrophenol
	4-nitrophenol
	2,4-dinitrophenol
	4,6-dinitro-*o*-cresol
	pentachlorophenol
Organonitrogen Compounds	benzidine
	3,3'-dichlorobenzidine
	2,4-dinitrotoluene
	2,6-dinitrotoluene
	1,2-diphenylhydrazine
	nitrobenzene
	N-nitrosodimethylamine
	N-nitrosodiphenylamine
	N-nitrosodipropylamine
Low Molecular Weight Polynuclear Aromatic Hydrocarbons (PAH)	acenaphthene
	naphthalene
	acenaphthylene
	anthracene
	phenanthrene
	fluorene
	1-methylnapthalene
	2-methylnapthalene
High Molecular Weight Polynuclear Aromatic Hydrocarbons (PAH)	fluoranthene
	benzo*(a)*anthracene
	benzo*(a)*pyrene
	benzo*(b)*fluoranthene
	benzo*(k)*fluoranthene
	chrysene
	benzo*(ghi)*perylene
	dibenzo*(a,h)*anthracene
	ideno(1,2,3-*cd*)pyrene
	pyrene
Chlorinated Aromatic Hydrocarbons	1,2,4-trichlorobenzene
	hexachlorobenzene
	2-chloronaphthalene
	1,2-dichlorobenzene
	1,3-dichlorobenzene
	1,4-dichlorobenzene
Chlorinate Aliphatic Hydrocarbons	hexachlorobutadiene
	hexachloroethane
	hexachlorocyclopentadiene
Halogenated Ethers	bis(2-chloroethyl)ether
	4-chlorophenyl ether
	4-bromophenyl ether
	bis(2-chloroisopropyl) ether
	bis(2-chlorethoxy)methane
Phthalates	bis(2-ethylhexyl)phthalate
	butyl benzyl phthalate
	di-*n*-butyl phthalate
	di-*n*-octyl phthalate
	diethyl phthalate
	dimethyl phthalate
Polychlorinated Biphenyls (PCB) as Aroclors[a]	PCB-1242
	PCB-1254
	PCB-1221
	PCB-1232
	PCB-1248
	PCB-1260
	PCB-1016
Miscellaneous Oxygenated Compounds	TCDD (dioxin)[b]
	PCDF (furan)
	isophorone
Pesticides	aldrin
	dieldrin
	chlordane
	chlorbenside
	dacthal
	DDT[c]
	endosulfan[d]
	endrin
	endrin aldehyde
	heptachlor
	heptachlor epoxide
	α-hexachlorocyclohexane
	β-hexachlorocyclohexane
	δ-hexachlorocyclohexane
	γ-hexachlorocyclohexane
	toxaphene
	mirex
	methoxychlor
	parathion
	malathion
	guthion
	demeton

Table 9-1. *(continued)*

Structural Compound Class	Contaminant
Volatile Halogenated Alkanes	tetrachloromethane
	1,2-dichloroethane
	1,1,1-trichloroethane
	1,1-dichloroethane
	1,1,2-trichloroethane
	1,1,2,2-tetrachloroethane
	chloroethane
	chloroform
	1,2-dichloropropane
	dichloromethane
	chloromethane
	bromomethane
	bromoform
	dichlorobromoethane
	fluorotrichloromethane
	dichlorodifluoromethane
	chlorodibromomethane
Volatile Halogenated Alkenes	1,1-dichlorethylene
	1,2-*trans*-dichlorethylene
	trans-1,3-dichloropropene
	cis-1,3-dichloropropene
	tetrachlorethene
	trichlorethene
	vinyl chloride
Volatile Aromatic Hydrocarbons	benzene
	ethylbenzene
	toluene
Chlorinated Benzenes	1,3-dichlorobenzene
	1,4-dichlorobenzene
	1,2-dichlorobenzene
	1,2,4-trichlorobenzene
	hexachlorobenzene
Volatile Unsaturated Carbonyl Compounds	acrolein
	acrylonitrile
Volatile Ethers	2-chlorethylvinylether
	bis(chloromethyl)ether
Metals	aluminum
	antimony
	arsenic
	beryllium
	butyltins
	cadmium
	chromium (hexavalent)
	cobalt
	copper
	iron
	lead
	manganese
	mercury
	nickel
	selenium
	silver
	thallium
	tin
	zinc
Miscellaneous	ammonia[e]
	asbestos
	benzoic acid
	cyanide
	guaiacols
	methylethyl ketone
	resin acids

[a]It is recommended that PCB analyses use congener-specific methods. The sum of the concentrations of specific congeners is an appropriate measure of total PCBs (see Table 9-3).
[b]Additional dioxin and furan (e.g., TCDF) compounds are listed in Table 9-2.
[c]Includes DDT, DDD, and DDE
[d]Includes ∝-endosulfan, β-endosulfan, and endosulfan sulfate.
[e]Ammonia may not be a contaminant of concern at certain open-water dredged material disposal sites (e.g., dispersive situations and situations with well-oxygenated overlying water).

Sediments in which metals are suspected to be contaminants of concern may also be analyzed for acid volatile sulfide (AVS) (Di Toro et al., 1990; EPA, 1991a). Although acceptable guidance on the interpretation of AVS measurements is not yet available, and AVS measurements are not generally recommended at this time, such measurements can provide information on the bioavailability of metals in anoxic sediments. Presently, AVS studies represent an area of on-going research which may be formally included in the manual if and when decision criteria are determined.

9.3.2 Selection of Analytical Techniques

Once the list of target analytes for sediments has been established, analytical methods have to be determined. The methods will, to some degree, dictate the amount of sediment sample required for each analysis. General sample sizes are provided in Table 8-2, and include possible requirements for more than one analysis for each group of analytes. The amount of sample used in an analysis affects the detection limits attainable by a particular method.

TOC analyses should be based on high-temperature combustion rather than on chemical oxidation. Some classes of organic compounds are not fully degraded by chemical/ultraviolet techniques. The volatile and nonvolatile organic components make up the TOC of a sample. Because inorganic carbon (e.g., carbonates and bicarbonates) can be a significant proportion of the total carbon in some sediment, the sample has to be treated with acid to remove the inorganic carbon prior to TOC analysis. The method of Plumb (1981) recommends HCl as the acid. An alternative choice might be sulfuric acid since it is nonvolatile, is used as the preservative, and does not add to the chloride burden of the sample. Whatever acid is used, it has to be demonstrated on sodium chloride blanks that there is no interference generated from the combined action of acid and salt in the sample. Acceptable methods for TOC analysis are available from EPA (1995).

For many metals analyses in marine/estuarine areas, the concentration of salt may be much greater than the analyte of interest and can cause unacceptable interferences in certain analytical techniques. In such cases, the freshwater approach of acid digestion followed by inductively coupled plasma-atomic emission spectrometry (ICP) or graphite furnace atomic absorption spectroscopy (GFAAS) should be coupled with appropriate techniques for controlling this interference. The Hg method in EPA (1986a; Method 7471) may be used for the analysis of Hg in sediment. Tributyltin may be analyzed by the method of Rice et al. (1987), and selenium and arsenic by the method of EPRI (1986). A total extraction of metal ions is neither necessary nor desirable for dredged material evaluations. The standard aqua regia extraction yields consistent and reproducible results.

The recommended method for analysis of semivolatile and volatile priority pollutants in sediment is described by Tetra Tech (1986a). Analysis for organic compounds should always use capillary-column gas chromatography (GC): gas chromatography/mass spectrometry (GC/MS) techniques for semi-volatile and volatile priority pollutants, and dual column gas chromatography/electron-capture detection (GC/ECD) for pesticides and PCBs (NOAA, 1989). Alternatively, GC/MS using selected ion monitoring can be used for PCB and pesticide analysis. These analytically sound techniques yield accurate data on the concentrations of chemicals in the sediment matrix. The analytical techniques for semivolatile organic compounds generally involve solvent extraction from the sediment matrix and subsequent analysis, after cleanup, using GC or GC/MS. Extensive cleanup is necessitated by the likelihood of (1) biological macromolecules, (2) sulfur from sediments with low or no oxygen, and (3) oil and/or grease in the sediment. The analysis of volatile organic compounds incorporates purge-and-trap techniques with analysis by either GC or GC/MS. If dioxin (i.e., 2,3,7,8, - TCDD) analysis is being performed, the methods of Kuehl et al. (1987), Smith et al. (1984), EPA (1989b; Method 8290), or EPA (1990c; Method 1613) and summary in EPA (1995) should be consulted. EPA Method 1613 is the recommended procedure for measuring the tetra- through octa- chlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs). This method has been developed for analysis of water, soil, sediment, sludge, and tissue. Table 9-2 shows the 17 compounds determined by Method 1613.

Techniques for analysis of chemical constituents have some inherent limitations for sediment samples. Interferences encountered as part of the sediment matrix, particularly in samples from heavily contaminated areas, may limit the ability of a method to detect or quantify some analytes. The most selective methods using GC/MS techniques are recommended for all nonchlorinated organic compounds because such analysis can often avoid problems due to matrix interferences. Gas chromatography/electron-capture detection (GC/ECD) methods are recommended as the primary analytical tool for all PCB and pesticide analyses because GC/ECD analysis will result in lower detection limits. The analysis and identification of PCBs by GC/ECD methods are based upon relative retention times and peak shapes. Matrix interferences may result in the reporting of false negatives, although congener-specific PCB analysis reduces this concern relative to use of the historical Aroclor® matching procedure.

PCBs have traditionally been quantified with respect to Aroclor® mixtures. This procedure can result in errors in determining concentrations (Brown et al., 1984). For dredged material evaluations, the concentration of total PCBs should be determined by summing the concentrations of specific individual PCB congeners identified in the sample (see Table 9-3). The minimum number of PCB congeners that should be analyzed are listed in the first column of Table 9-3 (i.e., "summation" column) (NOAA, 1989). This summation is considered the most accurate representation of the PCB concentration in samples. Additional PCB congeners are also listed in Table 9-3. McFarland and Clarke (1989) recommend these PCB congeners for analysis based on environmental abundance, persistence, and biological importance.

Table 9-2. PCDD and PCDF Compounds Determined by Method 1613

Native Compound[1]
2,3,7,8-TCDF
2,3,7,8-TCDD
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,4,7,8-HxCDD
1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,6,7,8-HpCDD
1,2,3,4,7,8,9-HpCDF
OCDD
OCDF

[1] Polychlorinated dioxins and furans:

TCDD = Tetrachlorodibenzo-p-dioxin
TCDF = Tetrachlorodibenzofuran
PeCDD = Pentachlorodibenzo-p-dioxin
PeCDF = Pentachlorodibenzofuran
HxCDD = Hexachlorodibenzo-p-dioxin
HxCDF = Hexachlorodibenzofuran
HpCDD = Heptachlorodibenzo-p-dioxin
HpCDF = Heptachlorodibenzofuran
OCDD = Octachlorodibenzo-p-dioxin
OCDF = Octachlorodibenzofuran

Table 9-3. Polychlorinated Biphenyl (PCB) Congeners Recommended for Quantitation as Potential Contaminants of Concern.

PCB Congener[a]	Congener Number[b]		
	Summation[c]	Highest Priority[d]	Second Priority[e]
2,4' diCB	8		
2,2',5 triCB	18		18
2,4,4' triCB	28		
3,4,4' triCB			37
2,2',3,5' tetraCB	44		44
2,2',4,5' tetraCB			99
2,2',5,5' tetraCB	52		52
2,3',4,4' tetraCB	66		
2,3',4',5 tetraCB			70
2,4,4',5 tetraCB			74
3,3',4,4' tetraCB	77	77	
3,4,4',5 tetraCB			81
2,2',3,4,5' pentaCB		87	
2,2',3,4',5 pentaCB		49	
2,2',4,5,5' pentaCB	101	101	
2,3,3',4,4' pentaCB	105	105	
2,3,4,4',5 pentaCB			114
2,3',4,4',5 pentaCB	118	118	
2,3',4,4',6 pentaCB			119
2',3,4,4',5 pentaCB			123
3,3',4,4',5 pentaCB	126[f]	126[f]	
2',3,3',4,4' hexaCB	128	128	
2,2',3,4,4',5' hexaCB	138	138	
2,2',3,5,5',6 hexaCB			151
2,2',4,4',5,5' hexaCB	153	153	
2,3,3',4,4',5 hexaCB		156	
2,3,3',4,4',5 hexaCB			157
2,3,3',4,4',6 hexaCB			158
2,3',4,4',5,5' hexaCB			167
2,3',4,4',5',6 hexaCB			168
3,3',4,4',5,5' hexaCB	169[f]	169[f]	
2,2',3,3',4,4',5 heptaCB	170	170	
2,2',3,4,4',5,5' heptaCB	180	180	
2,2',3,4,4',5',6 heptaCB		183	
2,2',3,4,4',6,6' heptaCB		184	
2,2',3,4',5,5',6 heptaCB	187		187
2,3,3',4,4',5,5' heptaCB			189

(continued)

Table 9-3. *(continued)*

PCB Congener[a]	Congener Number[b]		
	Summation[c]	Highest Priority[d]	Second Priority[e]
2,2',3,3',4,4',5,6 octaCB		195	
2,2',3,3',4,5,5',6' octaCB			201
2,2',3,3',4,4',5,5',6 nonaCB		206	
2,2',3,3',4,4',5,5',6,6' decaCB		209	

[a]PCB congeners recommended for quantitation, from dichlorobiphenyl (diCB) through decachlorobiphenyl (decaCB).

[b]Congeners are identified by their International Union of Pure and Applied Chemistry (IUPAC) number, as referenced in Ballschmiter and Zell (1980) and Mullin et al. (1984).

[c]These congeners are summed to determine total PCB concentration following the approach in NOAA (1989).

[d]PCB congeners having highest priority for potential environmental importance based on potential for toxicity, frequency of occurrence in environmental samples, and relative abundance in animal tissues (McFarland and Clarke, 1989).

[e]PCB congeners having second priority for potential environmental importance based on potential for toxicity, frequency of occurrence in environmental samples, and relative abundance in animal tissues (McFarland and Clarke, 1989).

[f]To separate PCBs 126 and 169, it is necessary to initially utilize an enrichment step with an activated carbon column (Smith, 1981).

McFarland et al. (1986) note that the most toxic PCB congeners lie mainly within the tetra-, penta-, and hexa- chlorobiphenyl groups. Sample preparation for PCB congener analysis should follow the techniques described by Tetra Tech (1986a) or EPA (1986a), but with instrumental analysis and quantification using standard capillary GC columns on individual PCB isomers according to the methods reported by NOAA (1989) (see also Dunn et al., 1984; Schwartz et al., 1984; Mullin et al., 1984; Stalling et al., 1987).

Although the methods mentioned above are adequate for detecting and quantifying concentrations of those PCB congeners comprising the majority of total PCBs in environmental samples, they are not appropriate for separating and quantifying PCB congeners which may coelute with other congeners and/or may be present at relatively small concentrations in the total PCB mixture. Included in this latter group of compounds, for example, are PCBs 126 and 169, two of the more toxic nonortho-substituted (coplanar) PCB congeners (Table 9-3). In order to separate these (and other toxic nonortho-substituted congeners), it is necessary to initially utilize an enrichment step with an activated carbon column (Smith, 1981). Various types of carbon columns have been used, ranging from simple gravity columns (e.g., in a Pasteur pipette) to more elaborate (and efficient) columns using high pressure liquid chromatography (HPLC) systems (see Schwartz et al., 1993). The preferred method of separation and quantitation of the enriched PCB mixture has been via high resolution GC-MS with isotope dilution (Kuehl et al., 1991; Ankley et al., 1993; Schwartz et al., 1993). However, recent studies have shown that if the carbon enrichment is done via HPLC, the nonortho-substituted PCB congeners of concern also may be quantifiable via more widely available GC/ECD systems (Schwartz et al., 1993).

The overall toxicity of nonortho-substituted PCBs at a site can be assessed based on a comparison with the toxicity of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD). A similar procedure can be used for assessing the toxicity of a mixture of dioxins and furans. In this "toxicity equivalency factor" (TEF) approach, potency values of individual congeners (relative to TCDD) and their respective sediment concentrations are used to derive a "summed" 2,3,7,8-TCDD equivalent (TCDD-EQ) (EPA, 1989c; Table 9-4). Ankley et al. (1992b) provide an example of the use of this approach.

TEFs have been derived for human health purposes. For aquatic organisms the relative toxicities of different PCB congeners and dioxins are likely to be quite different. For instance, wildlife or fish TEF for PCBs are not equivalent to those for humans (Walker et al., 1992).

To ensure that contaminants not included in the list of target analytes are not overlooked in the chemical characterization of the dredged material, the analytical results should also be scrutinized by trained personnel. The presence of persistent major unknown analytes should be noted. Methods involving GC/MS techniques for organic compounds are recommended for the identification of any unknown analytes.

Table 9-4. Methodology for Toxicity Equivalency Factors

Because toxicity information on some dioxin and furan species is scarce, a structure-activity relationship has been assumed. The toxicity of each congener is expressed as a fraction of the toxicity of 2,3,7,8 TCDD.

Compound	TEF
2,3,7,8 TCDD	1
other TCDD	0
2,3,7,8-PeCDDs	0.5
other PeCDDs	0
2,3,7,8-HxCDDs	0.1
other HxCDDs	0
2,3,7,8-HpCDDs	0.01
other HpCDDs	0
OCDD	0.001
2,3,7,8-TCDF	0.1
other TCDFs	0
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.5
other PeCDFs	0
2,3,7,8-HxCDFs	0.1
other HxCDFs	0
2,3,7,8-HpCDFs	0.01
other HpCDFs	0
OCDF	0.001

9.4 Chemical Analysis of Water

9.4.1 Analytical Targets

Analysis to determine the potential release of dissolved contaminants from the dredged material (standard elutriate) may be necessary to make a factual determination. Elutriate tests (Section 10.1.2.1) involve mixing dredged material with dredging site water and allowing the mixture to settle. The portion of the dredged material that is considered to have the potential to impact the water column is the supernatant remaining after undisturbed settling and centrifugation. Chemical analysis of the elutriate allows a direct comparison, after allowance for mixing, to applicable water quality standards (WQS). When collecting samples for elutriate testing, consideration should be given to adequate volumes of water and sediment required to prepare samples for analysis including replicates where appropriate. In some instances, when there is poor settling, the elutriate preparation has to be performed successively several times to accumulate enough water for testing.

Historical water quality information from the dredging site (Tier I) should be evaluated along with data obtained from the chemical analysis of sediment samples to select target analytes. Chemical evaluation of the dredged material provides a known list of constituents which might affect the water column. All target analytes identified in the sediment should initially be considered potential targets for water analysis. Nonpriority-pollutant chemical components which are found in measurable concentrations in the sediments should be included as targets if review of the literature indicates that these analytes have the potential to bioaccumulate in animals [i.e., have a high K_{ow} or bioconcentration factor (BCF)] and/or are of toxicological concern.

9.4.2 Analytical Techniques

In contrast to freshwater, there generally are no EPA approved methods for analysis of saline water although widely accepted methods have existed for some time (e.g., Strickland and Parsons, 1972; Grasshoff et al., 1983; Parsons et al., 1984). Application of the freshwater methods to saltwater will frequently result in higher detection limits than are common for freshwater unless care is taken to control the effects of salt on the analytical signal. Modifications or substitute methods (e.g., additional extract concentration steps, larger sample sizes, or concentration of extracts to smaller volumes) might be necessary to properly determine analyte concentration in seawater or to meet the desired target detection limits (TDLs). It is extremely important to ascertain a laboratory's ability to execute methods and attain acceptable detection limits in matrices containing up to 3% sodium chloride.

Once the list of target analytes for water has been established, analytical methods have to be determined. The water volume required for specific analytical methods may vary. A minimum of 1 L of elutriate should be prepared for metals analysis (as little as 100 mL may be analyzed). One liter of elutriate should be analyzed for organic compounds. Sample size should also include the additional volume required for the matrix spike and matrix spike duplicate analyses required as part of the analytical procedure. Samples from the dredging site and, where appropriate, disposal site, should be delivered for organic and metals analysis. Sample size is one of the limiting factors in determining detection limits for water analyses, but TDLs below the WQS must be the goal in all cases. Participating laboratories should routinely report detection limits achieved for a given analyte.

Detailed methods for the analysis of organic and inorganic priority pollutants in water are referenced in 40 CFR 136 and in EPA (1983). Additional approved methods include EPA (1986a,b; 1988a,b,c; 1990b,c); APHA (1989); ASTM (1991b); Tetra Tech (1985). Most of these methods will require modification to achieve low detection limits in saline waters. Analysis of the semivolatile organic priority pollutants involves a solvent extraction of water with an optional sample cleanup procedure and analysis using GC or GC/MS. The volatile priority pollutants are determined by using purge-and-trap techniques and are analyzed by either GC or GC/MS. If dioxin (i.e., 2,3,7,8, - TCDD) analysis is necessary, Kuehl et al. (1987), Smith et al. (1984), EPA (1989b; Method 8290), or EPA (1990c; Method 1613) should be consulted. EPA Method 1613 is the recommended procedure for measuring the tetra- through octa-PCDDs and PCDFs.

A primary requirement for analysis of inorganic and organic priority pollutants is to obtain detection limits which will result in usable, quantitative data that can subsequently be compared against applicable WQS to determine compliance with the water quality certification requirement under Section 401. Existing EPA methods for freshwater analysis need to be adapted to achieve environmentally meaningful detection limits in saline waters because of matrix interferences caused by salt. For example, it is recommended that sample extracts be concentrated to the lowest possible volume prior to instrumental analysis, and that instrumental injection volumes be increased to lower the detection limits. All PCB and pesticide analytes should be analyzed by using GC/ECD, since the GC/ECD methods are more sensitive to these compounds and will lower the detection limits. PCBs should be quantified as specific congeners (Mullin et al., 1984; Stalling et al., 1987) and as total PCBs based on the summation of particular congeners (NOAA, 1989).

Analysis of saline water for metals is subject to matrix interferences from salts, particularly sodium and chloride ions, when the samples are concentrated prior to instrumental analysis. The gold-amalgamation method using cold-vapor atomic absorption spectrophotometry (AAS) analysis is recommended to eliminate saline water matrix interferences for mercury analysis. Methods using solvent extraction and

AAS analysis may be required to reduce saline water matrix interferences for other target metals. Other methods appropriate for metals include: cadmium, copper, lead, iron, zinc, silver (Danielson et al., 1978); arsenic (EPRI, 1986); selenium and antimony (Sturgeon et al., 1985); low levels of mercury (Bloom et al., 1983); and, tributyltin (Rice et al., 1987). Graphite-furnace AAS techniques after extraction are recommended for the analysis of metals, with the exception of mercury.

9.5 Chemical Analysis of Tissues

9.5.1 Target Analytes

Bioaccumulation is evaluated by analyzing tissues of test organisms for contaminants determined to be of concern for a specific dredged material. Sediment contaminant data and available information on the bioaccumulation potential of those analytes have to be interpreted to establish target compounds.

The *n*-octanol/water partition coefficient (K_{ow}) is used to estimate the BCFs of chemicals in organism/water systems (Chiou et al., 1977; Kenaga and Goring, 1980; Veith et al., 1980; Mackay, 1982). The potential for bioaccumulation generally increases as K_{ow} increases, particularly for compounds with log K_{ow} less than approximately 6. Above this value, there is less of a tendency for bioaccumulation potential to increase with increasing K_{ow}. Consequently, the relative potential for bioaccumulation of organic compounds can be estimated from the K_{ow} of the compounds. EPA (1985) recommends that compounds for which the log K_{ow} is greater than 3.5 be considered for further evaluation of bioaccumulation potential. The organic compound classes of priority pollutants with the greatest potential to bioaccumulate are PAHs, PCBs, pesticides, and some phthalate esters. Generally, the volatile organic, phenol, and organonitrogen priority pollutants are not readily bioaccumulated, but exceptions include the chlorinated benzenes and the chlorinated phenols. Table 9-5 provides data for organic priority pollutants based on K_{ow}. Specific target analytes for PCBs and PAHs are discussed in Section 9.3.1. The water content and percent lipids should be routinely determined as part of tissue analyses for organic contaminants.

Table 9-6 ranks the bioaccumulation potential of the inorganic priority pollutants based on calculated BCFs. Dredged material contaminants with BCFs greater than 1,000 (log BCF >3) should be further evaluated for bioaccumulation potential.

Tables 9-5 and 9-6 should be used with caution because they are based on calculated bioconcentration from water. Sediment bioaccumulation tests, in contrast, are concerned with accumulation from a complex medium via all possible routes of uptake. The appropriate use of the tables is to help in selecting

Table 9-5. Octanol/Water Partition Coefficients (K_{ow}) for Organic Compound Priority Pollutants and 301(h) Pesticides[a].

Pollutant	Octanol/Water Partition Coefficient (log K_{ow})	Pollutant	Octanol/Water Partition Coefficient (log K_{ow})
Di-*n*-octyl phthalate	9.2	Acenaphthylene	4.1
Indeno(1,2,3-*cd*)pyrene	7.7	Butyl benzyl phthalate	4.0
Benzo(*ghi*)perylene	7.0	PCB-1221	4.0
PCB-1260	6.9	Hexachloroethane	3.9
Mirex[b]	6.9	Acenaphthene	3.9
Benzo(*k*)fluoranthene	6.8	α-hexachlorocyclohexane	3.8
Benzo(*b*)fluoranthene	6.6	δ-hexachlorocyclohexane	3.8
PCB-1248	6.1	ß-hexachlorocyclohexane	3.8
2,3,7,8-TCDD (dioxin)	6.1	γ-hexachlorocyclohexane	3.8
Benzo(*a*)pyrene	6.0	Parathion[b]	3.8
Chlordane	6.0	Chlorobenzene	3.8
PCB-1242	6.0	2,4,6-trichlorophenol	3.7
4,4'-DDD	6.0	ß-endosulfan	3.6
Dibenzo(*a,h*)anthracene	6.0	Endosulfan sulfate	3.6
PCB-1016	5.9	α-endosulfan	3.6
4,4'-DDT	5.7	Naphthalene	3.6
4,4'-DDE	5.7	Fluorotrichloromethane[c]	3.5
Benzo(*a*)anthracene	5.6	1,4-dichlorobenzene	3.5
Chrysene	5.6	1,3-dichlorobenzene	3.4
Endrin aldehyde	5.6	1,2-dichlorobenzene	3.4
Fluoranthene	5.5	Toxaphene	3.3
Hexachlorocyclopentadiene	5.5	Ethylbenzene	3.1
Dieldrin	5.5	*N*-nitrosodiphenylamine	3.1
Heptachlor	5.4	*P*-chloro-*m* cresol	3.1
Heptachlor epoxide	5.4	2,4-dichlorophenol	3.1
Hexachlorobenzene	5.2	3,3'-dichlorobenzene	3.0
Di-*n*-butyl phthalate	5.1	Aldrin	3.0
4-Bromophenyl phenyl ether	5.1	1,2-diphenylhydrazine	2.9
Pentachlorophenol	5.0	4-nitrophenol	2.9
4-Chlorophenyl phenyl ether	4.9	Malathion[b]	2.9
Pyrene	4.9	Tetrachloroethene	2.9
2-Chloronaphthalene	4.7	4,6-dinitro-*o*-cresol	2.8
Endrin	4.6	Tetrachloroethene	2.6
PCB-1232	4.5	Bis(2-chloroisopropyl)ether	2.6
Phenanthrene	4.5	1,1,1-trichloroethane	2.5
Fluorene	4.4	Trichloroethene	2.4
Anthracene	4.3	2,4-dimethylphenol	2.4
Methoxychlor[b]	4.3	1,1,2,2-tetrachloroethane	2.4
Hexachlorobutadiene	4.3	Bromoform	2.3
1,2,4-trichlorobenzene	4.2	1,2-dichloropropane	2.3
Bis(2-ethylhexyl)phthalate	4.2	Toluene	2.2

Table 9-5. *(continued)*

Pollutant	Octanol/Water Partition Coefficient (log K_{ow})	Pollutant	Octanol/Water Partition Coefficient (log K_{ow})
1,1,2-trichloroethane	2.2	Dimethyl phthalate	1.6
Guthion[b]	2.2	Chloroethane	1.5
Dichlorodiflouromethane[c]	2.2	2,4-dinitrophenol	1.5
2-chlorophenol	2.2	1,1-dichloroethylene	1.5
Benzene	2.1	Phenol	1.5
Chlorodibromomethane	2.1	1,2-dichloroethane	1.4
2,4-dinitrotoluene	2.1	Diethyl phthalate	1.4
2,6-dinitrotoluene	2.0	*N*-nitrosodipropylamine	1.3
Trans-1,2-dichloropropene	2.0	Dichloromethane	1.3
Cis-1,3-dichloropropene	2.0	2-chloroethylvinylether	1.3
Demeton[b]	1.9	Bis(2-chloroethoxy)methane	1.3
Chloroform	1.9	Acrylonitrile	1.2
Dichlorobromomethane	1.9	Bis(2-chloroethyl)ether	1.1
Nitrobenzene	1.9	Bromomethane	1.0
Benzidine	1.8	Acrolein	0.9
1,1-dichloroethane	1.8	Chloromethane	0.9
2-nitrophenol	1.8	Vinyl chloride	0.6
Isophorone	1.7	*N*-nitrosodimethylamine	0.6

[a]Adapted from Tetra Tech (1985).
[b]301(h) pesticides not on the priority pollutant list.
[c]No longer on priority pollutant or 301(h) list.

[Note: Mixtures, such as PCB Aroclors®, cannot have discrete K_{ow} values, however, the value given is a rough estimate for the mean. It is recommended that all PCB analyses use congener-specific methods. All PCB congeners have a log K_{ow} >4 (L. Burkhardt, EPA Duluth, pers. comm.).]

Table 9-6. Bioconcentration Factors (BCF) of Inorganic Priority Pollutants.[a]

Inorganic Pollutant	Log BCF[b]
Metals	
Methylmercury	4.6
Phenylmercury	4.6
Mercuric acetate	3.5
Copper	3.1
Zinc	2.8
Arsenic	2.5
Cadmium	2.5
Lead	2.2
Chromium IV	2.1
Chromium III	2.1
Mercury	2.0
Nickel	1.7
Thallium	1.2
Antimony	ND
Silver	ND
Selenium	ND
Beryllium	ND
Nonmetals	
Cyanide	ND
Asbestos	ND

[a]Adapted from Tetra Tech (1986b).
[b]ND: No data.

contaminants of concern for bioaccumulation analysis by providing a general indication of the relative potential for various chemicals to accumulate in tissues.

The strategy for selecting contaminants for tissue analysis should include three considerations, all of which are related to regulatory concern:

- the target analyte is a contaminant of concern and is present in the sediment as determined by sediment chemical analyses
- the target analyte has a high potential to accumulate and persist in tissues
- the target analyte is of toxicological concern.

Contaminants with a lower potential to bioaccumulate, but which are present at high concentrations in the sediments, should also be included in the target list because bioavailability can increase with concentration. Conversely, contaminants with a high accumulation potential and of high toxicological concern should be considered as targets, even if they are only present at low concentrations in the sediment. Nonpriority-pollutant contaminants which are found in measurable concentrations in the sediments should be included as targets for tissue analysis if they have the potential to bioaccumulate and persist in tissues, and are of toxicological concern.

9.5.2 Analytical Techniques

At present, formally approved standard methods for the analysis of priority pollutants and other contaminants in tissues are not available. However, studies conducted for EPA and other agencies have developed analytical methods capable of identifying and quantifying most organic and inorganic priority pollutants in tissues. The amount of tissue required for analysis is dependent on the analytical procedure and the tissue moisture content. General guidance, but *not* firm recommendations, for the amount of tissue required, is provided in Table 8-2. The required amounts may vary depending on the analytes, matrices, detection limits, and particular analytical laboratory. Tissue moisture content must be determined for each sample to convert applicable data from a wet-weight to a dry-weight basis, however both wet- and dry-weight data should be reported.

Detection limits depend on the sample size as well as the specific analytical procedure. TDLs should be determined for all analytes according to initial guidance in 40 CFR 136 and more definitive guidance in

EPA (1995; cf. Section 9.2). Detection limits should be specified based on the intended use of the data and specific needs of each evaluation.

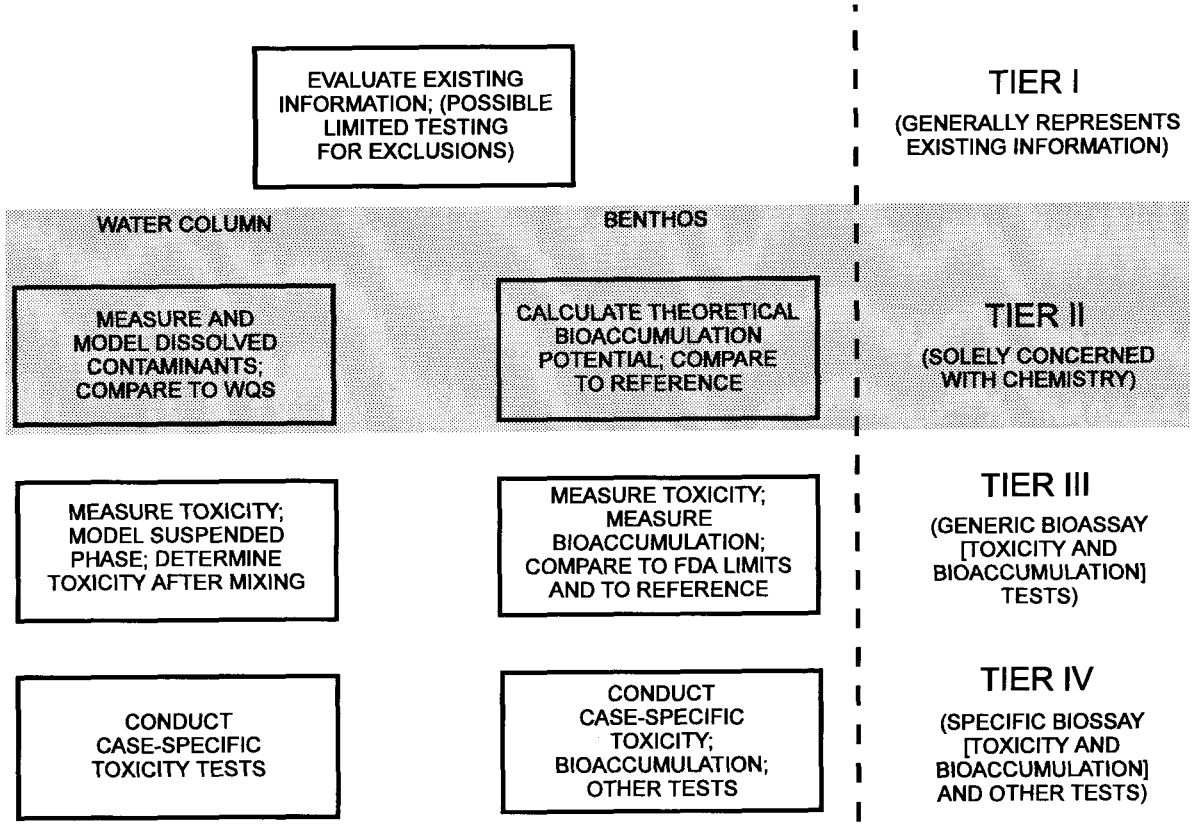
Existing methods for priority pollutant tissue analysis involve two separate procedures: one for organic compounds and another for metals. The recommended methods for the analysis of semivolatile organic pollutants are described in NOAA (1989). The procedure involves serial extraction of homogenized tissue samples with methylene chloride, followed by alumina and gel-permeation column cleanup procedures that remove coextracted lipids. An automated gel-permeation procedure described by Sloan et al. (1993) is recommended for rapid, efficient, reproducible sample cleanup. The extract is concentrated and analyzed for semivolatile organic pollutants using GC with capillary fused-silica columns to achieve sufficient analyte resolution. If dioxin (i.e., 2,3,7,8-TCDD) analysis is being performed, the methods of Mehrle et al. (1988), Kuehl et al. (1987), Smith et al. (1984), EPA (1989b; Method 8290), or EPA (1990c; Method 1613) should be consulted. EPA Method 1613 is the recommended procedure for measuring the tetra- through octa-PCDDs and PCDFs.

Chlorinated hydrocarbons (e.g., PCBs and chlorinated pesticides) should be analyzed by GC/ECD. PCBs should be quantitated as specific congeners (Mullin et al., 1984; Stalling et al., 1987) and not by industrial formulations (e.g., aroclors) because the levels of PCBs in tissues result from complex processes, including selective accumulation and metabolism (see the discussion of PCBs in Section 9.3.2). Lower detection limits and positive identification of PCBs and pesticides can be obtained by using chemical ionization mass spectrometry.

The same tissue extract is analyzed for other semivolatile pollutants (e.g., PAHs, phthalate esters, nitrosamines, phenols, etc.) using GC/MS as described by NOAA (1989), Battelle (1985), and Tetra Tech (1986b). These GC/MS methods are similar to EPA Method 8270 for solid wastes and soils (EPA, 1986a). Lowest detection limits are achieved by operating the mass spectrometer in the SIM mode. Decisions to perform analysis of nonchlorinated hydrocarbons and resulting data interpretation should consider that many of these analytes are readily metabolized by most fish and many invertebrates. Analytical methods for analysis of tissue samples for volatile priority pollutants are found in Tetra Tech (1986b).

Tissue lipid content is of importance in the interpretation of bioaccumulation information. A lipid determination should be performed on biota submitted for organic analysis if: (1) food chain models will be used; (2) test organisms could spawn during the test; (3) special circumstances occur (Tier IV), such as those requiring risk assessment. Bligh and Dyer (1959) provide an acceptable method, and the various available methods are evaluated by Randall et al. (1991).

Analysis for priority pollutant metals involves a nitric acid or nitric acid/perchloric acid digestion of the tissue sample and subsequent analysis of the acid extract using AAS or inductively coupled plasma-atomic emission spectrometry (ICP) techniques. Procedures in Tetra Tech (1986b) and EPA (1991c) are generally recommended. NOAA (1989) methods may also be used and are recommended when low detection levels are required. Microwave technology may be used for tissue digestion to reduce contamination and to improve recovery of metals (Nakashima et al., 1988). This methodology is consistent with tissue analyses performed by NOAA (1989), except for the microwave heating steps. Mercury analysis requires the use of cold-vapor AAS methods (EPA, 1991c). The matrix interferences encountered in analysis of metals in tissue may require case-specific techniques for overcoming interference problems. If tributyltin analysis is being performed, the methods of Rice et al. (1987) or Uhler et al. (1989) should be consulted.


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
(GENERALLY REPRESENTS EXISTING INFORMATION)
WATER COLUMN
BENTHOS
MEASURE AND MODEL DISSOLVED CONTAMINANTS; COMPARE TO WQS
CALCULATE THEORETICAL BIOACCUMULATION POTENTIAL; COMPARE TO REFERENCE
TIER II
(SOLELY CONCERNED WITH CHEMISTRY)
MEASURE TOXICITY; MODEL SUSPENDED PHASE; DETERMINE TOXICITY AFTER MIXING
MEASURE TOXICITY; MEASURE BIOACCUMULATION; COMPARE TO FDA LIMITS AND TO REFERENCE
TIER III
(GENERIC BIOASSAY [TOXICITY AND BIOACCUMULATION] TESTS)
CONDUCT CASE-SPECIFIC TOXICITY TESTS
CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
TIER IV
(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

10.0 GUIDANCE FOR PERFORMING TIER II EVALUATIONS

10.1 Tier II: Water Column Effects

If a water column determination cannot be made in Tier I, the Tier II water column evaluation must be conducted for comparison with numeric water-quality standards (WQS) (Section 5.1). There are two approaches for the Tier II water column evaluation for WQS compliance. One approach is to use numerical models provided in Appendix C of this manual as a screen, assuming conservatively that all of the contaminants in the dredged material are released into the water column during the disposal process. The other approach applies the same model, using the results from a chemical analysis of an elutriate prepared from the dredged material (Section 10.1.2.1).

10.1.1 Screen Relative To WQS

A screening approach may reduce the evaluation effort for dredged material that will cause only minimal water column impact. In a typical disposal operation, most contaminants remain associated with the dredged material that settles to the bottom and cause limited water column impact during descent. The screen is not a requirement but is intended to reduce the effort required to develop information required for factual determinations.

Appendix C provides guidance on which numerical computer or analytical models should be applied to particular dredged material disposal projects and the information that is necessary to perform the evaluations. Versions of models for use on IBM-compatible microcomputers and example applications are provided on the diskettes in the pocket inside the back cover of this manual. The output of the appropriate model is used to determine if additional testing is needed.

The model need be run only for the contaminant of concern that requires the greatest dilution. If this contaminant is shown to meet the WQS, all of the other contaminants that require less dilution will also meet the WQS. The contaminant requiring the greatest dilution is determined by calculating the dilution that would be required to meet the WQS. To determine the dilution *D,* the following equation is solved for each contaminant of concern in terms of dissolved concentrations:

$$D = [(C_s \times SS/1000) - C_{wq}] / (C_{wq} - C_{ds})$$

where C_s = concentration of the contaminant in the dredged material expressed as micrograms per kilogram (μg/Kg), on a dry weight basis;

SS	=	suspended solids concentration in the dredged material discharge expressed as grams per liter (g/L);
1000	=	conversion factor, g to Kg;
C_{wq}	=	WQS in micrograms per liter (µg/L); and
C_{ds}	=	background concentration of the contaminant at the disposal site in micrograms per liter (µg/L).

Note that if the concentration of the constituent in the dredged material (C_s x SS/1000) is less than C_{wq}, no calculation is necessary since no dilution is required. Note also that, if the ambient disposal-site water concentration (C_{ds}) of a constituent is greater than C_{wq}, water quality at the disposal site cannot be met by dilution. Appendix C provides detailed information for performing the above calculations and identifying the contaminant of concern requiring the greatest dilution.

The concentration of this contaminant is then modeled to determine its maximum concentration in the water column outside the boundary of the mixing zone. If this concentration is below the applicable WQS, no additional testing is necessary to make a determination regarding WQS. If the concentration is higher, additional testing is necessary, as described in Section 10.1.2.

Note that the procedure described above cannot be used to evaluate water column impact. It can be used *only* to determine whether additional testing for potential water-column impact, as described in Section 10.1.2, is necessary.

10.1.2 Elutriate Analysis Relative To WQS

For an elutriate analysis, the numerical mixing model (Appendix C) is run with chemical data obtained from an elutriate test conducted on the dredged material. The standard elutriate analysis is described in Section 10.1.2.1 and the analytical procedures for measuring constituents in the water are provided in Section 9.4.2. The model is, in effect, using data that more accurately represent the contaminant concentrations that will be present in the water column after consideration of mixing. If the numerical model (Appendix C) predicts that the concentration of all contaminants of concern at the edge of the mixing zone is less than the available, applicable WQS, the dredged material complies with WQS. Otherwise, it does not.

10.1.2.1 Standard Elutriate Preparation

The standard elutriate test is used to predict the release of contaminants to the water column resulting from open water disposal. Prior to use, all labware should be thoroughly cleaned as appropriate for the contaminant analysis. At a minimum, labware should be washed with detergent, rinsed with acetone, five times with tap water, placed in a clean 10% HCl acid bath for a minimum of 4 h, rinsed five times with tap water, and then thoroughly flushed with either distilled or deionized water.

The elutriate should be prepared by using water from the dredging site. Enough elutriate should be prepared for the chemical analyses and for the water column toxicity tests in Tier III.

The elutriate is prepared by subsampling approximately 1 L of the dredged material from the well-mixed original sample. The dredged material and unfiltered water are then combined in a sediment-to-water ratio of 1:4 on a volume basis at room temperature (22 ± 2°C). This is best accomplished by volumetric displacement. After the correct ratio is achieved, the mixture is stirred vigorously for 30 min with a mechanical or magnetic stirrer. At 10 min intervals, the mixture is also stirred manually to ensure complete mixing. After the 30 min mixing period, the mixture is allowed to settle for 1 h. The supernatant is then siphoned off without disturbing the settled material, and centrifuged to remove particulates prior to chemical analysis (approximately 2,000 rpm for 30 min, until visually clear). If the elutriate is to be used for toxicity testing, refer to the procedures in Section 11.1.4.

10.1.2.2 Chemical Analysis

Analytical procedures for specific constituents in water are provided in Section 9.4.2.

10.1.2.3 Comparison with WQS (Standard Elutriate Test)

The model need be run only for the contaminant that requires the greatest dilution to make a WQS determination. This contaminant may or may not be the same as that run in the screen (Section 10.1.1). Calculations must therefore be conducted for all of the contaminants detected during analysis of the elutriate to determine which one requires the greatest dilution. The contaminant requiring the greatest dilution is determined by calculating the dilution that would be required to meet the WQS. To determine the dilution D, the following equation is solved for each contaminant of concern in terms of dissolved concentrations:

$$D = (C_e - C_{wq})/(C_{wq} - C_{ds})$$

C_e = concentration of the dissolved contaminant in the standard elutriate in micrograms per liter (µg/L). All other terms are as previously defined in Section 10.1.1.

10.2 Theoretical Bioaccumulation Potential (TBP) of Nonpolar Organic Chemicals

The TBP is an approximation of the equilibrium concentration in tissues if the dredged material in question were the only source of contaminant to the organisms. The TBP calculation in Tier II is applied as a coarse screen to predict the magnitude of bioaccumulation likely to be associated with nonpolar organic contaminants in the dredged material. At present the TBP calculation can be performed only for nonpolar organic chemicals such as PCBs. However, methods for TBP calculations with metals and polar organic compounds are under development and may be added to this manual in the future. For the present, bioaccumulation potential of polar organic compounds, organometals, and metals in dredged material can only be tested (in Tiers III or IV), not calculated. However, it is still useful to calculate the TBP, which provides an indication of the magnitude of bioaccumulation of nonpolar organic compounds that may be encountered in testing at higher tiers. Additionally, if the TBP of the nonpolar organic compounds indicates that these contaminants are not bioavailable, this calculation may eliminate the need for further evaluation of these compounds and thereby reduce efforts in higher tiers.

Nonpolar organic chemicals include all organic compounds that do not dissociate or form ions. This includes the chlorinated hydrocarbon pesticides, many other halogenated hydrocarbons, PCBs, many PAHs including all the priority pollutant PAHs, dioxins and furans. It does not include metals and metal compounds, organic acids or salts, or organometallic complexes such as tributyltin or methyl mercury.

The environmental distribution of nonpolar organic chemicals is controlled largely by their solubility in various media. Therefore, in sediments they tend to occur primarily in association with organic matter (Karickhoff, 1981). In organisms they are found primarily in the body fats or lipids (Konemann and van Leeuwen, 1980; Geyer et al., 1982; Mackay, 1982; Bierman, 1990). Bioaccumulation of nonpolar organic compounds from dredged material can be estimated from the organic carbon content of the material, the lipid content of the organism, and the relative affinities of the chemical for sediment organic carbon and animal lipid content.

The TBP calculation assumes that various lipids in different organisms and organic carbon in different sediments are similar and have similar distributional properties. Other simplifying assumptions are that chemicals are freely exchanged between the sediments and tissues and that compounds behave

conservatively. In reality, compound size and structure may influence accumulation, and portions of organic compounds present on suspended particulates may have kinetic or structural barriers to availability. Another important assumption implicit in the TBP calculations is that there is no metabolic degradation or biotransformation of the chemical. Organic-carbon normalized contaminant concentrations are used such that the sediment-associated chemical can be characterized as totally bioavailable to the organism. Calculations based on these assumptions yield an environmentally conservative TBP value for the dredged material if the dredged material in question is the only source of the contaminant for the organism. However, note that TBP calculations are not valid for sediments with TOC $\leq$ 0.2%.

It is possible to relate the concentration of a chemical in one phase of a two-phase system to the concentration in the second phase when the system is in equilibrium. The TBP calculation focuses on the equilibrium distribution of a chemical between the dredged material or reference sediment and the organism. By normalizing nonpolar organic chemical concentration data for lipid content in organisms, and organic carbon in dredged material or reference sediment, it is possible to estimate the preference of a chemical for either phase. This approach is based on the work of Konemann and van Leeuwen (1980) and Karickhoff (1981).

McFarland (1984) took the approach one step farther. He calculated that the equilibrium concentration of nonpolar organic chemicals, which the lipids of an organism could accumulate as a result of exposure to dredged material, would be about 1.7 times the organic carbon-normalized concentration of the chemical in the dredged material. Concentrations are directly proportional to the lipid content of the organism and the contaminant content of the dredged material or reference sediment, and are inversely proportional to the organic carbon content of the dredged or reference material (Lake et al., 1987).

The possible chemical concentration in an organism's lipids [the lipid bioaccumulation potential (LBP)] would theoretically be 1.7 times the concentration of that chemical in the sediment organic carbon. Rubinstein et al. (1987) have shown, based on field studies with PCBs, that a value of 4 for calculating LBP is appropriate. However, note that more precise values for specific chemicals are now available. Current information on such values may be obtained from the ACOE Contaminated Sediment Bulletin Board (BBS: phone number is 601-634-4380; settings are N, 8, 1). LBP represents the potential contaminant concentration in lipid if the sediment is the only source of that contaminant to the organism. It is generally desirable to convert LBP to whole-body bioaccumulation potential for a particular organism of interest. This is done by multiplying LBP by that organism's lipid content, as determined by lipid analysis or from reported data. Soft-bodied invertebrate lipid contents may range from 1 - 2% wet weight (based on data from an oligochaete, midge, and amphipod species [G. Ankley, EPA Duluth and H. Lee, EPA Newport, pers. comm.]).

Theoretical bioaccumulation potential (TBP) can be calculated relative to the biota sediment accumulation factor (BSAF) as

$$TBP = BSAF\ (C_s / \%TOC)\ \%L$$

where TBP is expressed on a whole-body wet-weight basis in the same units of concentration as C_s, and

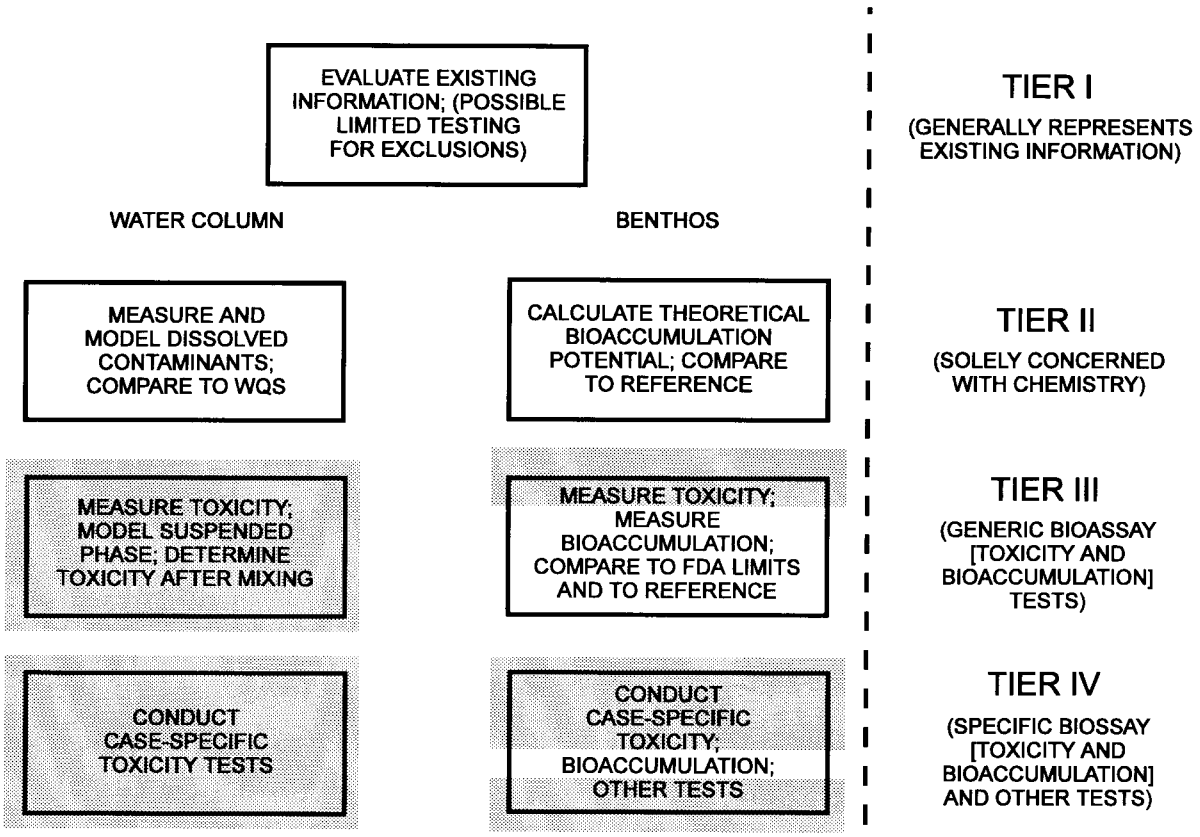
C_s = concentration of nonpolar organic chemical in the dredged material or reference sediment (any units of concentration may be used);

BSAF = 4 (Ankley et al., 1992c)

%TOC = total organic carbon content of the dredged material or reference sediment expressed as a decimal fraction (i.e., 2% = 0.02); and

%L = organism lipid content expressed as a decimal fraction (i.e., 3% = 0.03) of whole-body wet weight.

This calculation is based on work by McFarland and Clarke (1987).


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
(GENERALLY REPRESENTS EXISTING INFORMATION)
WATER COLUMN
BENTHOS
MEASURE AND MODEL DISSOLVED CONTAMINANTS; COMPARE TO WQS
CALCULATE THEORETICAL BIOACCUMULATION POTENTIAL; COMPARE TO REFERENCE
TIER II
(SOLELY CONCERNED WITH CHEMISTRY)
MEASURE TOXICITY; MODEL SUSPENDED PHASE; DETERMINE TOXICITY AFTER MIXING
MEASURE TOXICITY; MEASURE BIOACCUMULATION; COMPARE TO FDA LIMITS AND TO REFERENCE
TIER III
(GENERIC BIOASSAY [TOXICITY AND BIOACCUMULATION] TESTS)
CONDUCT CASE-SPECIFIC TOXICITY TESTS
CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
TIER IV
(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

11.0 GUIDANCE FOR PERFORMING BIOLOGICAL EFFECTS TESTS

Biological effects tests, i.e., toxicity tests, may be necessary if Tier I evaluations conclude that the dredged material contains contaminants which might result in an unacceptable adverse impact to the benthic environment and/or the water column. Toxicity tests with whole sediment are used to determine the potential for effects on benthic (bottom dwelling) organisms; toxicity tests with suspensions/solutions of dredged material are conducted to determine the potential effects on water column organisms.

The objective of water column toxicity tests is to determine the potential impact of dissolved and suspended contaminants on organisms in the water column, after considering mixing. Test organisms should be representative of appropriately sensitive water column species existing in the vicinity of the disposal site.

The objective of benthic toxicity tests is to determine the potential impact of whole sediment on benthic organisms at and beyond the boundaries of the disposal site. The organisms used in testing should be representative of appropriately sensitive infaunal or epifaunal organisms existing in the vicinity of the disposal site. Benthic toxicity tests are intended to determine the potential chemical toxicity of a dredged material as distinct from its physical (e.g., grain-size) effects. Some organisms, particularly marine, are affected by differences in sediment textures or absence of sediments (McFarland, 1981; DeWitt et al., 1988). Control and reference sediments should be selected to minimize any artifactual effects of differences in grain size. If the sediment texture varies considerably between the dredged material and the control or reference sediments, any possible effects of grain size have to be determined and considered when designing the tests and evaluating the test results (e.g., DeWitt et al., 1988).

11.1 Tier III: Water Column Toxicity Tests

Tests to evaluate dredged-material impact on the water column involve exposing test organisms to an elutriate dilution series containing both dissolved and suspended components of the dredged material. The test organisms are added to the exposure chambers and exposed for a prescribed period (usually 96 h though some tests, e.g., bivalve larvae, may be run for shorter periods). The surviving organisms are examined at specified intervals and/or at the end of the test to determine if the test material is producing an effect. An introductory guide to general toxicity testing is presented in Part 8000 of APHA (1989) and in ASTM (1994b). Biological testing aspects of these reference publications may be followed as long as they do not conflict with this manual.

11.1.1 Species Selection

Three species are recommended for use in the water column exposure and should represent different phyla where possible (Table 11-1). The rationale for testing more than a single species is to cover the potential range of differing species sensitivities and to be environmentally protective. Of the species tested, at least one needs to be a sensitive benchmark (starred) species except as provided below; however, this does not preclude the use of more than one benchmark species. Those non-benchmark species listed in Table 11-1 or other species can be used if a summary of test conditions and test acceptability criteria similar to the starred benchmark species are established, and data from reference toxicity tests (see Appendix G.2.10.5.2) are provided on the sensitivity of the species. In order to be technically justfied, species proposed for use regionally and not listed in Table 11-1 would need to meet the species characteristics criteria, provided later in this Section, and proponents need to generate the following supporting information:

- data from toxicity tests using a set of reference chemicals with differing modes of action demonstrating that the proposed species is as sensitive or more sensitive than the species in Table 11-1

- summary of test conditions and test acceptability criteria.

If species proposed for use regionally are tested in conjunction with a benchmark species, the above supporting information is desirable but not needed. However, if the region substututes all species, the above information is needed.

The test organisms may be from healthy laboratory cultures or may be field collected, but not from within the influence of former or active disposal sites or other discharges. Ideally, the test species should be the same or closely related to those species that naturally dominate biological assemblages in the vicinity of the disposal site. Species characteristics to consider when designing water-column tests include, not in order of importance:

- readily available year-round
- tolerate handling and laboratory conditions
- give consistent, reproducible response to toxicants
- related phylogenetically and/or by ecological requirements to species characteristic of the water column of the disposal site area in the season of the proposed disposal
- standardized test protocols are available
- can be readily tested as juveniles or larvae to increase sensitivity
- important ecologically, economically, and/or recreationally
- appropriately sensitive.

Table 11-1. Candidate Toxicity Test Species for Determining Potential Water Column Impact of Dredged Material Disposal. Details of testing procedures are provided in Appendix E.

Crustaceans

Mysid shrimp, *Mysidopsis* sp.* (N)[d]
*Neomysis americana** (N)
*Holmesimysis costata** (N)
Grass shrimp, *Palaemonetes* sp. (N)
Commercial shrimp, *Penaeus* sp. (N)
Cladocerans, *Daphnia magna** (F) [d]
*Daphnia pulex** (F) [d]
*Ceriodaphnia dubia** (F)[d]

Fish

Silversides, *Menidia* sp.* (N) (E)[d]
Sheepshead minnow,
*Cyprinodon variegatus** (N)[d]
Speckled sanddab, *Citharicthys stigmaeus* (N)
Grunion, *Leuresthes tenuis* (N)
Fathead minnow, *Pimephales promelas** (F)[d]
Bluegill sunfish, *Lepomis macrochirus* (F)
Channel catfish, *Ictalurus punctatus* (F)
Rainbow trout, *Oncorhynchus mykiss** (F)

Bivalves

Larvae of
Oyster, *Crassostrea* sp.* (N,E)[a]
Mussel, *Mytilus edulis** (N,E)[a]

Echinoderms

Larvae of
Sea urchins, *Strongylocentrotus* sp.*[bc] (N)
Lytechinus pictus[b] (N)
Sanddollar, *Dendraster* sp.*[bc] (N)

Note: Examples are not presented in order of importance; however, the asterisks indicate sensitive recommended benchmark species. Benchmark species comprise a substantial data base, represent the sensitive range of a variety of ecosystems, and provide comparative data on the relative sensitivity of local test species. Other species may be designated in future as benchmark species by EPA and USACE when the data on their response to contaminants are adequate.

[a] fertilized egg to hinged, D-shaped prodissoconch I larvae. Note that these two species can be used in estuarine waters down to appropriate low levels of salinity (see Appendix E).

[b] fertilized egg to pluteus larvae

[c] sperm fertilization

[d] These species can also be used in sublethal, chronic testing (methods for such testing are available but not detailed in this manual).

For the purpose of this manual, related to the tolerances of the test animals, (F) = Freshwater, salinity ≤ 1 ‰ (N) = Near Coastal, salinity ≥ 25‰ (E) = Estuarine, salinity 1-25‰. It is recognized that the commonly accepted salinity range for estuaries is 1-35‰ and near coastal salinity is usually greater than 30‰ salinity.

In addition to species occurring at the disposal site, other representative commercially available species or sensitive life stages of economically important species may be used. Mysids of the genera *Mysidopsis, Neomysis,* or *Holmesimysis* are highly recommended as test species. Embryo-larval stages of echinoderms, crustaceans, molluscs, or fish are also appropriate organisms. Adult fish and molluscs and large crustaceans must not be used for water column toxicity testing because of their generally greater resistance to contaminants, except as additional test organisms where data on economically important species are necessary to address public or regional concerns.

Regardless of their source, test organisms should be collected and handled as gently as possible. They should be gradually acclimated to the test conditions if test conditions differ from holding conditions. Field collected organisms must be tested within 2 weeks of collection. Animals from established laboratory cultures can be held indefinitely. Further details on methods are provided in ASTM (1994b).

11.1.2 Apparatus

Water column toxicity tests are generally conducted as static exposures in pre-cleaned glass chambers equipped with covers to minimize evaporation. The size of the chambers depends on the size of the test species. Before use, all glassware should be washed with detergent, rinsed five times with tap water, placed in a clean 10% HCl acid bath for a minimum of 4 h, rinsed with acetone, five times with tap water, and then thoroughly flushed with either distilled or deionized water.

Equipment and facilities must provide acceptable lighting requirements and temperature control. An environmental incubator or a water-bath system that allows temperature control within ±1°C is recommended.

11.1.3 Laboratory Conditions

Water column toxicity tests should be conducted under conditions known to be non-stressful to the test organisms. Salinity for marine/estuarine organisms should be stable within ±2‰ and, for all organisms, temperature should be stable within ±2°C throughout the exposure period. Dissolved-oxygen concentration should not be allowed to fall below an absolute minimum of 40% saturation for warm water species and 60% for cold water species. The temperature, salinity (if appropriate), dissolved oxygen, and pH in the test containers should be measured and recorded daily. Measurements of other parameters, for instance ammonia, may also be useful but need not be done daily.

11.1.4 Laboratory Procedures

Elutriate Preparation

Elutriate should be prepared using water collected from the dredging site. Disposal site water, clean seawater or freshwater, or artificial sea/salt mixtures should be used as dilution water for the tests. If sea/salt mixtures are used, they must be prepared in strict accordance with the manufacturer's instructions and allowed to age (with aeration) to ensure that all salts are in solution and pH has stabilized before use in any test. The elutriate is prepared by subsampling approximately 1 L of the homogenized dredged-material sample. The dredged material and unfiltered dredging site water are then combined in a sediment-to-water volumetric ratio of 1:4 at room temperature (22 ± 2°C). The mixture is then stirred vigorously for 30 min with a mechanical or magnetic stirrer. At 10 min intervals, the mixture is also stirred manually to ensure complete mixing. After the 30 min mixing period, the mixture is allowed to settle for 1 h. The liquid plus the material remaining in suspension after the settling period represents the 100% liquid plus suspended particulate phase. The supernatant is then carefully siphoned off, without disturbing the settled material, and immediately used for testing. With some very fine-grained dredged materials, it may be necessary to centrifuge the supernatant until the suspension is clear enough for the organisms to be visible in the testing chamber. Note that 15-40 L of elutriate may need to be prepared to test some species.

Test Design

The number of replicate exposure chambers per treatment should be determined according to the guidance in Appendix E. A minimum of five replicates per treatment and 10 organisms (except zooplankton or larvae) per replicate is generally recommended. Organism loading density must be low enough to avoid overcrowding stress.

At least three concentrations of the dredged-material elutriate should be tested; recommended treatments are 100%, 50%, and 10%. Water from the same source in which the animals were held prior to testing must be included as a control treatment subject to test survival acceptability criteria for controls (Appendix G). To properly evaluate the test results, any toxicity at 100% dilution water should also be determined.

The test organisms should be approximately of equal size and/or age and assigned randomly to the different treatments. Zooplankton and larvae are usually transferred with the aid of a pipette. Air must not be trapped on or under the animals during the transfer process. Larger animals may be transferred in fine-mesh nets. Animals which are dropped or exhibit abnormal behavior should be discarded.

The test chambers should be covered and randomly placed in an incubator or water bath. The test type is static non-renewal; the control and test solutions are not replaced. During the exposure period, aeration should not be supplied (unless necessary to keep dissolved oxygen concentration above 40% saturation

for warm water species or 60% for cold water species), and the test solutions should not be stirred. Some species of crustaceans, particularly larval forms, may require feeding during the test. All food used must be analyzed to ensure that it is acceptably free of contaminants and will support survival, growth or reproduction of test organisms (cf. EPA, 1994b).

Recommended test duration is 48-96 h for zooplankton and some larvae (e.g., oysters) and up to 96 h for other organisms. For bivalve larvae, the ASTM (1994c) procedure should be used. Useful procedures for other organisms are given in ASTM (1994b). For some tests, intermediate time observations may be made of survival but, for other tests, survival is only assessed at the end of the testing period. For intermediate observations, care must be taken to minimize any stress to the test organisms. Only the number of living organisms are counted, not the number of dead. An animal is judged dead if it does not move either after the water is gently swirled or after a sensitive part of its body is gently touched with a probe. At intermediate observations, a pipette or forceps is used to remove dead organisms, molted exoskeletons, and food debris.

If greater than acceptable mean mortality or abnormal development occurs in the control as defined in the procedures for proper conduct of that test, the test must be repeated. Further QA/QC considerations are provided in Appendix G.

11.1.5 Data Presentation and Analysis

Data Presentation

The data for each test species should be presented in separate tables that include the following information:

- the scientific name of the test species
- the number of organisms in each treatment at the start of the test
- the number of organisms alive at each observation period, if applicable
- the number of organisms recovered alive and/or in normal health from each chamber at the end of the test
- additional information including water quality and any behavioral or other abnormalities.

Data Analysis

It is possible that no mortality or other effects will be observed in any of the treatments or that survival or other effects in the dredged material treatments will be equal to or higher than in the control or in the dilution water treatments. In either of these situations, there is no need for statistical analysis and no indication of water column toxicity attributable to the dredged material. However, if survival or other

effects in the dilution water treatment is at least 10% greater than the 100% dredged-material treatment, the data have to be evaluated statistically to determine whether the dredged-material suspension is significantly more toxic than the dilution water. If the 100% dredged-material treatment is not statistically different from the dilution water, the dredged material is predicted not to be acutely toxic to water column organisms. An LC_{50} should not be calculated unless at least 50% of the test organisms die in at least one of the serial dilutions . If there are no mortalities greater than 50%, then the LC_{50} is assumed to be ≥100%. If a statistical difference exists and greater than 50% mortality or other effects occur in all of the treatments, it is not possible to calculate an LC_{50} or EC_{50} value. If the conditions are highly toxic, such that the 10% treatment has greater than 50% mortality, further dilution must be made (new treatments of less than 10% dredged material) to attain a survival of greater than 50% and determine the LC_{50} or EC_{50} by interpolation. Statistical procedures recommended for analyzing the test data are described in detail in Appendix D.

11.1.6 Conclusions

The Tier III water-column effects evaluation involves using a numerical model comparison with the WQS. Descriptions of the models and applications are given in Appendix C, and the models are provided on the diskettes that can be found in the pocket inside the back cover of this manual.

The modeled concentrations of the dredged material (expressed as percentages) are compared to 0.01 of the 48- or 96-h LC_{50} or EC_{50}, depending on the test duration. The maximum allowable concentration outside the mixing zone is 0.01 LC_{50} or EC_{50}. Note that the 0.01 factor is intended for acute mortality data (e.g., relating acute to chronic toxicity) and not for more subtle effects such as abnormalities, growth or reproduction, including EC_{50} data (NAS, 1972). However, in the absence of other alternatives, the 0.01 application factor should be applied to EC_{50} data although it is recognized that these results will be conservative and that derivation of this historic application factor was largely a matter of "best professional judgement" by the NAS (1972). Thus, site-specific review may be required in some cases to determine compliance.

11.2 Tier III: Benthic Toxicity Tests

Toxicity tests with whole sediment are designed to determine whether the dredged material is likely to produce unacceptable adverse effects on benthic organisms. In benthic toxicity tests, the test animals are exposed to the whole sediment and any effects recorded.

11.2.1 Species Selection

Species representing three life history strategies are recommended for use in the whole sediment toxicity tests, one each representing a filter feeder, deposit feeder and a burrowing organism where possible (Table 11-2). The rationale for testing more than a single species is to cover the range of differing species sensitivities and to be environmentally protective. No single species is adequately protective of the broad range of possible chemical contaminants nor of the equally broad range of possible biological responses. Of the species tested, at least one sensitive benchmark (starred) species needs to be be used in all cases except as provided below; however, this does not preclude the use of benchmark species representative of all three required categories. If only two different species are being tested they should, together, cover the following three life history strategies: filter feeder, deposit feeder, burrower. Since amphipods are excellent organisms for short term toxicity, they are recommended as one of the species to be tested. Non-benchmark species listed in Table 11-2 can be used if a summary of test conditions and test acceptability criteria similar to the starred benchmark species are established and data from reference toxicity tests (see Appendix G.2.10.5.2) are provided on the sensitivity of the species. In order be technically justified, species proposed for use regionally and not listed in Table 11-2 need to meet the species characteristics criteria provided later in this section and proponents need to provide the following supporting information:

- data from toxicity tests using a set of reference chemicals with differing modes of action demonstrating that the proposed species is as sensitive or more sensitive than the species in Table 11-2

- summary of test conditions and test acceptability criteria.

If species proposed for use regionally are tested in conjunction with a benchmark species, the above supporting information is desirable but not required. However, if the region substitutes all species, the above information is needed.

Benthic organisms are used to evaluate the potential benthic impact of dredged material disposal. Testing of contaminated sediments (e.g., Word et al., 1989; Gentile et al., 1988; Rogerson et al., 1985) and regulatory program experience since 1977 under the Marine Protection, Research, and Sanctuaries Act and the Clean Water Act have shown that different species have various degrees of sensitivity to the physical and chemical composition of sediments.

To accurately evaluate potential benthic impact, appropriately sensitive toxicity test species should be related as closely as possible, both phylogenetically and ecologically, to benthic organisms in the disposal

Table 11-2. Candidate Acute Toxicity Test Species for Determining Potential Benthic Impact of Dredged-Material Disposal. Details of testing procedures are provided in Appendix E. Additional guidance is provided in ASTM (1994d,e,f,g) and EPA (1994c,d).

Amphipod Crustaceans

*Ampelisca abdita** (N)[a] [d,b]
*Rhepoxynius abronius** (N) [d,b]
Grandidierella japonica (N) [d,b]
Corophium sp. (N) [f,d,b]
*Leptocheirus plumulosus** (E,N)[a] [d,b]
*Eohaustorius estuarius** (E) [d,b]
*Hyalella azteca** (E,F)[a] [d,b]

Polychaetes

Neanthes arenaceodentata (N)[a] [d,b]

Juvenile Bivalves (clams)

Paper pondshell freshwater mussel, *Anodonta imbecillis* (F) [f,b]

Crustaceans other than Amphipods

Mysid shrimp, *Mysidopsis* sp. (N) [f,d]
Neomysis americana (N) [f]
Holmesimysis costata (N) [f]
Commercial shrimp, *Penaeus* sp. (N) [d,b]
Grass shrimp, *Palaemonetes* sp. (N,E)[b] [d]

Insect Larvae

Midges, *Chironomus tentans** (F)[a] [d,b]
*C. riparius** (F)[a] [d,b]
Mayfly, *Hexagenia limbata* (F) [d,b]

Oligochaetes

Pristina leidyi (F) [d,b]
Tubifex tubifex (F)[a] [d,b]
Lumbriculus variegatus (F)[a] [d,b]

Note: Examples are not presented in order of importance; however, the asterisks indicate sensitive recommended benchmark species. Benchmark species comprise a substantial data base, represent the sensitive range of a variety of ecosystems, and provide comparative data on the relative sensitivity of local test species. Other species may be designated in future as benchmark species by EPA and the USACE when the data on their response to contaminants are adequate. Only benthic species should be tested. Although sediment dwellers are preferable, intimate contact with sediment is acceptable. Note that testing with all recommended taxa is not required; however, at least one starred amphipod taxon must be tested.

[f = filter feeder; d = deposit feeder; b = burrower]. Note that *A. abdita*, *L. plumulosus*, *C. tentans*, and *H. limbata* are not direct filter feeders, but are suspension feeders.

[a] These species can also be used in sublethal, chronic testing (methods for such testing are available but not detailed in this manual).

[b] This species can be used in estuarine waters down to appropriate low levels of salinity (see Appendix E).

For the purposes of this manual, related to the tolerances of the test animals, (F) = Freshwater, salinity $\leq$ 1‰ (N) = Near Coastal, salinity $\geq$ 25‰ (E) = Estuarine, salinity 1-25‰. It is recognized that the commonly accepted salinity range for estuaries is 1-35‰ and near coastal water is usually greater than 30‰ salinity.

site area. Commercially important but possibly less sensitive benthic species in the vicinity of the disposal site may also be considered for testing.

Sediment grain size is likely to vary substantially between the dredged material, the reference sediment, and the control sediment. If candidate test species are overly sensitive to the different grain sizes (for instance, excessive mortality in the reference sediments attributable to grain size and not to other factors), either this must be taken into account (e.g., DeWitt et al., 1988) or other, more grain-size tolerant species should be considered for the project.

Final selection of test species for a particular dredged material disposal project should be made in consultation with regional regulatory and scientific personnel. Two phylogenetically and ecologically different species are recommended to account for different sensitivities to contaminants. The following is a list, not necessarily in order of importance, of characteristics to consider for species selection:

- readily available year-round
- preferably ingest sediments
- tolerate grain sizes of dredged material and control and reference sediments equally well or differences should be accounted for
- give consistent, reproducible response to toxicants
- tolerate handling and laboratory conditions
- related phylogenetically and/or by ecological requirements to species characteristic of the benthic environment of the disposal site area in the season of the proposed disposal
- standardized test protocols are available
- important ecologically, economically, and/or recreationally
- appropriately sensitive.

Infaunal amphipods are excellent organisms for short term toxicity tests with whole sediment (Swartz et al., 1979, 1985; Mearns and Word, 1982; Rogerson et al., 1985; Nebeker et al., 1984; Gentile et al., 1988; Scott and Redmond, 1989; Word et al., 1989; Burton, 1991), and are strongly recommended as appropriate test species for acute toxicity bioassays in marine/estuarine/fresh waters. Guidance on available testing procedures (static, 10-d exposures) provided in ASTM (1994d,e) may be followed on all points that do not conflict with this manual. Infaunal amphipods are:

- sensitive
- readily available
- as a group, tolerant of a wide range of grain sizes and laboratory exposure conditions
- ecologically relevant to most dredged material disposal sites.

The identity of all species should be verified by experienced taxonomists, particularly for animals collected in the field. If the toxicity test animals are also to be used in estimating bioaccumulation potential, the factors discussed in Section 12.1.1 for species selection should also be considered.

11.2.2 Laboratory Procedures

General Test Procedures

Acceptable water quality parameters during testing include but are not necessarily restricted to:

- the correct temperature and pH range
- adequate oxygen levels
- proper lighting
- the correct salinity range (near coastal and estuarine organisms)
- the correct hardness range (fresh water organisms)
- the absence of, or insignificant concentrations of, toxicants such as ammonia.

Amphipod and other small organism tests are often, but not always, conducted in 1 L containers under static conditions (Appendix E). Static renewal or even flow-through methods such as those described by Redmond et al. (1989) or Benoit et al. (1993) may be required for certain tests or where static non-renewal conditions would result in unacceptable build-up of, for instance, ammonia and/or sulfides (see second and third paragraphs, Ammonia and Sulfide toxicity, this section).

Before use, all glassware should be washed with detergent, rinsed with acetone, five times with tap water, placed in a clean 10% HCl acid bath for a minimum of 4 h, rinsed five times with tap water, and then thoroughly flushed with either distilled or deionized water. Equipment and facilities must provide acceptable lighting requirements and temperature control. An environmental incubator or a water-bath system that allows temperature control within ± 1°C is recommended.

Dilution water should not be stressful to the test organisms, and should be stable throughout the exposure period. Salinity for marine/estuarine organisms should be stable within ± 2‰ and, for all organisms, temperature should be stable within ± 2°C throughout the exposure period. Dissolved oxygen concentration should not be allowed to fall below an absolute minimum of 40% saturation for warm water species and 60% for cold water species. The flow to the exposure chamber should be directed to achieve good mixing without disturbing the sediment on the bottom of the chamber.

A minimum of five replicate exposure chambers for the dredged material, reference, and control is recommended. The standard test duration is 10 d.

The quantity of sediment needed depends on the size of the exposure chambers. The sediment should be deep enough to meet the biological needs of the test organisms, i.e., allow organisms to burrow in their normal position, etc. Overcrowding of organisms must be avoided.

Prior to use in toxicity tests, sediments must be thoroughly homogenized. Very small amounts of clean diluent water may be added to facilitate mixing. If separation into liquid and solid phases occurs in posthomogenization storage, remixing will be required prior to usage.

The reference and control sediments, as well as the dredged material being tested, may contain live organisms. If necessary, macrobenthic organisms can be removed by press-sieving the sediments through an appropriately sized screen immediately prior to testing. The material remaining on the screen should be noted and discarded.

The experimental procedure described in ASTM (1994d) should be followed for preparing the exposure chambers for amphipod toxicity tests. For larger exposure chambers, sediment should be placed on the bottom of the exposure chamber and covered with clean diluent water; any sediment suspended during placement should be allowed to settle for 24 h before introducing the test organisms. In continuous-flow tests, the flow should be established after most of the suspended sediment has settled, usually 12 to 24 h, but at least 1 h before introducing the test organisms.

During the exposure period, daily records should be kept of obvious mortalities, emergence of infaunal organisms, formation of tubes or burrows, and any other or unusual behavior. Daily records of water quality (e.g., dissolved oxygen, salinity (if appropriate), ammonia, temperature, pH) should be maintained using test containers appropriate for this purpose. In flow-through or static-renewal systems, water quality may be kept within acceptable bounds by increasing the flow rate or frequency of water changes.

After the exposure period, live organisms are removed to clean diluent water, which may include sieving the sediments, and then counted. If greater than acceptable mean mortality occurs in the control, as defined in the procedures for proper conduct of that test, the test must be repeated. Organisms which show any response to gentle probing of sensitive parts or gentle swirling of the water should be considered alive. Sediment dwellers (e.g., amphipods) not recovered at the end of the test have to be considered dead. If organisms from these toxicity tests are to be used in estimating bioaccumulation potential, the survivors are gently and rapidly counted and then treated as described in Section 12.

Ammonia and Sulfide Toxicity

Whether ammonia is or is not a contaminant of concern depends on the disposal site. In order to identify elutriate or solid phase dredged material toxicity due to ammonia, it is essential to make routine measurements of ammonia on appropriate test fractions. These measurements are compared to water-only toxicity data for the same species used in the dredged material test (see Appendix F). The water-only toxicity data generated separately should be generated under conditions (e.g., pH, test length) reasonably similar to those in the test with the dredged material. If ammonia concentrations are too low to have potentially caused the observed toxicity in the dredged material sample, other contaminants are responsible for the toxicity. If ammonia concentrations are high enough to have caused the observed toxicity, toxicity identification evaluation (TIE) procedures should be used to confirm this suspicion. When there is no TIE confirmation that ammonia is responsible for sediment toxicity, it must be assumed that persistent contaminants other than ammonia are causing toxicity. Full details of procedures to identify ammonia as a toxicant in toxicity tests with dredged material are provided in Appendix F.

Whenever chemical evidence of ammonia is present at toxicologically important levels, i.e. ammonia concentrations exceed the species-specific acceptability ranges shown below (or 20 mg/L for freshwater organisms), and ammonia is not a contaminant of concern at the disposal site, the laboratory analyst should set up one or more beakers explicitly for the purpose of measuring interstitial ammonia. Ammonia in the sediment interstitial water should be reduced to below the species-specific level shown below (or to below 20 mg/L for freshwater organisms) before adding the benthic test organisms. Ammonia concentrations in the interstitial water can be reduced by sufficiently aerating the sample at saturation and replacing two volumes of water per day. The analyst should measure interstitial ammonia each day until it reaches a concentration below the appropriate species-specific level (or ≤20 mg/L for freshwater organisms). After placing the test organisms in the sediment, the analyst should ensure that ammonia concentrations remain within an acceptable range by conducting the toxicity test with continuous flow or volume replacement not to exceed two volumes per day. Peer-reviewed papers that deal with ammonia in sediments include: Dewitt et al. (1988), Scott and Redmond (1989), Burton (1991), EPA (1992, 1994c, 1994d), Benoit et al. (1993), Ankley et al. (1991, 1992a, 1992c, 1994).

General Acceptability Ranges for Ammonia in Marine and Estuarine Amphipod Sediment Toxicity Tests.

Parameter	*Rhepoxynius*	*Ampelisca*	*Eohaustorius*	*Leptocheirus*
Ammonia (total mg/L, pH 7.7)	<30	<30	<60	<60
Ammonia (unionized mg/L, pH 7.7)	<0.4	<0.4	<0.8	<0.8

The chemistry and toxicology of sulfides is less well-understood than that of ammonia. However, sulfides are not likely to be a problem in most open-water situations, or in bioassays where adequate oxygen levels are maintained in the overlying water.

11.2.3 Chronic/Sublethal Tests

Chronic/sublethal responses to sediment are presently only available, in addition to the end-point of survival, for a very few toxicity tests, for example: the amphipods *Hyalella azteca*, *Ampelisca abdita* and *Leptocheirus plumulosus;* the midges *Chironomus tentans* and *C. riparius*; the oligochaetes *Tubifex tubifex* and *Lumbriculus variegatus,* and the polychaete *Neanthes arenaceodentata.* [Note: EPA has recently developed chronic sediment toxicity test methods for freshwater organisms (*C. tentans and H. azteca*). EPA and USACE are jointly developing a chronic sediment toxicity test method manual for marine and estuarine organisms (*L. plumulosus*). These documents are currently under review and will be published as standard methods manuals.] Unlike acute toxicity tests, there is presently no consensus as to what level of chronic/sublethal effects (e.g., reduction of growth, reproduction, fecundity, survival of young) is cause for concern. Further, there is also no consensus as to when such effects would preclude disposal or would constitute unacceptable adverse effects requiring some type of management action. Hence, chronic/sublethal tests are not presently part of Tier III in this national manual. However, regional testing manuals may apply appropriate chronic/sublethal tests to sediments in advance of their inclusion in this national manual provided this is done with a benchmark species (e.g., *C. tentans*) or *in addition to* the benchmark testing.

Guidance for conducting the above tests may be found in publications including Nebeker and Miller (1988), Nebeker et al. (1984), Johns and Ginn (1990), Johns et al. (1990), Ingersoll and Nelson (1990), Dillon et al. (1993), Phipps et al. (1993), McGee et al. (1993). Burton (1991) provides a comprehensive review of freshwater sediment toxicity tests. Survival and growth are the endpoints of all of these tests. In addition, some tests also measure reproductive end-points.

Criteria for control acceptability for chronic/sublethal tests are specific to the test and organism. If control criteria are exceeded, the test must be repeated.

11.2.4 Data Presentation and Analysis

Data Presentation

The data for each test species should be presented in separate tables that include the following information:

- scientific name of the test species

- number of organisms in each treatment at the start of the test
- number of organisms recovered alive and/or in normal health from each chamber at the end of the test (including positive and negative controls)
- information regarding emergence, burrowing, tube building, behavioral abnormalities, growth, reproduction, and any other observations
- water-quality data for each test chamber for each day.

Data Analysis

It is possible that neither mortality nor other effects will be observed in any of the treatments or that survival in the dredged material will be equal to or higher than survival in the reference or control sediments. In either of these situations, there is no need for statistical analysis and no indication of adverse effects due to the dredged material. Similarly, if survival is higher in test sediments than in the control, but lower than in the reference area, and control survival is at acceptable levels (i.e., 90% or greater survival), there is no need for statistical analysis and no indication of benthic toxicity due to the dredged material. However, if survival in the reference sediment is higher than in the dredged material treatments and exceeds the allowable percent difference between the two treatments, the data have to be analyzed statistically to determine whether there is a significant difference between the reference and dredged material. Statistical procedures recommended for analyzing benthic acute toxicity data are described in detail in Appendix D. Local guidance must be developed to interpret chronic/sublethal tests.

11.2.5 Conclusions

Guidance on the use of the results to reach a determination is provided in Section 6.2.

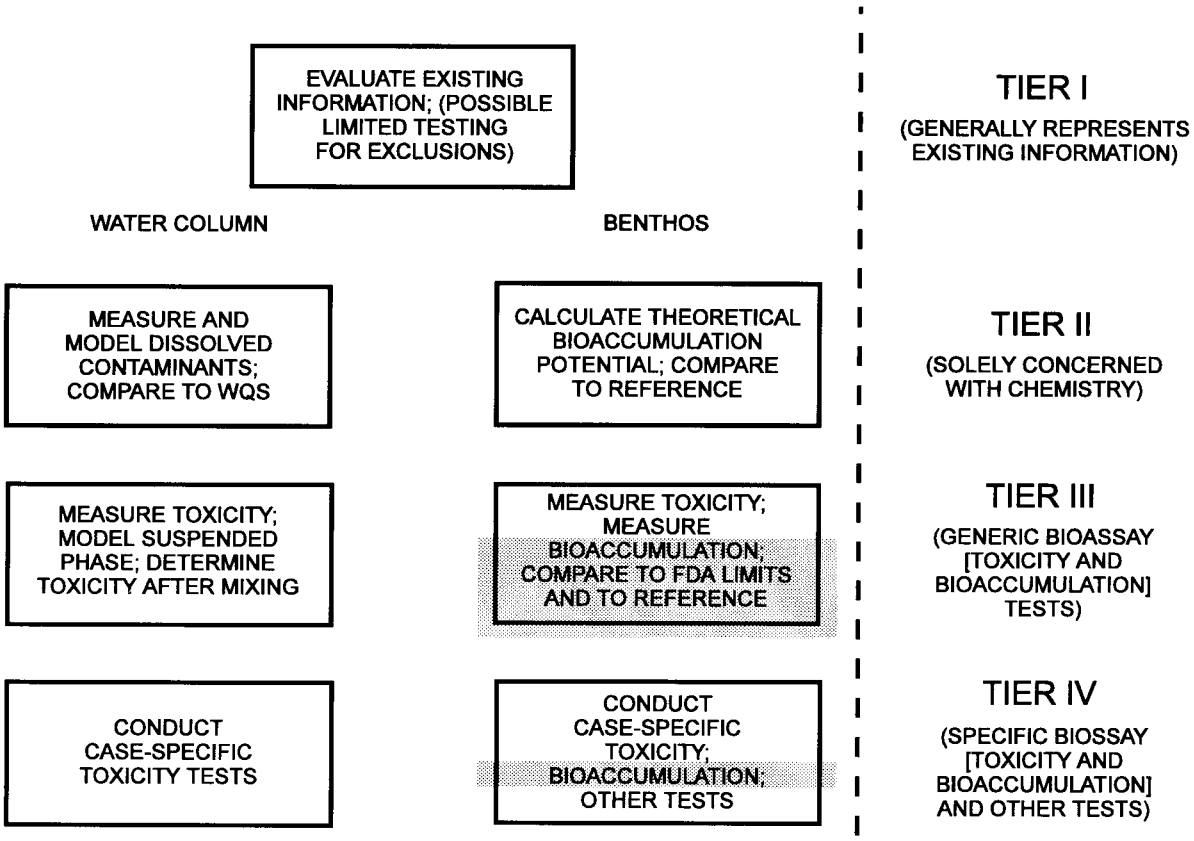
11.3 Tier IV: Chronic/Sublethal Effects Evaluations

At present, it is not appropriate to incorporate sediment chronic/sublethal effects testing in this national manual (see Sections 6.0 and 11.2.3). When standardized chronic effects tests are approved, they will be incorporated in Tier III. Until then, such non-standard tests should be used in Tier IV except where regional testing manuals apply such tests in advance of their inclusion in future revisions of this national manual, provided this is done with a benchmark species or *in addition to* the benchmark testing.

11.4 Tier IV: Case Specific Evaluations

Biological effects tests in Tier IV should be used only in situations that warrant special investigative procedures. They may include chronic/sublethal tests, field studies such as benthic infaunal studies (EPA, 1992), experimental studies such as *in situ* toxicity tests or toxicity identification evaluation (Ankley et

al., 1992a), risk assessments and/or no effects levels for aquatic life. In such cases, test procedures have to be tailored for specific situations, and general guidance cannot be offered. Such studies have to be selected, designed, and evaluated as the need arises, with the assistance of administrative and scientific expertise from EPA and USACE, and other sources as appropriate.


EVALUATE EXISTING INFORMATION; (POSSIBLE LIMITED TESTING FOR EXCLUSIONS)
TIER I
(GENERALLY REPRESENTS EXISTING INFORMATION)
WATER COLUMN
BENTHOS
MEASURE AND MODEL DISSOLVED CONTAMINANTS; COMPARE TO WQS
CALCULATE THEORETICAL BIOACCUMULATION POTENTIAL; COMPARE TO REFERENCE
TIER II
(SOLELY CONCERNED WITH CHEMISTRY)
MEASURE TOXICITY; MODEL SUSPENDED PHASE; DETERMINE TOXICITY AFTER MIXING
MEASURE TOXICITY; MEASURE BIOACCUMULATION; COMPARE TO FDA LIMITS AND TO REFERENCE
TIER III
(GENERIC BIOASSAY [TOXICITY AND BIOACCUMULATION] TESTS)
CONDUCT CASE-SPECIFIC TOXICITY TESTS
CONDUCT CASE-SPECIFIC TOXICITY; BIOACCUMULATION; OTHER TESTS
TIER IV
(SPECIFIC BIOSSAY [TOXICITY AND BIOACCUMULATION] AND OTHER TESTS)

12.0 GUIDANCE FOR PERFORMING BIOACCUMULATION TESTS

Bioaccumulation is defined in relation to disposal activities in the Definitions section at the beginning of this manual.

12.1 Tier III: Determination Of Bioavailability

Bioavailability tests are designed to evaluate the potential of benthic organisms to bioaccumulate contaminants of concern from the proposed dredged material. Lee et al. (1989) and Boese and Lee (1992) discuss bioaccumulation methodology in detail and may be followed on any matter that does not conflict with this manual. Tier III bioavailability tests are based on analysis of tissues of organisms after 28 d of exposure (see Section 6.3). Although time series testing is a component of Tier IV bioaccumulation testing, it may also be appropriate in Tier III, for instance where K_{ow} values are greater than 5.5 (see Section 12.2.1).

12.1.1 Species Selection and Apparatus

The selection of aquatic organisms for use in the determination of bioaccumulation will depend on their inability to metabolize some types of organic compounds, and their ability to survive exposure to the test sediments. Two species should be used in bioaccumulation testing where possible (Table 12-1), unless adequate regional data are available to justify single species testing. Test species should provide adequate biomass for chemical analysis, and preferably ingest sediments and survive in dredged material and control and reference sediments equally well (or where differences can be accounted for). The rationale for testing more than a single species is to cover the range of differing species contaminant accumulation and to be environmentally protective. Of the species tested, at least one must be a benchmark species; however, this does not preclude the use of more than one benchmark species. Non-benchmark species listed in Table 12-1 can achieve benchmark status if a summary of test conditions and test acceptability criteria similar to the starred benchmark species are provided that meet the required species characteristics criteria. To be technically justified, species proposed for use regionally and not listed in Table 12-1 would also need to meet the species characteristics criteria and proponents should provide a summary of test conditions and test acceptability criteria except where species are to be tested *in addition to* the benchmark species. In this latter case, this information is desirable but not needed.

Table 12-1. Candidate Test Species for Determining Potential Bioaccumulation from Whole Sediment Tests. Details of testing procedures are provided in Appendix E; additional guidance is provided in EPA (1994c,d).

Polychaetes

*Neanthes arenaceodentata** (N)
*Nereis virens** (N,E)[a]
Arenicola marina (N)

Oligochaetes

Lumbriculus variegatus (F)*

Insect Larvae

Mayfly, *Hexagenia limbata* or sp. (F)

Bivalves

Macoma clam, *Macoma nasuta**(N,E)[a]
Yoldia clam, *Yoldia limatula* (N)

Crustaceans

Diporeia sp. (F)

Note: Examples are not presented in order of importance; however, the asterisks indicate recommended benchmark species. Other species may be designated in future as benchmark species by EPA and USACE when the data on their response to contaminants are adequate. Only benthic species should be tested. Although sediment ingesters are preferable, intimate contact with sediment is acceptable.

Only tests which do not require feeding of the organisms are included. Feeding is a research issue; for the present, food is not to be added because it provides additional organic carbon and can alter contaminant partitioning during testing.

For the purpose of this manual, related to the tolerances of the test animals, (F) = Freshwater, salinity ≤ 1‰ (N) = Near Coastal, salinity ≥ 25‰ (E) = Estuarine, salinity 1-25‰. It is recognized that the commonly accepted salinity range for estuaries is 1-35‰ and near coastal water is usually greater than 30‰ salinity.

[a] *Macoma nasuta* and *Nereis virens* bioaccumulation tests are in the process of standardization by EPA; it is expected that these will, in future, be the primary benchmark species for near coastal waters. Further, these two species can be used in estuarine waters down to appropriate low levels of salinity (see Appendix E).

Apparatus to be used for testing is described in Section 11.2.2. Additional requirements for voiding gut contents are described in Section 12.1.2. Species characteristics to consider when designing bio-accumulation tests include, not in order of importance:

- readily available year-round
- provide adequate biomass for analysis
- preferably ingest sediments
- preferably high in lipids
- survive in dredged material and control and reference sediments equally well, allowing adequate tissue for analysis
- tolerate handling and laboratory conditions
- related phylogenetically and/or by ecological requirements to species characteristic of the disposal site area in the season of the proposed discharge
- important ecologically, economically, and/or recreationally
- inefficient metabolizers of contaminants, particularly PAH.

Regional scientists and regulatory personnel should be consulted for additional guidance. A minimum amount of tissue is required for analysis, otherwise it will be impossible to quantify the amount of contaminant present (Section 9.5.2). Examples of the amounts of tissue which may be required are provided in Table 8-2. However, the amounts shown are not set amounts; more or less may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory. If the biological needs of the organisms or adequate voiding (e.g., clams) require the presence of sediment, uncontaminated sand should be used (Section 12.1.2). Data in the form of "concentration below detection limits" are not quantitative; definitive concentration measurements are the goal, where such are possible within reasonable method and target detection limits.

12.1.2 Experimental Conditions

Test conditions are similar but not identical to those described in Section 11.2.2 for whole sediment toxicity tests. Overlying water renewal may be required to maintain adequate water quality. Food or additional sediment should not be provided during the test. Control animals should be sampled and archived at both the beginning and the end of testing. If discrepancies are found during data analysis, the archived samples can be analyzed to possibly resolve any problem(s). Due care should be taken not to exceed species-specific biomass loadings (overcrowding; APHA, 1989).

Digestive tracts of the animals should be emptied or removed immediately after termination of the exposure period. Sediment in digestive tracts may contain inert constituents and the contaminants of concern in forms which are not biologically available but which may be incorrectly identified as such during chemical analysis (e.g., see Lobel et al., 1991).

If the animals are large enough to make it practical, the best procedure is to excise the digestive tract. However, test organisms are seldom large enough to allow this, and most organisms have to be allowed to void the material, in separate aquaria in clean, sediment-free water. Some organisms will pass material through the digestive tract only if more material is ingested. These animals have to be purged in aquaria with clean sand. Animals are not fed during the purging period. Fecal material is siphoned from the aquaria twice during the 24-h purging period. To minimize the possibility of loss of contaminants from tissues, purging for longer periods is not recommended. Shells or exoskeletons which generally contain low levels of contaminants are, where possible, removed and not included in the analysis as their weight would give an artificially low indication of bioavailability.

An initial time-zero of each sample is collected for tissue analysis. Tissue contaminant concentrations in control animals must be determined to ensure that background levels are not inordinate. Although procedures for Tier III and IV laboratory bioaccumulation tests have been discussed separately, it may be possible to combine these procedures in practice. This can be done by following the steady state (Tier IV) bioaccumulation procedure which involves sequential time-series analyses, but initially analyzing only the 28 d sample and freezing the other samples. If these data, as part of the Tier III bioavailability evaluation, do not allow a determination to be made, then the remaining time series samples may be analyzed and used in the Tier IV steady-state bioaccumulation evaluation.

12.1.3 Chemical Analysis

Chemical analysis will involve some or all of the contaminants identified in Sections 4.2 and 9.5.1. Analytical procedures are provided in Section 9.5.2.

12.1.4 Data Presentation and Analysis

Data Presentation

Data should be presented in tabular format, listing tissue concentration of each contaminant, by organism and by sediment type (e.g., dredged and reference). Similar information to that detailed in Section 11.2.4

should be provided. Although bioaccumulation species/tests cannot be used to determine toxicity requirements, any mortalities which occur during bioaccumulation testing must be documented.

Data Analysis

Contaminant tissue concentrations in test organisms are statistically compared to the FDA Action Levels (Table 6-1) (refer to Figure 3-3). These tissue concentrations are also statistically compared with reference organism concentrations (Appendix D). In some cases, tissue concentrations in organisms exposed to one or more of the dredged-material samples may be less than or equal to reference organism concentrations. Providing the reference data are appropriate, this result indicates that bioavailability of the contaminants of concern in the dredged material is not greater than in the reference area sediment.

The sample of organisms archived at the initiation of the exposure can be useful in interpreting results. It can add perspective to the magnitude of uptake during the exposure period. In some cases, elevated body burdens may not be due to the dredged material or reference sediment, but may have been already present in the organisms at the start of the test.

12.1.5 Conclusions

Guidance on reaching a determination is provided in Section 6.3.

12.2 Tier IV: Determination Of Steady State Bioaccumulation

Tier IV bioaccumulation evaluation, if necessary, provides for determination, either by laboratory testing (ASTM, 1984) or by collection of field samples, of the steady state concentrations of contaminants in organisms exposed to the dredged material as compared with organisms exposed to the reference site material. Testing options include longer laboratory exposures (not discussed), collection of organisms living in the material to be dredged and at the reference site for body burden determinations (Section 12.2.2) or *in situ* exposures using transplanted organisms, for instance caged mussels (not discussed). Tier IV determinations follow the guidance in Section 7.2.

12.2.1 Laboratory Testing

The necessary species, apparatus and test conditions for laboratory testing are those for Tier III bioaccumulation testing (see Sections 12.1.1 and 12.1.2). Tissue samples taken at different times during

the exposure period provide the basis for determining the rate of uptake and elimination of contaminants. From these rate data, the steady state concentration of contaminants in the tissues can be calculated, even though the steady state might not have been reached during the actual exposure. For the purposes of this test, steady state is defined as the concentration of contaminant that would occur in tissue after constant exposure conditions.

An initial time-zero sample of each species is collected for tissue analysis. Additional tissue samples are collected from each of the five replicate reference and dredged-material exposure chambers at intervals of, for instance, 2, 4, 7, 10, 18, and 28 d. It is critical that enough tissue is available to allow for interval body burden analyses at the specified detection limits.

Complete tissue concentration data should be presented in tabular format. Recommended statistical methods for fitting a curve to determine steady-state tissue concentration are provided in Appendix D. The statistical procedures use an iterative curve-fitting process to determine the key variables ($k_1 C_s$ the uptake rate-constant times the contaminant concentration in the sediment, and k_2 the depuration rate constant). An initial value for C_s has to be supplied. When the sediment concentration of the contaminant of concern is used, the ratio of k_1/k_2 is the sediment bioaccumulation factor (BAF) (Lake et al., 1987; Rubinstein et al., 1987), the ratio of steady-state tissue concentration to sediment concentration.

A determination is made based on the magnitude of bioaccumulation from the dredged material, its comparison with the available FDA levels, steady-state bioaccumulation from the reference sediment, and the body burden of reference organisms. Guidance for making determinations based on these comparisons is provided in Section 7.2 and can include risk assessment and no effects levels for aquatic life.

Guidance on quality assurance/quality control (QA/QC) considerations for bioaccumulation testing are provided in Appendix G.3.17 and EPA (1995).

12.2.2 Field Assessment of Steady State Bioaccumulation

Field sampling programs obviate difficulties related to quantitatively considering field-exposure conditions in the interpretation of test results, since the animals are exposed to the conditions of mixing and sediment transport actually occurring at the disposal site. Difficulties related to the time required to conduct laboratory bioaccumulation studies are also overcome if organisms already living at the disposal site are used for field bioaccumulation studies. This approach is technically valid for predictive purposes only where there is a true historical precedent for the proposed operation being evaluated. That is, a field assessment can be used only where the quality of the sediment to be dredged can be shown not to have deteriorated

or become more contaminated since the last dredging and disposal operation. In addition, disposal has to be proposed for the site at which the dredged material in question has been previously disposed or for a site of similar sediment type supporting a similar biological community. This approach is generally not appropriate for multi-user disposal sites. Knowledge of the contaminant body burden of the organisms living around the proposed disposal site is used in evaluating bioaccumulation results in Tier IV (Section 7.2).

12.2.2.1 Apparatus

Major items required include:

- a vessel capable of operating at the disposal site and equipped to handle benthic sampling devices; navigation equipment has to allow precise positioning
- sampling devices such as a box corer, Smith-MacIntyre, Van Veen, Petersen, Ponar, Ekman or other benthic grab
- stainless steel screens to remove animals from the sediment
- tanks for transporting the animals to the laboratory in collection site water
- laboratory facilities for holding the animals prior to analysis
- chemical and analytical facilities as required for the desired analyses.

12.2.2.2 Species Selection

The species selected for analysis have to be present in sufficient numbers for adequate sample collection at all stations and to provide sufficient tissue for analysis (see Section 12.1.1). The same species must be collected at all stations because bioaccumulation cannot be compared across species lines. If these conditions cannot be met, the field assessment approach cannot be implemented.

If possible, several samples of sufficient size for analysis should be collected at each station to provide a statistical estimate of variability in tissue contaminant content. Collection of more than one sample per station, however, may prove impractical if a composite of many small organisms has to be used or if suitable organisms are not abundant at the disposal site.

To minimize the numbers and collection effort required, it is desirable to select the largest appropriate species. However, highly mobile epifauna (such as crustaceans, certain molluscs, and fish) should not be used, because a relationship cannot be established between their location when collected and their

body burden at the time of collection. Therefore, relatively large, immobile species are the most desirable organisms. However, analyses should not be conducted on single organisms as the objective is to obtain representative data for the entire population of organisms. Any relatively immobile species collectable in sufficient numbers at all stations may be used, but the required collection effort increases sharply as organism size decreases.

As discussed previously, if PAH are contaminants of concern, it is essential that bioaccumulation studies include one or more species with very low ability to metabolize PAH. Bivalve molluscs and oligochaetes are widely accepted as meeting this requirement.

12.2.2.3 Sampling Design and Conduct

Sufficient tissue to obtain definitive body burden data has to be collected using the same species from each of at least three stations within the disposal site boundaries and from an acceptable reference site. It is mandatory that several stations be sampled, rather than collecting all of the animals at one station, in order to provide a measure of the variability that exists in tissue concentrations in the animals in the area. Samples from all stations should be collected on the same day if possible.

12.2.2.4 Basis for Evaluation of Bioaccumulation

Evaluations are made by comparison to contaminant concentrations in field organisms living around, but not affected by, the disposal site, similar to the reference area approach (Section 3.1). In this case, reference data involve at least three stations located in an uncontaminated material sedimentologically similar to that within the disposal site, in a direction perpendicular to (i.e., not in the direction of) the net bottom transport. If the direction of net bottom transport is not known, at least six stations surrounding the disposal site should be established in sediments sedimentologically similar to those within the disposal site.

12.2.2.5 Sample Collection and Handling

Repeated collections should be made at the same location until an adequate tissue volume is obtained. Gently wash the sediment obtained by the sampler through 1-mm mesh stainless-steel screens, and place the retained organisms of the desired species in holding tanks.

Label the samples clearly and return the organisms to the laboratory, being careful to keep them separated and to maintain nonstressful levels of temperature and dissolved oxygen. In the laboratory, maintain them in clean water in separate containers. Do not place any sediment in the containers and do not feed the organisms. Immediately discard any organisms that die. Remove sediment from the digestive tracts of the organisms and, as possible, shells or exoskeletons (Section 12.1.2).

12.2.2.6 Chemical Analysis

Chemical analysis will involve some or all of the contaminants identified in Sections 4.2 and 9.5.1. Analytical procedures are provided in Section 9.5.2.

12.2.2.7 Data Presentation and Analysis

Complete tissue concentration data for all samples should be presented in tabular format as previously described. Since Tier IV testing will generally use non-standard methods and approaches, complete documentation is critical. Recommended statistical methods presented in Appendix D may not include all data analyses necessary for all Tier IV tests.

12.2.2.8 Conclusions

A determination is made based on the magnitude of bioaccumulation in organisms collected within the boundaries of the reference site, compared with bioaccumulation in organisms living within the area to be dredged. Guidance for making a determination based on these comparisons is provided in Section 7.2.

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US Army Corps
of Engineers
Buffalo District

Soil Investigation

Parcel J
Fox Shores Drive
Kaukauna, Wisconsin
(BRRTS No. #02-45-548419)

September 2021

Contents

List of Figures ii
List of Tables ii
Appendices ii
1. Introduction 1
1.1 General 1
1.2 Site Description 1
1.3 Site History 2
1.3.1 Previous Investigations and Remedial Activities 3
2. Project Scope and Objectives 6
2.1 Definition of the Problem 6
2.2 Project Objectives 6
2.3 Project Action Levels 7
3. Field Activities 7
3.1 General 7
3.2 Mobilization/Demobilization 7
3.3 Test Pit Excavation 7
3.4 Equipment Decontamination 8
3.5 Field Variances 8
4. Sub Surface Conditions and Site Geology 8
5. Site Investigation Results 8
6. Conclusions 10
7. References 10

List of Figures
(Following Text)

Figure 1 Site Location Map

Figure 2 Location of Parcel J

Figure 3 Test Pit Locations

Figure 4 Test Pit Lead and Benzo(a)pyrene Results

List of Tables
(Following Figures)

Table 1 Soil Metal Analytical Results

Table 2 Soil PAH Analytical Results

Table 3 Soil PCB Analytical Results

Table 4 Soil TCLP Results

Appendices
(Following Tables)

Appendix A Test Pit Logs

1. Introduction

1.1 General

This evaluation has been prepared to summarize the field activities and analytical results associated with a soil investigation performed at Parcel J, a federally owned parcel along the Fox River in Kaukauna, Wisconsin, managed by the U.S. Army Corps of Engineers (USACE) (Figure 1). The U.S. Army Corps of Engineers (USACE) performed this field investigation to gather data necessary to evaluate soil contaminant concentrations within site soils.

In August 2020, the Wisconsin Department of Natural Resources (WDNR) issued a letter indicating that USACE was responsible for the investigation and remediation of contaminated soil on Parcel J (BRRTS #02-45-548419). Parcel J has previously been investigated by USACE in 2001, 2003, 2004 and 2005 as part of the larger transfer of federal properties associated with the Fox River navigation system to the State of Wisconsin. The Memorandum of Agreement (MOA) between the Department of the Army and the State of Wisconsin (dated September 11, 2000) provides that "Subject to the availability of funds and based on the Environmental Baseline Studies to be completed pursuant to paragraph C.2. of this Article, the Government agrees to complete any necessary remediation action required by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and provide the applicable warranties and covenants required by section 120(h) of CERCLA." Due to elevated lead concentrations within the western portion of Parcel J (west of the Kaukauna Power Canal) this portion of the parcel was not transferred with the rest of the Fox River properties (the eastern portion was retained by USACE for operation and maintenance of the adjacent federal dam). USACE will perform this field investigation to gather data necessary to evaluate soil lead concentrations along the western portion of Parcel J.

The field activities describe within this Technical Memorandum are consistent with the elements set forth in the CERCLA (CERCLA; 42 [USC] 9601 et seq.), as amended; the National Contingency Plan (NCP) of March 8, 1990 (40 Code of Federal Regulations [CFR] Part 300).

A Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) were developed and comprise the Sampling and Analysis Plan (SAP) for the SI. The SAP provided a consistent framework of policies, procedures, functional activities and organization that were used during field and laboratory activities related to the acquisition of chemical data. The QAPP outlined the Quality Assurance (QA) program and Quality Control (QC) procedures that were used to verify and maintain the level of performance required to meet the project objectives. An Activity Hazard Analysis (AHA) was prepared for the SI field activities and attached as Appendix A of the SAP (USACE, 2021).

1.2 Site Description

Parcel J is located on the Lower Fox River in the City of Kaukauna, Outagamie County, WI, approximately 40 kilometers (km) [25 miles (mi)] southwest of Green Bay (Figure 1). Parcel J is approximately 2.4 acres, with the parcel bisected into two portions by the Kaukauna Power

Canal. The western portion is a thin strip of land along the south shore of the Fox River on the west side of the Kaukauna Power Canal, approximately 700 feet long and 25 to 50 feet wide (0.6 acres), and the eastern portion is about 1.8 acres between the Fox River and east side of the Kaukauna Power Canal, at the Fox River U.S. Dam Right Abutment. The eastern portion is associated with USACE operation and maintenance of the Dam. A portion of the parcel downstream of the Dam (0.5 acres) was transferred to the State of Wisconsin. The western portion of Parcel J is abutted by several residential apartment complexes and the eastern portion is abutted by a city park.

Previous investigations of the western portion of Parcel J indicate that lead concentrations within shallow soils (0-4 feet) sporadically exceed the residential direct contact screening level of 400 mg/kg, ranging from 15 to 11,000 mg/kg. Shallow soils generally consist of historic fill made up of sand and gravel with silty clay. The fill is underlain by native glacial till (red-brown silty clay) to a depth of 10 to 15 feet, at which contact with bedrock is assumed. Groundwater is present at depths of 7 to >10 feet, although wells probed to a depth of 15 feet produced only limited quantities of water for sample collection due to the low hydraulic conductivity of the overburden soils. Shallow groundwater flow is to the south, moving away from the Fox River. Previous groundwater sampling on the parcel indicated lead was not detectable at a detection limit of 1 µg/L.

Parcel J is designated by the Wisconsin Department of Natural Resources (WDNR) in the Bureau for Remediation and Redevelopment Tracking System (BRRTS) as No.02-45-548419.

1.3 Site History

In 1872, the USACE acquired navigational control of the Fox River waterway, between the cities of Menasha and De Pere, Wisconsin.

By the 1940s, the Fox River, which originally played a major role in regional transportation and commerce, saw a major decline in navigation with the advent of railroads and highways. The Upper Fox River locks (Portage to Lake Winnebago) were abandoned by the USACE in 1962. In 1983, the USACE closed the Lower Fox River to commercial traffic and discontinued operation and maintenance of the locks and placed its property holdings in caretaker status. The USACE continued to own and operate nine federal dams and retain control over four privately-owned dams on the Lower Fox River, however, as part of its flood control responsibilities.

Beginning in the 1980's, an effort began to transfer ownership of the locks from the USACE to the State of Wisconsin with the goal of renovating and reopening the locks for commercial and recreational boating. In preparation for this transfer, a MOA was signed on September 11, 2000 (USACE 2015) by the Wisconsin Governor, the Secretary of the WDNR, and the Assistant Secretary of the Army for Civil Works. In the MOA (Paragraph B of Article I), the federal government agreed to "complete any necessary remediation action required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and to provide the applicable warranties and covenants required by Section 120(h) of CERCLA."

In 2001, the FRNSA was created to manage the Fox River Locks following this transfer of ownership of the system from the USACE to the State of Wisconsin DOA. As specified in Chapter 237, Wisconsin Statutes, the FRNSA's primary mission is to repair, rehabilitate, operate and maintain the locks system.

On September 17, 2004, the USACE began transferring the ownership of the 17 locks, 38 ha (94 ac) of land bordering the Lower Fox River, three harbors, and an assortment of related buildings along the Lower Fox River to the Wisconsin DOA. The western portion of Parcel J was not included in this transfer due to the presence of lead contamination in soil.

The area west of the Kaukauna Power Canal was historically used as a rail service/maintenance yard, including carpentry, machine, blacksmith, tin, and repair shops, supply warehouses, engine and coal rooms, and a roundhouse for locomotive maintenance, by the Chicago and Northwestern Railway from the late 1800s through the 1980s, until being redeveloped as residential apartment complexes (Partner 2018). The western portion of Parcel J is located along the northern periphery of the historic rail service/maintenance yard, with historic development in the form of buildings and tracks occurring to the south.

A Phase 1 Environmental Site Assessment (ESA) and Environmental Baseline Survey of the Fox River properties was conducted in 2000 (Barr 2000). A review of this assessment does not indicate that products containing emerging contaminants, including PFAS, were produced, used, handled or stored at the site. Previous investigations indicate that historic fill along the western portion of the parcel is sporadically impacted by elevated concentrations of lead. USACE has not had any discernable historic use of this portion of the property.

1.3.1 Previous Investigations and Remedial Activities

The eastern portion of Parcel J was investigated in 2001, after a Phase I Environmental Site Assessment (ESA) indicated potential recognized environmental conditions (RECs) including historic surface disturbances and historic industrial use by the Kaukauna Water Power Company (Barr 2000). Three temporary groundwater wells were installed and sampled for volatile organic compounds (VOCs) (Kc-1-01, Kc-2-01, and Kc-3-01) and three soil borings were collected for analyses of soil polychlorinated biphenyls (PCBs) and metals (Kd-1-01, Kd-2-01, Kd-3-01) (Altech 2001). Soil metal concentrations were below screening criteria (lead concentrations ranged from 39 to 291 mg/kg) and PCBs were not detectable in soil. VOCs were not detected in groundwater except for low level detections of toluene and ethyl benzene, which were below screening criteria. Soils generally consisted of reddish brown moderately hard and moderately plastic silty clay (glacial till) with minor percentages of sand and gravel, with increased sand and gravel occasionally in the upper 2 to 3 feet. Fill material was occasionally encountered, consisting of dark brown to black sandy clay, with cinders, wood fragments, gravel, and concrete fragments intermixed with portions of native clay soil. Groundwater was encountered at depths of 9 to 10 feet; however, the wells were extremely slow to recharge, indicating the clayey soils to be of low permeability.

The western portion of Parcel J was initially investigated in 2003 to address the potential impact of past adjacent industrial use (Altech 2006). Soil was sampled and analyzed for metals and VOCs from three locations at depth intervals of between 0 and 2 feet below ground surface.

Lead was identified as the contaminant of concern for the property as lead concentrations ranged from 61 to 320 mg/kg, greater than the then non-industrial direct contact screening criteria of 250 mg/kg. Further sampling occurred in 2004, in which 17 locations were sampled to a maximum depth of 4 feet. Soil borings were screened at 0.5 to 1.0 foot intervals with an XRF to profile lead concentrations. XRF lead concentrations ranged from < 30 mg/kg to 4,000 mg/kg, with the highest concentrations occurring within the 0-2-foot depth interval. The bottom depth interval of each soil boring was submitted for laboratory analysis of lead. Laboratory determined lead concentrations ranged from 18 to 11,000 mg/kg at depths of 0.5 to 4 feet below ground surface. To further characterize soil lead concentrations across the soil profile, ten soil borings were collected in 2005 to depths of 8.5 to 10 feet below ground surface. Soil was sampled and analyzed for lead at depth intervals of 0-2 feet, 4-6 feet, and 7-9 feet. Soil lead concentrations in the 0-2 feet interval ranged from 15 to 2,100 mg/kg, compared to a range of 3.3 to 79 mg/kg across the deeper intervals. Samples for toxic characteristic leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP) testing were collected from the two locations with the highest lead concentrations (440 mg/kg and 2,100 mg/kg). TCLP results ranged from 0.85 to 1.1 mg/L, below the hazardous waste threshold of 5.0 mg/L. The SPLP results ranged from 27 to 330 µg/L, above the WDNR groundwater preventive action limit and enforcement standard for lead of 1.5 µg/L and 15 µg/L, respectively. Three temporary groundwater wells were also installed to depths of 15 feet, however only one well produced enough groundwater to be sampled, again indicating very slow recharge rates from the predominantly clay soils. Lead was not detectable in the groundwater sample at a reporting limit of 1 µg/L, less than the preventative action limit of 1.5 µg/L. Across the sampling events, elevated lead levels have been limited to the upper 4 feet of soil, within the shallow fill/sand-based soil layers, with reduced lead concentrations within the deeper, native clay-based soil layers. Depth to groundwater ranged from 7 to greater than 10 feet. Across the three sampling events, 50 samples were collected across 30 locations, with lead concentrations greater than the residential direct contact screening criteria in 10 of the 50 total samples, and at 10 of the 30 locations. Most of the elevated results within the western portion of Parcel J are located across the eastern half toward the Power Canal.

Three adjacent properties associated with the historic rail service/maintenance yard have recently been the subject of environmental investigations: Fox Shores apartments (BRRTS #02-45-582746), Ghost Town Fitness (BRRTS #02-45-5479110), and the Roundhouse Manor apartments (BRRTS #07-45-559282) (Figure 2). These properties housed most of the buildings and rail spurs associated with the rail yard and are down gradient of Parcel J.

The Fox Shores apartment complex immediately south of the western portion of Parcel J has been subject to various remedial investigations from 2018 to 2020, including sampling of 27 soil borings to depths of between 1.5 and 10 feet, and 5 groundwater wells (Stantec 2020). Soil samples generally consisted of silty clay, with some sand and gravel layers and fill layers within the upper 4 feet. Samples were collected primarily from the 0-2 and 2-4 feet intervals for laboratory analysis of polycyclic aromatic hydrocarbons (PAHs), VOCs, and RCRA metals. Groundwater was sampled in the fall and the spring for PAHs, VOCs and RCRA metals. Groundwater was generally encountered at 4 to 6 feet below ground surface, and the wells were able to be purged dry, again owing to the low hydraulic conductivity of the mainly clay soils. Groundwater flow was toward the south, moving away from the Fox River and Parcel J. Across

two rounds of groundwater sampling, arsenic was above the preventive action limit of 1 µg/L in 3 of the 5 wells, with concentrations ranging from 1.3 to 17 µg/L in those wells, with one instance of being above the enforcement standard of 10 µg/L. Arsenic is a naturally occurring constituent in soil and groundwater and is sometimes found at high levels (>10 µg/L) in groundwater in Outagamie County (WDNR 2021). Concentrations of benzo(a)pyrene (0.36 µg/L), benzo(b)fluoranthene (0.29 µg/L), and chrysene (1.5 µg/L) were detected above the groundwater enforcement standard of 0.2 µg/L across three separate wells, however, were believed to be associated with suspended solids within the sample, rather than mobile dissolved results. VOCs were not detected at levels above groundwater screening criteria. Based on these results it was concluded that groundwater impacts were minimal, with site soil contaminants not significantly impacting groundwater quality. The soil sampling results indicated the widespread presence of historic urban fill consisting of clay with sand/gravel present at depths of up to 3 feet, underlain by native silty clay soil. Within the shallow soil samples (0-4 feet), arsenic, lead, and various PAHs were occasionally detected above residential direct contact screening criteria. Arsenic was detected above the background threshold value of 8 mg/kg in 12 of 27 samples, with a maximum concentration of 240 mg/kg and lead was detected above the residential direct contact criteria of 400 mg/kg in 7 out of 27 samples with a maximum concentration of 97,000 mg/kg. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, dibenzo(a,h)anthrathene and indeno(1,2,3-cd)pyrene were the PAHs detected above residential direct contact criteria, with benzo(a)pyrene most often exceeding criteria, with 21 out of 31 results above the criteria of 0.115 mg/kg. When compared to typical urban background soil concentrations, 5 out of 31 results exceeded 95% Upper Confidence Limits for PAHs in Milwaukee undisturbed soils (Siemering and Thiboldeaux 2021). These conditions were associated with apparent petroleum impacted soils sporadically located between the apartment buildings north of Bicentennial Court and along landscaped areas adjacent to Bicentennial Court and Fox Shores Drive. VOCs were not detected above screening criteria.

The property immediately southeast of the Fox Shores apartment complex, Ghost Town Fitness Center, was subject to soil and groundwater sampling and analysis in 2006. A soil boring and groundwater well were installed to evaluate potential environmental impacts associated with the historic use as a rail service/maintenance yard (Terracon 2006). Specifically, this area historically consisted of the machine shop, blacksmith, and locomotive roundhouse. Soil and groundwater were analyzed for diesel range organics, VOCs, and RCRA metals. Groundwater was encountered at 4 feet below ground surface. Soil concentrations did not exceed screening criteria, however there were minor exceedances of the groundwater preventive action limit for arsenic (3 µg/L compared to 1 µg/L) and selenium (14.7 µg/L compared to 10 µg/L). Based on these results the site was granted a PAL exemption and closure in 2006.

The property immediately east of Ghost Town Fitness Center, the Roundhouse Manor apartments, was investigated in 2012 to address potential environmental impacts associated with the historic use of the site, including housing the railroad roundhouse, turn table, sand house, water tank, coal shed, hoist and coal dump, and rail spurs. Four soil borings were collected to depths of 10 to 16.5 feet, with two borings converted to temporary monitoring wells. Groundwater was present at 10.5 to 12.5 feet below ground surface. Soil and groundwater were sampled and analyzed for total petroleum hydrocarbons – diesel range organics (TPH-DRO), metals, VOCs, and PAHs. Low levels of arsenic (5.6 mg/kg to 11.4 mg/kg), lead (105 mg/kg to

133 mg/kg), and TPH-DRO (151 mg/kg to 170 mg/kg) were detected in soil samples above screening criteria and PAHs benzo(a)anthracene, benzo(a)pyrene, and phenanthracene were detected above the preventive action limit in groundwater. To further evaluate groundwater conditions, groundwater was resampled from a more robustly developed monitoring well, with no exceedances determined. Based on these results, the site was granted a no further action required determination.

Based on the previous investigations of the western portion of Parcel J, lead concentrations within shallow soils (0-4 feet) sporadically exceed the residential direct contact screening level of 400 mg/kg. Shallow soils generally consist of historic fill made up of sand and gravel with silty clay. The fill is underlain by native glacial till (red-brown silty clay), which is of low hydraulic conductivity, limiting groundwater flow and infiltration. Groundwater is present at depths of greater than 7 feet and flows to the south, moving away from the Fox River and Parcel J. Previous groundwater sampling on the parcel and on adjacent, downgradient properties, confirm limited impacts to groundwater from soil contaminants. Contaminant conditions are assumed to be associated with the historic development of the adjacent area to the south as a rail service/maintenance yard.

2. Project Scope and Objectives

The objective of the field work and analysis described in this section is to define contaminant concentrations in fill and soils along the western portion of Parcel J. Based on the previous investigations on Parcel J and adjacent parcels, RCRA metals and PAHs in surficial soils require further evaluation.

2.1 Definition of the Problem

Soil sampling and analysis is needed to determine the extent that soils may need to be remediated along the western portion of Parcel J due to lead and/or PAH contamination (Figure 2). The USACE proposed this field investigation to determine the horizontal and vertical extent of contaminant impacted soil along the western portion of Parcel J.

2.2 Project Objectives

The following Data Quality Objectives (DQOs) were established for the SAP following the USEPA DQO process. The SAP DQOs were established using available previous site investigation data to evaluate potential remedial activities associated with the handling and/or removal of impacted material.

The objectives for the field investigation were:

- Determine whether soil contaminant concentrations along the western portion of Parcel J represent a risk to human health.
- Determine the horizontal and vertical extent, and volume of contaminated soil that may have to be remediated.

2.3 Project Action Levels

The western portion of Parcel J is undeveloped and USACE has no active use of the area. However, this portion of the parcel is adjacent to several residential apartment complexes. As such, apartment residents may come into contact with site soil if they enter the parcel. To evaluate the potential risk to apartment residents from direct contact with parcel soils, the USEPA Regional Screening Level (RSL) and Regional Removal Management level (RML) for lead in residential soil of 400 mg/kg will be used as a screening criterion (USEPA 2021a,b). This represents the USEPA screening level for lead in soil for residential land use (USEPA 1994).

PAH data will be reviewed based on USEPA residential direct contact RSLs (target cancer risk [TR]=1E-06; target hazard quotient [THQ]=0.1), regional urban background concentrations for Milwaukee, WI (Siemering and Thiboldeaux 2021), and USEPA residential direct contact RMLs (TR=1E-04; THQ=1) (USEPA 2021b).

RCRA metals data will be reviewed based on USEPA residential direct contact RSLs (TR=1E-06; THQ=0.1), Wisconsin background threshold values, and USEPA residential direct contact RMLs (TR=1E-04; THQ=1).

The RSLs are chemical specific concentrations in soil that indicate when further evaluation may be necessary under CERCLA and the RMLs are chemical specific concentrations in soil that may be used to support the decision to undertake a CERCLA removal action.

3. Field Activities

3.1 General

This section describes the field activities that were performed on May 25, 2021.

The scope of the field work and analysis included the following activities:

- Excavation of 15 test pits.
- Field classification and profiling of soil layers.
- Collection of soil samples for laboratory analysis.

3.2 Mobilization/Demobilization

The health and safety procedures outlined in the AHA were followed during performance of all on-site activities. The field investigation activities were completed in modified level D personal protective equipment (PPE).

3.3 Test Pit Excavation

Fifteen test pits were excavated along the parcel at the approximate locations shown on Figure 3. Test pits were excavated utilizing a Wacker Neuson EZ 28 Mini Excavator equipped with a 2 ft-

wide bucket. The test pits were excavated until native material or refusal was encountered, which was generally at depths of 1 – 4 feet below ground surface. Upon completion, all test pits were backfilled and compacted in one-foot lifts with the excavated spoils materials.

Samples were collected across one-foot intervals following procedures identified in the FSP (USACE, 2021). The fill and soil units encountered were documented on Test Pit logs which are provided in Appendix A.

All soil and sediment samples were shipped under chain-of-custody (COC) control to ALS Environmental Laboratory of Middletown, PA. Soil samples were analyzed for RCRA metals by EPA 6010C and PAHs (16 priority pollutants) by EPA 8270D. Three samples were analyzed for total polychlorinated biphenyls (PCBs) as aroclors by EPA 8082A. Samples with lead results greater than 400 mg/kg were also subjected to Toxicity Characteristic Leaching Procedure (TCLP) testing for metals (EPA 1311).

3.4 Equipment Decontamination

To assure that no outside contamination was introduced into the samples/data, thereby invalidating the samples/data, all non-dedicated/non-disposable equipment used during the SI was decontaminated as per the FSP (USACE, 2021).

3.5 Field Variances

Several conditions in the field made it necessary to implement modifications to excavation and sampling as presented in the FSP. Test pit locations JTP-1, JTP-8, JTP-10, JTP-12, and JTP-14 were offset slightly to avoid either a utility line or trees.

4. Sub Surface Conditions and Site Geology

Geologic conditions at the site are characterized by unconsolidated deposits overlaying consolidated/competent bedrock. The unconsolidated deposits generally consist of dark brown loam/fill ranging from 1 to 3 feet thick overlying native reddish brown clayey till. The bedrock at the site is of the Sinnipee Group which consists of tan, gray of buff dolomite with some limestone and shale (Brown, 2005). The Sinnipee Group includes Galena, Decorah and Platteville Formations. Previous soil borings indicate that depth to bedrock is greater than 10 feet below ground surface along the parcel (Altech 2006). Groundwater was not encountered in any test pit. Previous temporary monitoring wells and borings along the Parcel J indicate groundwater may be present at depths of greater than 7 feet below ground surface (Altech 2006).

5. Site Investigation Results

The USACE received data reports from ALS Environmental Laboratory and these reports were reviewed by a USACE chemist. The USACE review verified compliance with requested testing, completeness of the analytical report, and confirm the receipt of all requested deliverables. In addition, the data was verified to identify method, batch, or individual sample results which may have limitations or be unacceptable.

Table 1 presents the soil analytical results for lead, arsenic, barium, cadmium, chromium, mercury, selenium, and silver. Lead concentrations were greater than the USEPA residential screening level of 400 mg/kg on a sporadic basis across the site at locations JTP-1 (1-3 feet), JTP-2 (0-1 feet), JTP-3 (0-1 foot), JTP-9 (0-1 foot), JTP-14 (0-2 feet), and JTP-15 (1-3 feet), ranging up to 1,660 mg/kg. Lead concentrations within the top foot of soil greater than 400 mg/kg were limited to locations JTP-2 (1,660 mg/kg), JTP-3 (861 mg/kg), JTP-9 (721 mg/kg), and JTP-14 (767 mg/kg) representing 4 out of 15 locations. Lead concentrations within the top foot of soil ranged from 11 mg/kg to 1,660 mg/kg, with an average concentration of 365 mg/kg and a median concentration of 188 mg/kg. Generally, lead concentrations were highest in the surficial fill layer to depths of 1-3 feet, and decreased sharply to background levels within the underlying native reddish brown clay till. Within the underlying reddish brown soils, lead concentrations ranged from 3 mg/kg to 208 mg/kg, with an average concentration of 32 mg/kg and a median concentration of 12 mg/kg. Soil concentrations of arsenic, barium, cadmium, chromium, mercury, selenium, and silver were generally below residential direct contact RSLs or background threshold values, with the exception of low-level exceedances of arsenic and mercury collocated with elevated lead concentrations. Arsenic concentrations were greater than the background threshold value of 8 mg/kg at locations JTP-1 (1-3 feet), JTP-2 (0-1 foot), JTP-3 (0-2 feet), JTP-9 (0-1 foot), JTP-11 (0-1 foot), JTP-14 (0-2 feet), and JTP-15 (1-3 feet), ranging up to 31 mg/kg. Arsenic concentrations within the top foot of soil greater than 8 mg/kg were limited to sample locations JTP-2 (31 mg/kg), JTP-3 (27 mg/kg), JTP-9 (9 mg/kg), JTP-11 (13 mg/kg), and JTP-14 (15 mg/kg), representing 5 out of 15 samples. Arsenic concentrations within the top foot of soil ranged from 3 to 31 mg/kg, with an average concentration of 10 mg/kg and a median concentration of 6 mg/kg. Similar to lead, arsenic concentrations were lower within the underlying reddish brown soils, ranging from 2 mg/kg to 8 mg/kg, with an average and median concentration of 4 mg/kg. Mercury concentrations were only greater than the residential direct contact RSL of 1.1 mg/kg at location JTP-15, at a depth interval of 1-3 feet below ground surface. These concentrations were 2.8 mg/kg and 4.8 mg/kg, which would represent Hazard Quotients (HQ) of less than 1.

Table 2 presents the soil analytical results for PAHs. Most results were not inconsistent with typical urban background concentrations, with the exception of locations JTP-2 (0-1), JTP-4 (0-1), and JTP-6 (0-3). At these locations, concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene exceeded USEPA residential RSLs and 95% upper confidence limits for background concentrations in Milwaukee, WI (Siemering and Thiboldeaux 2021). The concentration of benzo(a)pyrene at location JTP-4 (0-1 foot) of 11,800 µg/kg exceeded the USEPA residential RML of 11,000 µg/kg, although this result was not replicated within the field duplicate sample, which was 5,000 µg/kg. Within the top foot of soil, benzo(a)pyrene concentrations greater than the undisturbed Milwaukee soils UCL of 2,060 µg/kg were limited to locations JTP-2 (3,020 µg/kg), JTP-4 (11,800 µg/kg; 5,000 µg/kg duplicate), and JTP-6 (2,420 µg/kg). Benzo(a)pyrene concentrations within the top foot of soil ranged from 30 µg/kg to 11,800 µg/kg, with an average concentration of 1,486 µg/kg and a median concentration of 468 µg/kg. Similar to lead, in most instances PAH concentrations decrease substantially within the underlying native reddish brown clayey till, to non-detectable levels. An exception was location JTP-6, where PAH concentrations within the reddish brown clay at the interface with the fill layer were similar to concentrations within the surficial fill.

Figure 4 displays the soil lead and benzo(a)pyrene concentrations for each test pit location. Generally, soil concentrations above screening criteria are present sporadically throughout the parcel within historic surficial fill to depths of 1 to 3 feet below ground surface with decreasing concentrations within the underlying native reddish brown clayey till. These conditions are consistent with results from previous investigations on the parcel and adjacent parcels.

Table 3 presents the soil analytical results for PCBs. PCBs were not detectable in the sampled soils.

Table 4 presents the TCLP testing results for metals. All sample results were less than regulatory thresholds for the toxicity characteristic.

6. Conclusions

This soil investigation indicates that in most instances site soils meet residential screening criteria, however there are discrete areas of elevated contaminant concentrations. Currently the parcel has vegetated ground cover and is fenced, limiting contact with site soil if not disturbed. These conditions should continue to be maintained. Soils with lead concentrations greater than the USEPA screening level for residential land use of 400 mg/kg are present at locations JTP-1, JTP-2, JTP-3, JTP-9, JTP-14, and JTP-15 at depths of 1 to 3 feet below ground surface. These lead concentrations are associated with historic surficial fill and decrease sharply to background levels within the underlying native reddish brown clayey till. PAH concentrations exceed USEPA residential RSLs and typical urban background levels at locations JTP-2, JTP-4, and JTP-6 at depths of 1 to 3 feet below ground surface, with benzo(a)pyrene exceeding the USEPA residential RML at location JTP-4 within the 0-1 foot interval. Similar to lead, concentrations of PAHs are generally highest within the surficial historic fill layer at depths of 1-3 feet below ground surface and decrease to background levels within the underlying native reddish brown clayey till. Generally, soil concentrations of lead and PAHs exceed screening criteria sporadically throughout the parcel within the surficial historic fill layer to depths of 1 to 3 feet below ground surface. These results indicate that a removal action under CERCLA may be warranted to provide a long-term remedy and allow the property to be transferred. Based on an estimated surface area of 23,678 square feet across the parcel, and an average fill depth of 20 inches, 1,460 bank cubic yards of historic fill may be estimated across the parcel. Adding another foot across the parcel to address uncertainty in the estimate would add 876 bank cubic yards, for 2,336 bank cubic yards.

7. References

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Figures



Legend

- Parcel J Boundary
- Kaukauna Lock Locations

0 1,000 Feet

US Army Corps of Engineers Buffalo District U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS BUFFALO, NY	SITE LOCATION MAP	
Name: 20210108_ParcelJ_SiteLoc.mxd Drawn By: h5tdekmh Date Saved: 08 Jan 2021 Time Saved: 3:54:46 PM	KAUKAUNA POWER CANAL PARCEL J KAUKAUNA, WISCONSIN	FIGURE 1

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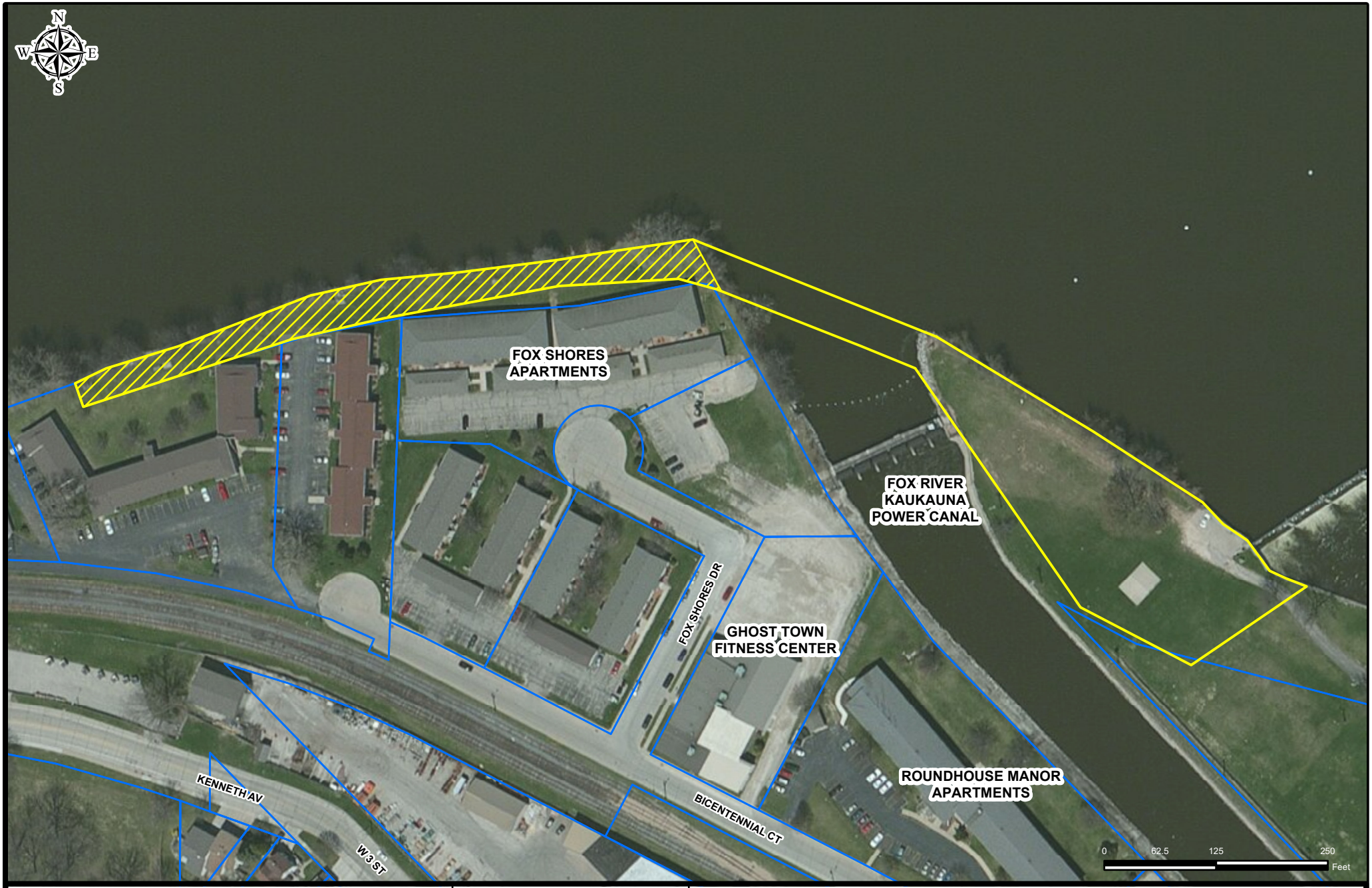

Legend

- Parcel J Sample Area
- Parcel J Boundary
- Tax Parcel Boundary

US Army Corps of Engineers
Buffalo District

Drawn By: h5tdekmh
Date Saved: 03 Feb 2021
Time Saved: 8:17:37 AM

LOCATION OF PARCEL J NEAR
KAUKAUNA POWER CANAL

KAUKAUNA POWER CANAL PARCEL J
KAUKAUNA, WISCONSIN

FIGURE 2

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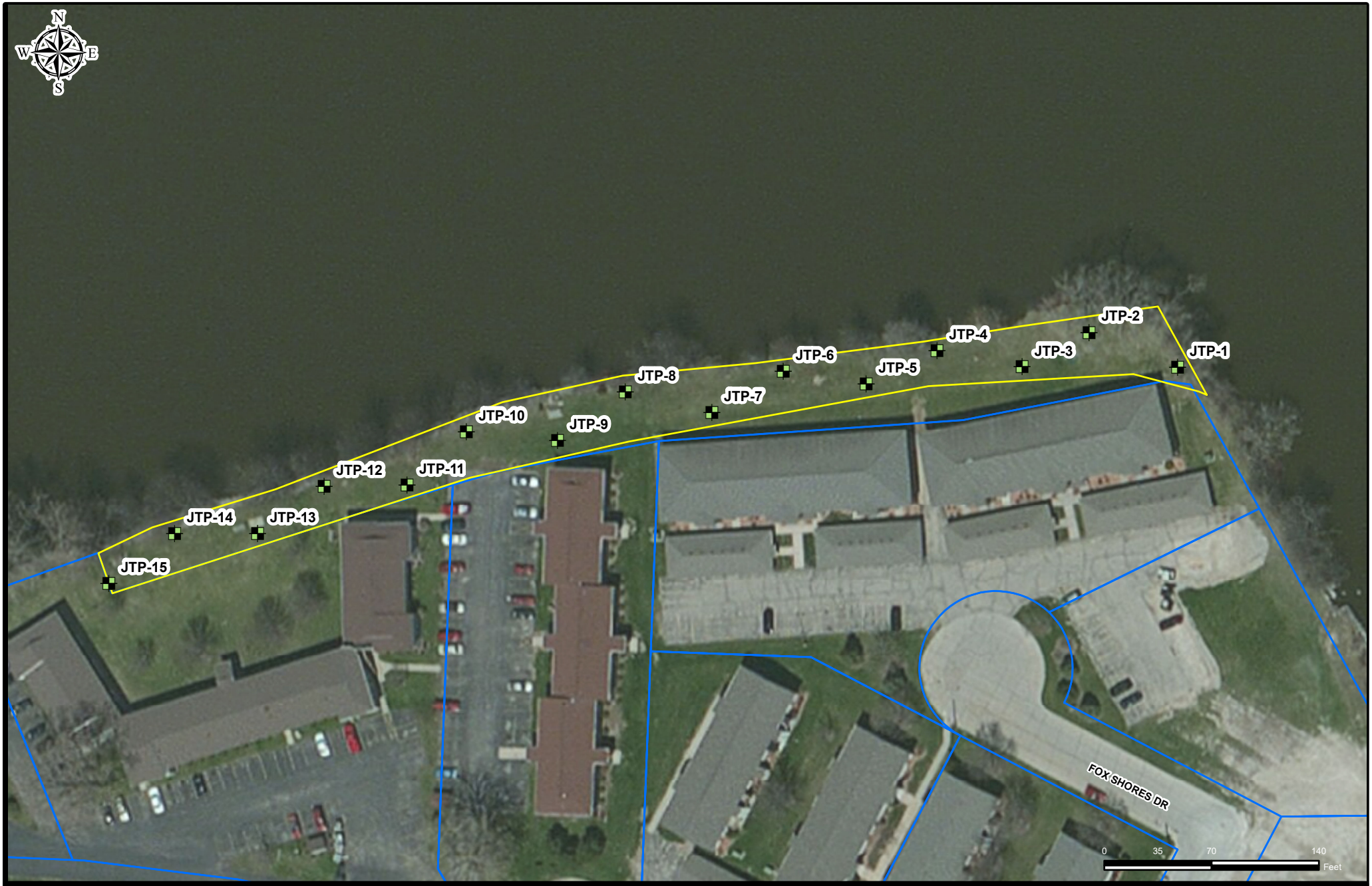

Legend

- Proposed Test Pit Locations
- Parcel J Sample Area
- Tax Parcel Boundary

US Army Corps of Engineers
Buffalo District

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Date Saved: 03 Feb 2021
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PARCEL J PROPOSED TEST PIT LOCATIONS

KAUKAUNA POWER CANAL PARCEL J
KAUKAUNA, WISCONSIN

FIGURE 3

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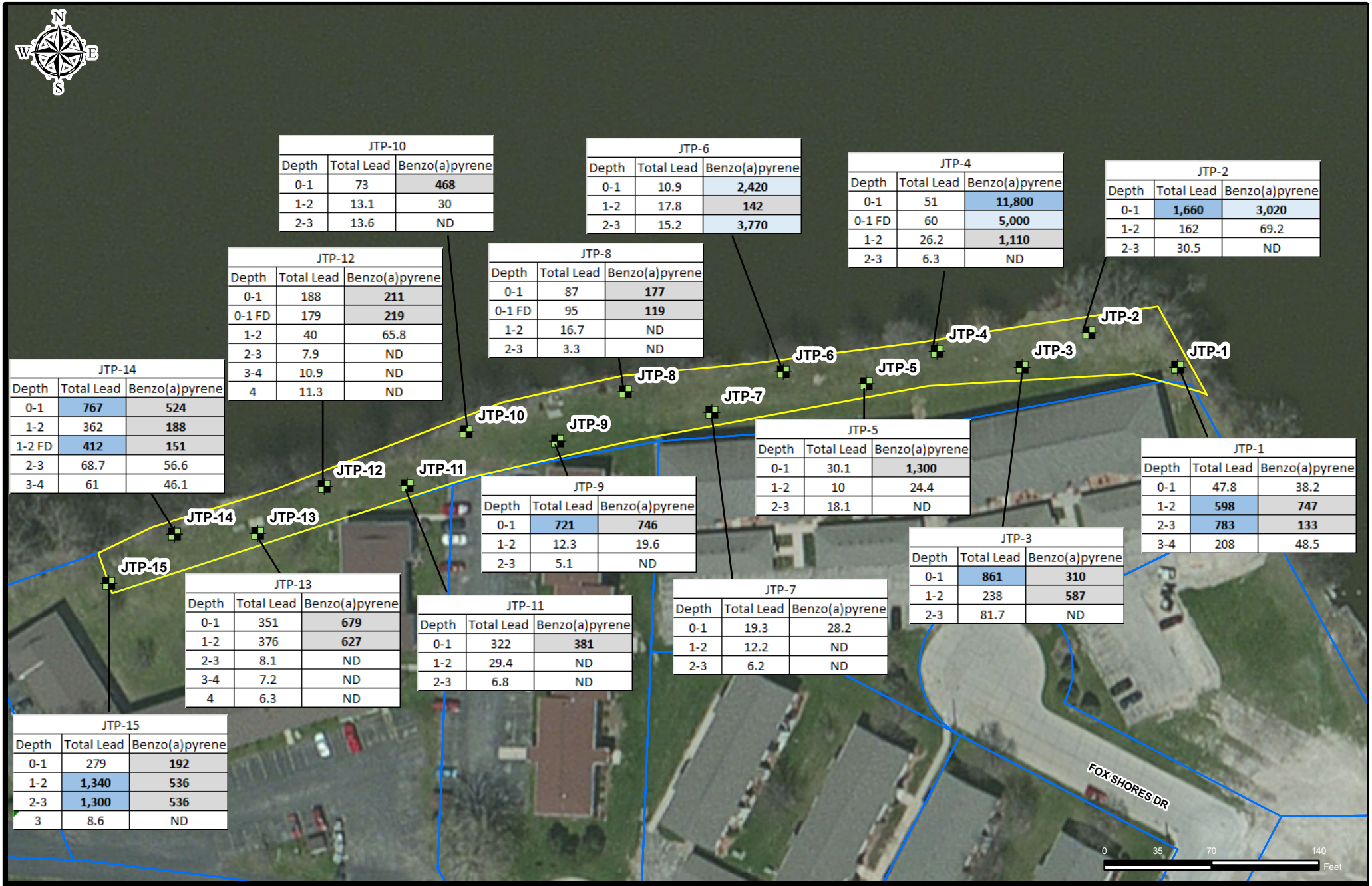

JTP-10		
Depth	Total Lead	Benzo(a)pyrene
0-1	73	**468**
1-2	13.1	30
2-3	13.6	ND

JTP-6		
Depth	Total Lead	Benzo(a)pyrene
0-1	10.9	**2,420**
1-2	17.8	**142**
2-3	15.2	**3,770**

JTP-4		
Depth	Total Lead	Benzo(a)pyrene
0-1	51	**11,800**
0-1 FD	60	**5,000**
1-2	26.2	**1,110**
2-3	6.3	ND

JTP-2		
Depth	Total Lead	Benzo(a)pyrene
0-1	**1,660**	**3,020**
1-2	162	69.2
2-3	30.5	ND

JTP-12		
Depth	Total Lead	Benzo(a)pyrene
0-1	188	**211**
0-1 FD	179	**219**
1-2	40	65.8
2-3	7.9	ND
3-4	10.9	ND
4	11.3	ND

JTP-8		
Depth	Total Lead	Benzo(a)pyrene
0-1	87	**177**
0-1 FD	95	**119**
1-2	16.7	ND
2-3	3.3	ND

JTP-14		
Depth	Total Lead	Benzo(a)pyrene
0-1	**767**	**524**
1-2	362	**188**
1-2 FD	**412**	**151**
2-3	68.7	56.6
3-4	61	46.1

JTP-5		
Depth	Total Lead	Benzo(a)pyrene
0-1	30.1	**1,300**
1-2	10	24.4
2-3	18.1	ND

JTP-1		
Depth	Total Lead	Benzo(a)pyrene
0-1	47.8	38.2
1-2	**598**	**747**
2-3	**783**	**133**
3-4	208	48.5

JTP-9		
Depth	Total Lead	Benzo(a)pyrene
0-1	**721**	**746**
1-2	12.3	19.6
2-3	5.1	ND

JTP-3		
Depth	Total Lead	Benzo(a)pyrene
0-1	**861**	**310**
1-2	238	**587**
2-3	81.7	ND

JTP-13		
Depth	Total Lead	Benzo(a)pyrene
0-1	351	**679**
1-2	376	**627**
2-3	8.1	ND
3-4	7.2	ND
4	6.3	ND

JTP-11		
Depth	Total Lead	Benzo(a)pyrene
0-1	322	**381**
1-2	29.4	ND
2-3	6.8	ND

JTP-7		
Depth	Total Lead	Benzo(a)pyrene
0-1	19.3	28.2
1-2	12.2	ND
2-3	6.2	ND

JTP-15		
Depth	Total Lead	Benzo(a)pyrene
0-1	279	**192**
1-2	**1,340**	**536**
2-3	**1,300**	**536**
3	8.6	ND

Legend

- 2021 Test Pit Results
- Parcel J Sample Area & Transect
- Tax Parcel Boundary

US Army Corps of Engineers
Buffalo District

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Time Saved: 1:03:54 PM

2021 TEST PIT LEAD (MG/KG) & BENZO(A)PYRENE (UG/KG) RESULTS PER DEPTH INTERVAL (FT.)

KAUKAUNA POWER CANAL PARCEL J
KAUKAUNA, WISCONSIN

FIGURE 4

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Tables

Table 1. Kaukauna Parcel J Soil RCRA Metals Concentrations (ALS 2021)

Metal (mg/kg)	USEPA Residential Direct Contact Regional Screening Levels (TR=1E-06; THQ=0.1) (May 2021)	Background Threshold Value	USEPA Residential Direct Contact Regional Removal Management Levels (TR=1E-04; THQ=1) (May 2021)	JTP-1				JTP-2			JTP-3			JTP-4				JTP-5			JTP-6		
				light brown loam/fill	light brown loam/fill	light brown loam/fill	reddish brown clay with gravel	dark brown loam/fill	reddish brown clay/loam	reddish brown clay	light brown gravelly loam/fill	Black gravelly fill/coal	reddish brown gravelly clay	light brown gravelly loam/fill	light brown gravelly loam/fill	light brown sand and gravel	reddish brown gravelly clay	light brown gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	light brown gravelly loam/fill	light brown sand and gravel	reddish brown gravelly clay
				0-1	1-2	2-3	3-4	0-1	1-2	2-3	0-1	1-2	2-3	0-1	0-1 FD	1-2	2-3	0-1	1-2	2-3	0-1	1-2	2-3
Silver	39		390	0.18 U	0.19 U	0.88 U	0.9 U	0.93 U	0.82 U	0.18 U	4.2	0.98 J	0.96 U	0.17 U	0.17 U	0.9 U	0.19 U	0.16 U	0.19 U	1.3 J	0.15 U	0.17 U	0.18 U
Arsenic	0.68	8	35	3	10	17	7 J	31	4.6 J	3	27	26	6 J	3	5	3.6 U	5	4	5	7 J	3	3	3
Barium	1,500	364	15,000	35	111	80	76	516	61	48	68	90	87	36	48	47	82	55	86	118	14	42	39
Cadmium	7.1	1	71	0.18 U	0.76	0.88 U	0.9 U	1.9 J	0.82 U	0.18 U	2.4 J	0.96 U	0.96 U	0.33 J	0.39 J	0.9 U	0.19 U	0.26 J	0.21 J	2 J	0.15 U	1.2	0.18 U
Chromium, Total		44		13	20	32	22	19	17	16	24	13	24	14	19	17	29	20	26	27	8	8	17
Mercury	1.1		11	0.065 UJ	0.22 J	0.24 J	0.093 J	0.74 J	0.075 J	0.068 UJ	0.21 J	0.25 J	0.27 J	0.095 J	0.08 J	0.069 UJ	0.071 UJ	0.068 UJ	0.07 UJ	0.076 UJ	0.061 UJ	0.062 UJ	0.067 UJ
Lead	400	52	400	48	598	783	208	1,660	162	31	861	238	82	51	60	26	6	30	10	18	11	18	15
Selenium	39		390	1.8 U	1.9 U	8.8 U	9 U	9.3 U	8.2 U	1.8 U	8.7 U	9.6 U	9.6 U	1.7 U	1.7 U	9 U	1.9 U	1.6 U	1.9 U	10.5 U	1.5 U	1.7 U	1.8 U

Metal (mg/kg)	USEPA Residential Direct Contact Regional Screening Levels (TR=1E-06; THQ=0.1) (May 2021)	Background Threshold Value	USEPA Residential Direct Contact Regional Removal Management Levels (TR=1E-04; THQ=1) (May 2021)	JTP-7			JTP-8				JTP-9			JTP-10			JTP-11			
				light brown gravelly loam/fill	light brown sand and gravel	reddish brown clay	dark gray gravelly loam/fill	dark gray gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	dark gray gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	dark brown gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	dark gray gravelly loam/fill	reddish brown gravelly clay	reddish brown clay	
				0-1	1-2	2-3	0-1	0-1 FD	1-2	2-3	0-1	1-2	2-3	0-1	1-2	2-3	0-1	1-2	2-3	
Silver	39		390	0.17 U	0.16 U	0.19 U	0.92 U	0.92 U	0.17 U	0.16 U	0.88 U	0.18 U	0.17 U	0.15 U	0.17 U	0.17 U	4.8	0.16 U	0.17 U	
Arsenic	0.68	8	35	5	1.8 J	4	6.2 J	7.2 J	4	1.9 J	9 J	4	4	4	4	3	13	1.9 J	7	
Barium	1,500	364	15,000	49	12	83	36	44	36	19	41	51	45	41	52	34	91	31	84	
Cadmium	7.1	1	71	0.17 U	0.38 J	0.19 U	1.2 J	0.94 J	0.17 U	0.16 U	1.2 J	0.18 U	0.17 U	0.42 J	0.17 U	0.17 U	6.3	0.2 J	0.17 U	
Chromium, Total		44		20	7	33	26	34	15.5 J	9	11	18	17	14	16	13	22	12	19	
Mercury	1.1		11	0.068 UJ	0.066 UJ	0.072 UJ	0.11 J	0.19 J	0.065 UJ	0.066 UJ	0.34 J	0.07 UJ	0.066 UJ	0.07 J	0.082 J	0.07 UJ	0.079 J	0.066 UJ	0.071 UJ	
Lead	400	52	400	19	12	6	87	95	17	3	721	12	5	73	13	14	322	29	7	
Selenium	39		390	1.7 U	1.6 U	1.9 U	9.2 U	9.2 U	1.7 U	1.6 U	8.8 U	1.8 U	1.7 U	1.5 U	1.7 U	1.7 U	25.5 J	1.6 U	1.7 U	

Metal (mg/kg)	USEPA Residential Direct Contact Regional Screening Levels (TR=1E-06; THQ=0.1) (May 2021)	Background Threshold Value	USEPA Residential Direct Contact Regional Removal Management Levels (TR=1E-04; THQ=1) (May 2021)	JTP-12						JTP-13					JTP-14					JTP-15			
				dark brown gravelly loam/fill	dark brown gravelly loam/fill	reddish brown gravelly clay	reddish brown clay	reddish brown clay	reddish brown clay	dark gray loam/fill	dark gray gravelly loam/fill	reddish brown clay with sand and gravel	reddish brown clay with sand and gravel	reddish brown clay with sand and gravel	dark gray sandy loam/fill	dark brown gravelly loam/fill	dark brown gravelly loam/fill	reddish brown gravelly clay	reddish brown clay	dark brown loam/fill	dark gray loam/fill	dark gray gravelly loam/fill	reddish brown gravelly clay
				0-1	0-1 FD	1-2	2-3	3-4	4	0-1	1-2	2-3	3-4	4	0-1	1-2	1-2 FD	2-3	3-4	0-1	1-2	2-3	3
Silver	39		390	0.9 U	0.82 U	0.18 U	0.18 U	0.21 U	0.21 U	0.9 U	0.93 U	0.17 U	0.16 U	0.19 U	0.85 U	0.91 U	0.86 U	0.19 U	0.19 U	0.92 U	0.95 U	0.87 U	0.18 U
Arsenic	0.68	8	35	8.1 J	7 J	4	2 J	8	8	8.2 J	7.9 J	3	3	5	15	15	8.9 J	4	3	5.9 J	11	14	3
Barium	1,500	364	15,000	72	55	46	33	163	149	74	49	26	39	51	77	89	56	53	39	62	159	110	51
Cadmium	7.1	1	71	0.92 J	0.82 U	0.19 J	0.18 U	0.21 U	0.21 U	1.1 J	1.2 J	0.17 U	0.16 U	0.19 U	1.9 J	8	1.5 J	0.21 J	0.22 J	0.92 U	2.2 J	2.2 J	0.18 U
Chromium, Total		44		12	13	16	12	49	42	20	12	10	11	19	19	24	18	16	14	17	21	21	18
Mercury	1.1		11	0.097 J	0.086 J	0.07 UJ	0.069 UJ	0.081 UJ	0.085 UJ	0.49	0.21	0.071 U	0.07 U	0.071 U	0.57	0.33	0.38	0.077 U	0.13 J	0.48	4.8	2.8 J	0.072 U
Lead	400	52	400	188	179	40	8	11	11	351	376	8	7	6	767	362	412	69	61	279	1,340	1,300	9
Selenium	39		390	9 U	8.2 U	1.8 U	1.8 U	2.1 U	2.1 U	9 U	9.3 U	1.7 U	1.6 U	1.9 U	8.5 U	9.1 U	8.6 U	1.9 U	1.9 U	9.2 U	9.5 U	8.7 U	1.8 U

> USEPA Residential Direct Contact Regional Screening Level (May 2021)

> USEPA Residential Direct Contact Regional Screening Level (May 2021) and Background Threshold Value

> USEPA Residential Regional Removal Management Level (May 2021)

U: Not detected at the specified detection limit

J: Estimated value

Table 2. Kaukauna Parcel J Soil PAH Concentrations (ALS 2021)

PAH (µg/kg)	USEPA Residential Direct Contact Regional Screening Levels (TR=1E-06; THQ=0.1) (May 2021)	Milwaukee Undisturbed Soils 95% UCL (Siemering and Thiboldeaux 2020)	USEPA Residential Direct Contact Regional Removal Management Levels (TR=1E-04; THQ=1) (May 2021)	JTP-1				JTP-2			JTP-3			JTP-4				JTP-5			JTP-6		
				light brown loam/fill	light brown loam/fill	light brown loam/fill	reddish brown clay with gravel	dark brown loam/fill	reddish brown clay/loam	reddish brown clay	light brown gravelly loam/fill	Black granular fill/coal	reddish brown gravelly clay	light brown gravelly loam/fill	light brown gravelly loam/fill	light brown sand and gravel	reddish brown gravelly clay	light brown gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	light brown gravelly loam/fill	light brown sand and gravel	reddish brown gravelly clay
				0-1	1-2	2-3	3-4	0-1	1-2	2-3	0-1	1-2	2-3	0-1	0-1 FD	1-2	2-3	0-1	1-2	2-3	0-1	1-2	2-3
Acenaphthene	360,000	102	3,600,000	18.1 U	31.2 J	18.7 U	19.3 U	142	18.7 U	17.5 U	37.5 J	73 J	20 U	2,870	199	42 J	20 U	92.5 J	18.8 U	21 U	472	17.6 U	686
Acenaphthylene		70		18.1 U	69.3 J	18.7 U	19.3 U	438	18.7 U	17.5 U	18.6 U	19.8 U	20 U	651	697	177	20 U	156	18.8 U	21 U	395	22.8 J	404
Anthracene	1,800,000	321	18,000,000	18.1 U	151	44.3 J	19.3 U	945	22.1 J	17.5 U	251	328	20 U	4,060	1,300	282	20 U	361	18.8 U	21 U	1,350	37.1 J	2,920
Benzo(a)anthracene	1,100	1,860	110,000	21 J	761	135	38.8 J	3,410	88.7 J	17.5 U	303	877	20 U	13,300	4,510	990	20 U	1,230	21 J	21 U	2,300	116	4,480
Benzo(a)pyrene	110	2,060	11,000	38.2 J	747	133	48.5 J	3,020	69.2 J	17.5 U	310	587	20 U	11,800	5,000	1,110	20 U	1,300	24.4 J	21 U	2,420	142	3,770
Benzo(b)fluoranthene	1,100	2,860	110,000	25.6 J	570	229	71.3 J	4,420	150	17.5 U	377	1,150	20 U	6,840	4,320	787	20 U	1,000	20.4 J	21 U	1,910	112	2,940
Benzo(g,h,i)perylene		1,440		52.6 J	415	205	65.7 J	2,090	93.3 J	17.5 U	521	1,190	22.5 J	4,890	2,900	650	20 U	795	20.8 J	21 U	1,350	91.8 J	1,720
Benzo(k)fluoranthene	11,000	1,340	1,100,000	23.3 J	586	187	29.1 J	2,300	58.1 J	17.5 U	258	434	20 U	6,170	3,670	974	20 U	1,040	24.8 J	21 U	1,790	118	2,870
Chrysene	110,000	2,360	11,000,000	39.2 J	935	211	29.5 J	5,180	274	17.5 U	542	2,260	20 U	14,600	4,440	954	20 U	1,230	24.7 J	21 U	2,260	119	4,050
Dibenz(a,h)anthracene	110	411	11,000	18.1 U	103 J	42.8 J	19.3 U	720	27 J	17.5 U	65 J	340	20 U	1,300	714	148	20 U	188	18.8 U	21 U	320	26 J	537
Fluorene	240,000	98.2	2,400,000	18.1 U	39 J	18.7 U	19.3 U	234	18.7 U	17.5 U	33.9 J	120	20 U	2,810	385	74.5 J	20 U	128	18.8 U	21 U	672	17.6 U	2,580
Fluoranthene	240,000	4,220	2,400,000	29.2 J	1,240	225	57.9 J	5,450	83.5 J	17.5 U	548	381	22.6 J	25,300	11,300	2,200 J	25.2 J	2,490	35.2 J	29.5 J	6,310	235	12,200
Indeno(1,2,3-c,d)pyrene	1,100	1,270	110,000	26.3 J	387	172	55.9 J	2,050	44.8 J	17.5 U	275	779	20 U	4,580	3,030	662	20 U	805	19.7 J	21 U	1,450	97 J	1,940
Naphthalene	2,000	173	130,000	18.1 U	69.4 J	63.7 J	53.6 J	463	45.5 J	17.5 U	104 J	622	20 U	1,060	250	81.4 J	20 U	98.9 J	18.8 U	21 U	336	85.4 J	384
Phenanthrene		1,650		23.2 J	794	219	108 J	4,620	211	17.5 U	461	2,110	21.6 J	36,600	5,010	1,020	20 U	1,550	19.8 J	21 U	6,190	181	15,200
Pyrene	180,000	3,590	1,800,000	50.2 J	1,720	245	67.2 J	5,130	105 J	17.5 U	590	645	22.7 J	32,800	10,700	1,980 J	24.5 J	2,500	38.5 J	26 J	5,040	213	8,270

PAH (µg/kg)	USEPA Residential Direct Contact Regional Screening Levels (TR=1E-06; THQ=0.1) (May 2021)	Milwaukee Undisturbed Soils 95% UCL (Siemering and Thiboldeaux 2020)	USEPA Residential Direct Contact Regional Removal Management Levels (TR=1E-04; THQ=1) (May 2021)	JTP-7			JTP-8				JTP-9			JTP-10			JTP-11		
				light brown gravelly loam/fill	light brown sand and gravel	reddish brown clay	dark gray gravelly loam/fill	dark gray gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	dark gray gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	dark brown gravelly loam/fill	reddish brown gravelly clay	reddish brown gravelly clay	dark gray gravelly loam/fill	reddish brown gravelly clay	reddish brown clay
				0-1	1-2	2-3	0-1	0-1 FD	1-2	2-3	0-1	1-2	2-3	0-1	1-2	2-3	0-1	1-2	2-3
Acenaphthene	360,000	102	3,600,000	17.6 U	17.5 U	19.2 U	18.8 U	18.3 U	17.9 U	18 U	17.9 U	18.8 U	18.3 U	17 U	19.3 U	19 U	18.4 U	17.5 U	18.3 U
Acenaphthylene		70		17.6 U	17.5 U	19.2 U	18.8 U	18.3 U	17.9 U	18 U	228	18.8 U	18.3 U	17 U	19.3 U	19 U	61.1 J	17.5 U	18.3 U
Anthracene	1,800,000	321	18,000,000	17.6 U	17.5 U	19.2 U	46.6 J	33.6 J	17.9 U	18 U	116	18.8 U	18.3 U	35.6 J	19.3 U	19 U	150	17.5 U	18.3 U
Benzo(a)anthracene	1,100	1,860	110,000	25.2 J	17.5 U	19.2 U	130	113	17.9 U	18 U	648	18.8 U	18.3 U	324	21 J	19 U	330	22.4 J	18.3 U
Benzo(a)pyrene	110	2,060	11,000	28.2 J	17.5 U	19.2 U	177	119	17.9 U	18 U	746	19.6 J	18.3 U	468	30 J	19 U	381	17.5 U	18.3 U
Benzo(b)fluoranthene	1,100	2,860	110,000	29.8 J	17.5 U	19.2 U	180	117	17.9 U	18 U	734	18.8 U	18.3 U	548	32.3 J	19 U	503	24.6 J	18.3 U
Benzo(g,h,i)perylene		1,440		24.2 J	17.5 U	19.2 U	166	117	17.9 U	18 U	538	18.8 U	18.3 U	399	23.7 J	19 U	394	27.2 J	18.3 U
Benzo(k)fluoranthene	11,000	1,340	1,100,000	24.9 J	17.5 U	19.2 U	139	86.1 J	17.9 U	18 U	704	18.8 U	18.3 U	433	20.3 J	19 U	384	24.7 J	18.3 U
Chrysene	110,000	2,360	11,000,000	33 J	17.5 U	19.2 U	160	135	17.9 U	18 U	885	18.8 U	18.3 U	485	28.9 J	19 U	714	28.8 J	18.3 U
Dibenz(a,h)anthracene	110	411	11,000	17.6 U	17.5 U	19.2 U	32.8 J	18.3 U	17.9 U	18 U	129	18.8 U	18.3 U	86.1 J	19.3 U	19 U	80.6 J	17.5 U	18.3 U
Fluorene	240,000	98.2	2,400,000	17.6 U	17.5 U	19.2 U	18.8 U	18.3 U	17.9 U	18 U	17.9 U	18.8 U	18.3 U	17 U	19.3 U	19 U	18.4 U	17.5 U	18.3 U
Fluoranthene	240,000	4,220	2,400,000	43.9 J	17.5 U	19.2 U	221	204	17.9 U	18 U	1,310	20.2 J	18.3 U	784	40.2 J	19 U	671	36.7 J	18.3 U
Indeno(1,2,3-c,d)pyrene	1,100	1,270	110,000	22.6 J	17.5 U	19.2 U	146	94.1 J	17.9 U	18 U	529	18.8 U	18.3 U	393	19.3 U	19 U	308	17.5 U	18.3 U
Naphthalene	2,000	173	130,000	18 J	17.5 U	19.2 U	108 J	138	17.9 U	18 U	147	18.8 U	18.3 U	76.3 J	19.3 U	19 U	306	24.5 J	18.3 U
Phenanthrene		1,650		32.7 J	17.5 U	24 J	502	449	17.9 U	18 U	891	18.8 U	18.3 U	363	27.3 J	19 U	695	42.5 J	18.3 U
Pyrene	180,000	3,590	1,800,000	41.3 J	17.5 U	19.2 U	255	226	17.9 U	18 U	1,220	20.1 J	18.3 U	629	34.1 J	19 U	681	36.7 J	18.3 U

PAH (µg/kg)	USEPA Residential Direct Contact Regional Screening Levels (TR=1E-06; THQ=0.1) (May 2021)	Milwaukee Undisturbed Soils 95% UCL (Siemering and Thiboldeaux 2020)	USEPA Residential Direct Contact Regional Removal Management Levels (TR=1E-04; THQ=1) (May 2021)	JTP-12						JTP-13					JTP-14					JTP-15			
				dark brown gravelly loam/fill	dark brown gravelly loam/fill	reddish brown gravelly clay	reddish brown clay	reddish brown clay	reddish brown clay	dark gray loam/fill	dark gray gravelly loam/fill	reddish brown clay with sand and gravel	reddish brown clay with sand and gravel	reddish brown clay with sand and gravel	dark gray sandy loam/fill	dark brown gravelly loam/fill	dark brown gravelly loam/fill	reddish brown gravelly clay	reddish brown clay	dark brown loam/fill	dark gray loam/fill	dark gray gravelly loam fill	reddish brown gravelly clay
				0-1	0-1 FD	1-2	2-3	3-4	4	0-1	1-2	2-3	3-4	4	0-1	1-2	1-2 FD	2-3	3-4	0-1	1-2	2-3	3
Acenaphthene	360,000	102	3,600,000	18.4 U	18.4 U	18.5 U	19.2 U	22.4 U	22.5 U	59.7 J	84.3 J	18.5 U	18.6 U	19.5 U	18.5 U	18.3 U	19.1 U	19.6 U	20 U	19.9 U	34.3 J	18.4 U	19.1 U
Acenaphthylene		70		18.4 U	18.4 U	18.5 U	19.2 U	22.4 U	22.5 U	54.2 J	44.6 J	18.5 U	18.6 U	19.5 U	18.5 U	18.3 U	19.1 U	19.6 U	20 U	19.9 U	19.6 U	18.4 U	19.1 U
Anthracene	1,800,000	321	18,000,000	40.8 J	51.4 J	18.5 U	19.2 U	22.4 U	22.5 U	226	301	18.5 U	18.6 U	19.5 U	84.5 J	26.2 J	24.2 J	19.6 U	20 U	36 J	139	130	19.1 U
Benzo(a)anthracene	1,100	1,860	110,000	193	185	30.8 J	19.2 U	22.4 U	22.5 U	620	610	18.5 U	18.6 U	19.5 U	394	142	118	39.6 J	39.3 J	157	473	488	19.1 U
Benzo(a)pyrene	110	2,060	11,000	211	219	65.8 J	19.2 U	22.4 U	22.5 U	679	627	18.5 U	18.6 U	19.5 U	524	188	151	56.6 J	46.1 J	192	536	536	19.1 U
Benzo(b)fluoranthene	1,100	2,860	110,000	208	182	32 J	19.2 U	22.4 U	22.5 U	514	448	18.5 U	18.6 U	19.5 U	469	152	137	40.8 J	39.4 J	164	417	443	19.1 U
Benzo(g,h,i)perylene		1,440		132	129	37.8 J	19.2 U	22.4 U	22.5 U	358	338	18.5 U	18.6 U	19.5 U	351	117	94.2 J	34.4 J	28 J	106 J	334	319	19.1 U
Benzo(k)fluoranthene	11,000	1,340	1,100,000	144	144	50 J	19.2 U	22.4 U	22.5 U	533	494	18.5 U	18.6 U	19.5 U	360	147	114	48.4 J	28.6 J	141	390	429	19.1 U
Chrysene	110,000	2,360	11,000,000	230	225	55.4 J	19.2 U	22.4 U	22.5 U	729	671	18.5 U	18.6 U	19.5 U	502	153	179	44.5 J	40.6 J	180	559	531	19.1 U
Dibenz(a,h)anthracene	110	411	11,000	30.9 J	38.9 J	18.5 U	19.2 U	22.4 U	22.5 U	96.4 J	85.2 J	18.5 U	18.6 U	19.5 U	105 J	29.6 J	24.6 J	19.6 U	20 U	24.6 J	84.3 J	80.6 J	19.1 U
Fluorene	240,000	98.2	2,400,000	18.4 U	19.7 J	18.5 U	19.2 U	22.4 U	22.5 U	61 J	102 J	18.5 U	18.6 U	19.5 U	26 J	18.3 U	19.1 U	19.6 U	20 U	19.9 U	35.8 J	29.2 J	19.1 U
Fluoranthene	240,000	4,220	2,400,000	407	383	97.1 J	19.2 U	22.4 U	22.5 U	1,270	1,430	18.5 U	18.6 U	19.5 U	612	248	185	76.3 J	60.9 J	301	912	984	19.1 U
Indeno(1,2,3-c,d)pyrene	1,100	1,270	110,000	135	135	40.7 J	19.2 U	22.4 U	22.5 U	364	346	18.5 U	18.6 U	19.5 U	331	107 J	90.9 J	35.1 J	33.2 J	111 J	358	345	19.1 U
Naphthalene	2,000	173	130,000	136	149	28.5 J	19.2 U	22.4 U	22.5 U	250	207	18.5 U	18.6 U	19.5 U	464	79.9 J	111 J	40.1 J	76.3 J	72 J	273	281	19.1 U
Phenanthrene		1,650		312	436	50.9 J	19.2 U	22.4 U	22.5 U	1,120	1,440	18.5 U	18.6 U	19.5 U	822	191	217	81 J	77.5 J	206	856	737	19.1 U
Pyrene	180,000	3,590	1,800,000	370	339	85.7 J	19.2 U	22.4 U	22.5 U	1,160	1,240	18.5 U	18.6 U	19.5 U	560	219	182	67.7 J	56.6 J	262	852	872	19.1 U

> USEPA Residential Direct Contact Regional Screening Level (May 2021)
> USEPA Residential Direct Contact Regional Screening Level (May 2021) and Milwaukee undisturbed soil 95% UCL
> USEPA Residential Regional Removal Management Level (May 2021)

U: Not detected at the specified detection limit
J: Estimated value

Table 3. Kaukauna Parcel J Soil PCB Concentrations (ALS 2021)

PCB arcolor (mg/kg)	JTP-10	JTP-14	JTP-3
	reddish brown gravely clay	reddish brown gravely clay	light brown gravelly loam/fill
	1-2	2-3	0-1
PCB-1016	0.011 U	0.012 U	0.011 U
PCB-1221	0.011 U	0.012 U	0.011 U
PCB-1232	0.011 U	0.012 U	0.011 U
PCB-1242	0.011 U	0.012 U	0.011 U
PCB-1248	0.011 U	0.012 U	0.011 U
PCB-1254	0.011 U	0.012 U	0.011 U
PCB-1260	0.011 U	0.012 U	0.011 U

U: Not detected at the specified detection limit

Table 4. Kaukauna Parcel J Soil TCLP Metal Concentrations (ALS 2021)

Metal (mg/L)	Sample ID									Regulatory Level (mg/L)
	JTP 1 1-2	JTP 1 2-3	JTP 14 0-1	JTP 14 1-2	JTP 15 1-2	JTP 15 2-3	JTP 2 0-1	JTP 3 0-1	JTP 9 0-1	
Silver	0.0063 U	0.0063 U	0.0063 U	0.0063 U	0.0063 U	0.0063 U	0.0063 U	0.0063 U	0.0063 U	5.0
Arsenic	0.042 U	0.042 U	0.042 U	0.042 U	0.042 U	0.042 U	0.042 U	0.042 U	0.042 U	5.0
Barium	0.46	0.53	0.37	0.39	0.92	0.7	0.65	0.4	0.34	100.0
Cadmium	0.008 J	0.006 J	0.007 J	0.0055 J	0.011	0.01	0.027	0.01	0.0065 J	1.0
Chromium, Total	0.009 U	0.009 U	0.009 U	0.009 U	0.015 J	0.009 U	0.009 U	0.009 U	0.009 U	5.0
Mercury	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.00016 UJ	0.2
Lead	0.29	0.24	0.2	0.076	0.67	0.2	0.29	0.05	0.16	5.0
Selenium	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U	1.0

U: Not detected at the specified detection limit

J: Estimated value

Appendix A

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-1**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**16:30**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	offset 10 feet to north
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Light brown gravelly loam/fill, dry, loose	JTP-1 0-1
2	Light brown gravelly loam/fill with pieces of coal, dry, loose	JTP-1 1-2
3	Light brown gravelly loam/fill with pices of coal, dry, loose	JTP-1 2-3
4	Reddish brown clay with gravel, dry, firm	JTP-1 3-4
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-2**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**16:15**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark brown loam/fill, dry, loose	JTP-2 0-1
2	Reddish brown clay loam, dry, firm	JTP-2 1-2
3	Reddish brown clay, dry, firm	JTP-2 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-3**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**16:00**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Light brown gravelly loam/fill, dry, loose	JTP-3 0-1
2	Black granular fill, coal pieces, dry, loose	JTP-3 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-3 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-4**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**15:45**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Light brown gravelly loam/fill, dry, loose	JTP-4 0-1
2	Ligh brown sand and gravel, dry, loose	JTP-4 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-4 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-5**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**15:30**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Light brown gravelly loam/fill, dry, loose	JTP-5 0-1
2	Reddish brown gravelly clay, dry, firm	JTP-5 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-5 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-6**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**15:15**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Light brown gravelly loam/fill, dry, loose	JTP-6 0-1
2	Ligh brown sand and gravel, dry, loose	JTP-6 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-6 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-7**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**15:15**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Light brown gravelly loam/fill, dry, loose	JTP-7 0-1
2	Light brown gravel with sand, dry, loose	JTP-7 1-2
3	Reddish brown clay, dry, firm	JTP-7 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-8**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**14:45**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	10.5 offset South
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark gray gravelly loam/fill, dry, loose	JTP-8 0-1
2	Reddish brown gravelly clay, dry, firm	JTP-8 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-8 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-9**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**14:30**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark gray gravelly loam/fill, dry, loose	JTP-9 0-1
2	Reddish brown gravelly clay, dry, firm	JTP-9 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-9 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-10**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**14:15**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	6.5' offset to south
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark brown gravelly loam/fill, dry, loose	JTP-10 0-1
2	Reddish brown gravelly clay, dry, firm	JTP-10 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-10 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-11**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**14:00**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark gray loam/fill, dry, loose	JTP-11 0-1
2	Reddish brown gravelly clay, dry, firm	JTP-11 1-2
3	Reddish brown clay, dry, firm	JTP-11 2-3
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-12**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**13:37**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	4' offset south
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark brown gravelly loam/fill, dry, loose	JTP-12 0-1
2	Reddish brown gravelly clay, dry, firm	JTP-12 1-2
3	Reddish brown clay, dry, firm	JTP-12 2-3
4	Reddish brown clay, dry, firm	JTP-12 3-4
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-13**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**13:00**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Drak gray loam/fill, dry, loose	JTP-13 0-1
2	Dark gray gravelly loam/fill, dry, loose	JTP-13 1-2
3	Reddish brown clay with sand and gravel, dry, firm	JTP-13 2-3
4	Reddish brown clay with sand and gravel, dry, firm	JTP-13 3-4
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-14**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**12:30**
EQUIPMENT:	**Auger**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	11' offset south
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark gray sandy loam/fill, dry, loose	JTP-14 0-1
2	Dark brown gravelly loam/fill, dry, loose	JTP-14 1-2
3	Reddish brown gravelly clay, dry, firm	JTP-14 2-3
4	Reddish brown clay, dry, firm	JTP-14 3-4
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Remarks:

USACE - Buffalo District		**SOIL TEST PIT LOG**	
PROJECT:	**Kaukauna WI Parcel J**	**STATION ID:**	**JTP-15**
PROJECT NUMBER:		**SHEET:**	of
CLIENT:	**USACE LRC**	**DATE:**	**5/25/2021**
BORING CONTRACTOR:	**USACE LRC**	**START TIME:**	**10:00**
EQUIPMENT:	**Wacker Neuson EZ 28 Mini Excavator**	**END TIME:**	
DRILLER:	**C. Sowers**	**NORTHING:**	
LOGGER:	**A Lenox**	**EASTING:**	
		WATER DEPTH:	

DEPTH (FT)	SOIL DESCRIPTION (TYPE, PARTICLE SIZE, COLOR, MOISTURE, CONSISTENCY, OBSERVATION, ETC.)	COMMENTS (SAMPLE ID, QA/QC, ETC.)
1	Dark brown loam/fill, dry, loose	JTP-15 0-1
2	Dark gray loam/fill, dry, loose	JTP-15 1-2
3	Dark gray gravelly loam/fill, dry, firm	JTP-15 2-3
4	Refusal at 3' over reddish brown gravely clay	JTP-15 3
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Remarks:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 6 1993

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Transmittal of Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA (Publication 9360.0-32)

FROM: Henry L. Longest II, Director
Office of Emergency and Remedial Response

TO: Director, Waste Management Division
Regions I, IV, V, VII, VIII
Director, Emergency and Remedial Response Division
Region II
Director, Hazardous Waste Management Division
Regions III, VI, IX
Director, Hazardous Waste Division
Region X
Director, Environmental Services Division
Regions I, VI, VII
Superfund Branch Chiefs, Regions I-X
Regional Counsels, Regions I-X

PURPOSE

The purpose of this memorandum is to transmit new guidance on the appropriate use of non-time-critical removal authority under Superfund and the development of Engineering Evaluation/ Cost Analysis (EE/CA) reports and EE/CA Approval Memorandums. This guidance supersedes the March 30, 1988, outline from Timothy Fields, Jr. to the Superfund Branch Chiefs on the EE/CA process.

BACKGROUND

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) allows non-time-critical removal actions to be taken when there is a planning period of at least six months before on-site activities need to be initiated, and the lead agency determines that a removal action is appropriate (see 55 FR 8666, March 8, 1990). The most recent guidance on this subject was issued on March 30, 1988, when a draft outline of a EE/CA document was distributed for Regional review.

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Despite clear authority to perform non-time-critical removal actions, few have been conducted. In order to encourage increased use of this type of response, we have developed this guidance to provide the Regional offices, as well as States and potentially responsible parties (PRPs), with the necessary information to conduct effective non-time-critical removal actions.

IMPLEMENTATION

Based on comments we have received while preparing this guidance, we expect that Regional offices will vary in implementing this guidance. A range of program staff may be called upon to conduct non-time-critical removal actions in the various Regions. We expect that the readers of this document will differ in their experience and training. Therefore, the guidance contains features that will be beneficial to readers coming from all perspectives, from EPA On-Scene Coordinators and Remedial Project Managers to State agency staff to members of the public. For example, the document contains thirteen bibliographic sections that identify sources of more detailed information, and numerous exhibits and diagrams. Readers who are unfamilar with the material presented in the guidance can therefore easily come up to speed with some additional reading, while readers already familiar with the process can simply focus on the significant material presented in the text.

So that the Regions may make maximum use of the information presented here, the guidance has been written to allow as much flexibility as possible, giving Regional managers the latitude to use information from various sources, make site-specific decisions, and take initiative on resolving problems. We have established a process called streamlined risk evaluation as an intermediate form of risk assessment unique to non-time-critical removal actions. There is also a side-by-side comparison of the EE/CA and remedial investigation/feasibility study (RI/FS) processes, to point out similarities and distinctions.

The information in this publication will assist Regional offices in accelerating selected responses in accordance with the Superfund Accelerated Cleanup Model (SACM). Bound copies of the guidance will be shipped directly to the Regional offices in eight to twelve weeks for distribution to Regional staff.

If you have any questions on this guidance, please contact Deborah Y. Dietrich at 703-603-8760.

Attachment

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Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA

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August 1993

GUIDANCE ON CONDUCTING NON-TIME-CRITICAL REMOVAL ACTIONS UNDER CERCLA

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

Notice

The policies and procedures set forth herein are intended solely as guidance for government personnel. They are not intended, nor can they be relied on, to create any rights enforceable by any party in litigation with the United States (U.S.). U.S. Environmental Protection Agency officials may decide to follow this guidance or act at variance with it, based on an analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

Contents

Page

1.0 INTRODUCTION AND OVERVIEW 1

1.1 The SACM Approach 2

1.2 Overview of the Removal Action Process 3

1.3 Roles and Responsibilities 7
Regional Decision Team 7
State Involvement 8
Potentially Responsible Party (PRP) Involvement 8
Responsibility for Post-Removal Site Control (PRSC) 8

1.4 Resources 9

1.5 Enforcement and Cost Recovery 10
PRP Search and Identification 10
Notice Letters 10
PRP Negotiation 11
Cost Recovery 11

1.6 Public Involvement and the Administrative Record 12
Community Relations Requirements 13
Administrative Record Requirements 14

1.7 Action Memorandum 15

1.8 On-Scene Coordinator Reports 17

2.0 CONDUCTING THE ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) 19

2.1 Overview 19

2.2 EE/CA Approval Memorandum 22

2.3 EE/CA Executive Summary 23

2.4 Site Characterization 24
Site Description and Background 25
Previous Removal Actions 26
Source, Nature, and Extent of Contamination 27
Analytical Data 28
Streamlined Risk Evaluation 29

Contents (Continued)

Page

2.5 Identification of Removal Action Scope, Goals, and Objectives 31
- Statutory Limits on Removal Actions 31
- Determination of Removal Scope 32
- Determination of Removal Schedule 32

2.6 Identification and Analysis of Removal Action Alternatives 33
- Treatment Technologies 33
- Treatment Technology Information Sources 34
- Effectiveness 35
- Implementability 40
- Cost 43

2.7 Comparative Analysis of Removal Action Alternatives 45

2.8 Recommended Removal Action Alternative 45

Appendix A References 47

Appendix B Key Word Index 52

Appendix C Comparison of EE/CA to RI/FS 54

Appendix D Model Notice of Decision Not to Use Special Notice Procedures 56

Exhibits

Exhibit Number	Title	Page Number
1.	Non-Time-Critical Removal Action Process	5
2.	Action Memorandum Outline	16
3.	EE/CA Development Process	21
4.	EE/CA Approval Memorandum	22
5.	EE/CA Outline	23
6.	Information From Previous Removal Actions Applicable To Current EE/CA	27
7.	Objectives/Criteria To Be Used in Comparative Analysis of Alternatives	36
8.	Identification and Evaluation of ARARs During Non-Time-Critical Removal Actions	38

List of Acronyms

AOC—Administrative Order on Consent

ARARs—Applicable or Relevant and Appropriate Requirements

ARCS—Alternative Remedial Contracting Strategy

ATSDR—Agency for Toxic Substances and Disease Registry

ATTIC—Alternative Treatment Technology Information Center

CA—Cooperative Agreement

CERCLA—Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended

CFR—Code of Federal Regulations

CLP—Contract Laboratory Program

CLU-IN—Cleanup Information Bulletin Board

CRP—Community Relations Plan

DOD—Department of Defense

DOE—Department of Energy

EE/CA—Engineering Evaluation/Cost Analysis

EIS—Environmental Impact Statement

EPA—United States Environmental Protection Agency

ERCS—Emergency Response Cleanup Services

ERRS—Emergency and Rapid Response Services

ERT—Environmental Response Team

FR—Federal Register

LTCS—Long-Term Contracting Strategy

MCLs—Maximum Contaminant Levels

MCLGs—Maximum Contaminant Level Goals

MOU—Memorandum of Understanding

NCP—National Oil and Hazardous Substances Pollution Contingency Plan

NPL—National Priorities List

NRT—National Response Team

List of Acronyms (Continued)

O&M—Operation and Maintenance

OMB—Office of Management and Budget

OPA—Office of Policy Analysis

ORC—Office of Regional Counsel

ORD—Office of Research and Development

OSC—On-Scene Coordinator

OSWER—Office of Solid Waste and Emergency Response

PA—Preliminary Assessment

PRP—Potentially Responsible Party

PRSC—Post-Removal Site Control

QA/QC—Quality Assurance/Quality Control

RA—Regional Administrator

RRT—Regional Response Team

RCRA—Resource Conservation and Recovery Act

RDT—Regional Decision Team

RI/FS—Remedial Investigation/Feasibility Study

ROD—Record of Decision

RPM—Remedial Project Manager

SACM—Superfund Accelerated Cleanup Model

SARA—Superfund Amendments and Reauthorization Act of 1986

SI—Site Inspection

SITE—Superfund Innovative Technology Evaluation

START—Superfund Technical Assessment and Response Team

TAT—Technical Assistance Team

TBC—To Be Considered

TIO—Technology Innovation Office

UAO—Unilateral Administrative Order

List of Acronyms (Continued)

USGS—United States Geological Survey

VISITT—Vendor Information System for Innovative Treatment Technologies

VOC—Volatile Organic Compound

CHAPTER 1

INTRODUCTION AND OVERVIEW

The purpose of this guidance is to provide information on the procedures and activities the U.S. Environmental Protection Agency (EPA) uses in conducting non-time-critical removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). On-Scene Coordinators (OSCs) and Remedial Project Managers (RPMs) should use this guidance to ensure that non-time-critical removal actions are conducted in accordance with applicable laws, regulations, and EPA policy.

This guidance focuses primarily on those aspects of the removal process that are unique to non-time-critical removal actions. Introductory material presented in this chapter provides a context for how non-time-critical removal actions fit within the overall Superfund program.

Chapter 1 contains seven sections, as follows:

- Section 1.1 describes non-time-critical removal actions in relation to the Superfund Accelerated Cleanup Model (SACM).
- Section 1.2 provides an overview of the removal process.
- Section 1.3 highlights the roles and responsibilities of Federal, State, and private entities in conducting non-time-critical removal actions.
- Section 1.4 outlines the resources available to OSCs/RPMs in conducting non-time-critical removal actions.
- Section 1.5 describes enforcement and cost recovery activities.
- Section 1.6 highlights public involvement and administrative record requirements for non-time-critical removal actions.
- Section 1.7 describes Action Memorandum requirements for non-time-critical removal actions.

Chapter 2 provides guidance for conducting an Engineering Evaluation/Cost Analysis (EE/CA), which analyzes removal action alternatives for a site. Chapter 2 supersedes the outline for conducting an EE/CA dated March 30, 1988. An EE/CA, required under section 300.415(b)(4)(i) of the NCP for all non-time-critical removal actions, provides a vehicle for public involvement and evaluates and recommends the appropriate response.

Chapter 2 describes the following EE/CA activities:

- Section 2.1 provides information on when non-time-critical removal actions may be appropriate and on the EE/CA development process.

- Section 2.2 describes the purpose and content of the EE/CA Approval Memorandum.
- Section 2.3 explains that the Executive Summary should provide a general overview of the EE/CA.
- Section 2.4 highlights the types of information that should be gathered to characterize the site, determine the source, nature, and extent of contamination, and assess risks posed by the site.
- Section 2.5 outlines how to identify removal action objectives for the non-time-critical removal action.
- Section 2.6 describes the process for identifying and analyzing removal action alternatives.
- Section 2.7 describes how to compare removal action alternatives for effectiveness, implementability, and cost.
- Section 2.8 describes how to determine the recommended removal action alternative.

Details on conducting removal actions are found in a variety of laws, regulations, and guidance documents. Additional references that may be consulted for further information are presented at the conclusion of each section of this chapter, with a list of references presented in Appendix A of this guidance. Appendix B presents a key word index of major terms used in this guidance. Appendix C presents a comparison of the EE/CA process and the remedial investigation/feasibility study (RI/FS) process. Appendix D presents a model Notice of Decision Not to Use Special Notice Procedures.

1.1 THE SACM APPROACH

SACM is now being implemented to make Superfund cleanups more timely and efficient. The non-time-critical removal action represents a primary SACM tool for accomplishing early actions, and can be applied to a broad array of response actions. Specifically, SACM involves:

- A continuous process for assessing site-specific conditions and the need for action
- Cross-program coordination of response planning
- Prompt risk reduction through early action
- Appropriate cleanup of long-term environmental problems
- Early public notification and participation
- Early initiation of enforcement activities.

SACM should be considered for all Superfund activities, so long as implementation is consistent with requirements of the NCP and CERCLA. Overall Superfund program priorities remain the same: address the worst problems first, aggressively pursue enforcement, and involve the public during all stages of the work. The goals of SACM are being accomplished by focusing on the front end of the cleanup process and better integrating all Superfund program components.

1.1 THE SACM APPROACH (CONTINUED)

SACM encourages EPA Regions to explore new ways to use removal authorities under the NCP to achieve prompt risk reduction. An integrated removal and remedial site management strategy under SACM will most likely involve the increased use of non-time-critical removal authority to achieve prompt risk reduction at Superfund sites. Regional Decision Teams (RDTs), a SACM concept introduced in OSWER Publication 9203.1-05I, Volume I, Number 5, "SACM Regional Decisions—Interim Guidance" (December 1992), PB93-96266, are anticipated to emphasize early actions such as non-time-critical removal actions without jeopardizing the Superfund program's commitment to enforcement first. Decisions will be made to ensure that an early action will be consistent with any long-term action that may eventually be required. In the context of non-time-critical removal actions, this means that opportunities for treatment and permanence should be fully evaluated in the EE/CA, where appropriate (see Chapter 2).

For More Information:

1. OSWER Publication 9203.1-05I, Volume 1, Numbers 1-5 (December 1992)
   - "Status of Key SACM Program Management Issues—Interim Guidance," PB93-963262.
   - "Early Action and Long-Term Action Under SACM—Interim Guidance," PB93-963263.
   - "Enforcement Under SACM—Interim Guidance," PB93-963264.
   - "Assessing Sites Under SACM—Interim Guidance," PB93-963265.
   - "SACM Regional Decision Teams—Interim Guidance," PB93-963266.
2. OSWER Publication 9200.2-02, "Accelerated Response at NPL Sites Guidance" (December 15, 1989), PB90-258302/CCE.
3. OSWER Publication 9203.1-03, "Guidance on Implementation of the Superfund Accelerated Cleanup Model (SACM) under CERCLA and the NCP" (July 7, 1992), PB93-963252.
4. OSWER Publication 9203.1-03A, "Exercising Flexibility Through the Superfund Accelerated Cleanup Model (SACM)" (October 26, 1992), PB93-963253.
5. OSWER Publication 9360.0-15, "The Role of Expedited Response Actions Under SARA" (April 21, 1987), PB91-214221/CCE.

1.2 OVERVIEW OF THE REMOVAL ACTION PROCESS

CERCLA and the NCP define removal actions to include "the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release." EPA has categorized removal actions in three ways: emergency, time-critical, and non-time-critical, based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated. Emergency and time-critical removal actions respond to releases requiring action within 6 months; non-time-critical removal actions respond to releases requiring action that can start later than 6 months after the determination that a response is

necessary. Each response is unique and may require more expedited response based on the threatened population, contaminants of concern, and other factors. The following are potential removal actions identified in section 300.415(b)(2)(i)-(viii) of the NCP:

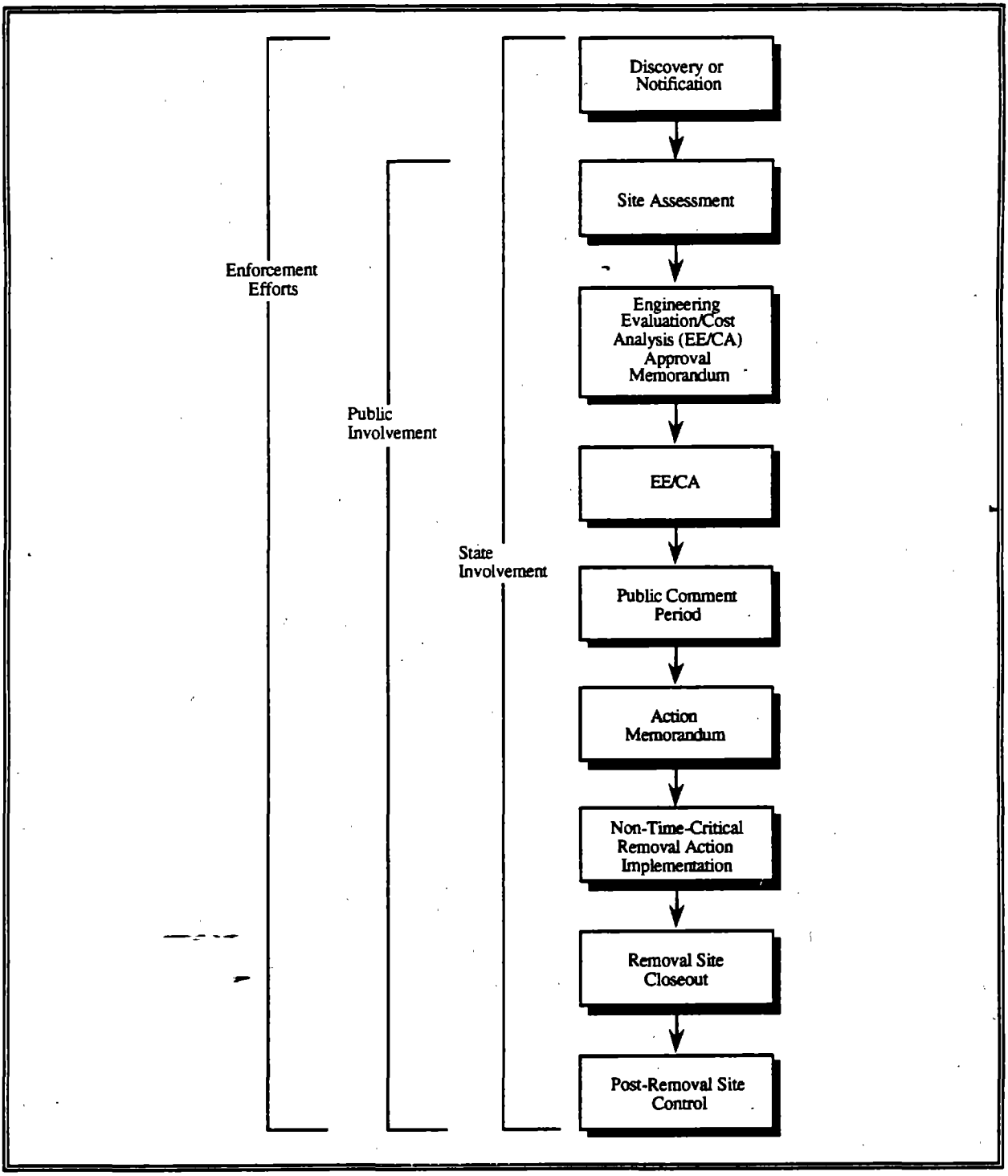
- Prevention or abatement of actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants
- Prevention or abatement of actual or potential contamination of drinking water supplies or sensitive ecosystems
- Stabilization or elimination of hazardous substances in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release
- Treatment or elimination of high levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface that may migrate
- Minimization or elimination of the effects of weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or to be released
- Elimination of threat of fire or explosion
- Determination of availability of other appropriate Federal or State response mechanisms to respond to the release
- Mitigation or abatement of other situations or factors that may pose threats to public health, welfare, or the environment.

OSCs/RPMs must always consider section 300.415 in determining the appropriateness of taking any removal action. Section 300.415(d)(1)-(9) of the NCP provides a partial list of removal actions that may be taken to address specific situations. Exhibit 1, on the following page, illustrates the non-time-critical removal action process.

The following steps are for non-time-critical removal actions:

- Section 300.410 of the NCP outlines the process for conducting a **removal site evaluation**, which includes a removal preliminary assessment (PA) and, if warranted, a removal site inspection (SI). The OSC/RPM performs the removal PA, based on readily available information, to identify the source and nature of the release or threatened release and to assess the threat to public health, the magnitude of the threat, and the factors necessary to determine the need for a removal action. The removal PA also determines if more information is needed to characterize the release, such as off-site or on-site inspection of conditions and sampling. If more information is necessary, the OSC/RPM performs a removal SI. Data gathered during the removal site evaluation help OSCs/RPMs determine the need for response, if any, and the urgency of the response. For non-time-critical removal actions, OSCs/RPMs further characterize the release and propose the removal action as a result of the EE/CA process, as discussed in Chapter 2. The subsequent selection of the appropriate response is made in the Action Memorandum.

EXHIBIT 1
Non-Time-Critical Removal Action Process*



* Additional removal actions or remedial actions may occur at any time, depending on the exigencies of the site conditions.

1.2 OVERVIEW OF THE REMOVAL ACTION PROCESS (CONTINUED)

- In general, the **EE/CA Approval Memorandum** is prepared by the OSC/RPM once the removal site evaluation has been completed and the need for a non-time-critical removal action has been determined. This memorandum serves three important functions. First, the memorandum is used to secure management approval and funding to conduct the EE/CA. Second, it documents that the situation meets the NCP criteria for initiating a removal action and that the proposed action is non-time-critical. Third, it provides detailed information pertaining to the site background; threats to public health, welfare, or the environment posed by the site (e.g., expected changes in the situation if no action is taken or if the action is delayed); enforcement activities related to the site; and projected costs.

- An **EE/CA** must be completed for all non-time-critical removal actions as required by section 300.415(b)(4)(i) of the NCP. The goals of the EE/CA are to identify the objectives of the removal action and to analyze the various alternatives that may be used to satisfy these objectives for cost, effectiveness, and implementability. While an EE/CA is similar to the RI/FS conducted for remedial actions, it is less comprehensive. The Action Memorandum summarizes the EE/CA. EE/CAs are considered CERCLA section 104(b)(1) studies. Therefore, EE/CA costs are not counted toward the $2 million statutory limit on removal actions.

- A public notice describing the EE/CA (see Chapter 2) and announcing a **public comment period** must be published in a major local newspaper. The public notice may be combined with notice of the availability of the administrative record file, pursuant to the administrative record requirement in section 300.820 of the NCP. The EE/CA is part of the administrative record file and is subject to the public comment and comment response requirements for the administrative record.

For More Information:

1. CERCLA:
   - §101, Definitions
   - §104(a), Removal Action
   - §104(b), Investigations, Monitoring, etc., by President
   - §104(b)(1), Information; Studies and Investigations
   - §104(c)(1), Statutory Limits
   - §104(f), Contracts for Response Action; Compliance with Federal Health and Safety Standards
   - §113(g)(2), Actions for Recovery of Costs Statute of Limitations
   - §113(k), Administrative Record and Participation Procedures
2. NCP:
   - §300.5, Definitions
   - §300.400(b), Limitations on Response
   - §300.410, Removal Site Evaluation
   - §300.415, Removal Action
   - §300.415(b)(4), EE/CA Requirement
   - §300.415(b)(5), Exemptions to Statutory Limitations on Fund-Financed Removal Actions
   - §300.415(c), Contribution to Remedial Action

1.2 OVERVIEW OF THE REMOVAL ACTION PROCESS (CONTINUED)

§300.150, Worker Health and Safety
§300.160, Documentation and Cost Recovery
§300.135(m), Reporting Requirements for Response Operations
§300.165, OSC Reports
§300.820, Administrative Record File for a Removal Action

3. OSWER Publication 9203.1-05I, Volume 1, Number 4, "Assessing Sites Under SACM—Interim Guidance" (December 1992), PB93-963265.
4. OSWER Publication 9285.1-03, "Standard Operating Safety Guides" (June 1992), PB92-963414.
5. OSWER Publication 9285.8-02, "Health and Safety Audit Guidelines: SARA Title I, Section 126" (December 1989), EPA/540/G-89/010, PB90-204157.
6. OSWER Publication 9360.0-02C, "Removal Cost Management System: Version 3.2" (May 1990), EPA/540/P-90/003, PB90-272691.
7. OSWER Publication 9360.0-12A, "Final Guidance on Implementation of the 'Consistency' Exemption to the Statutory Limits on Removal Actions" (June 12, 1989), PB90-274465/CCE.
8. OSWER Publication 9360.0-12FS, "Exemptions from the Statutory Limits on Removal Actions" (November 1990), PB91-921304/CCE.
9. OSWER Publication 9360.0-18, "Removal Program Priorities" (March 31, 1988), PB91-205484/CCE.
10. OSWER Publication 9360.2-04, "Authorization for Regional Administrators to Approve Consistency Exemption at NPL Sites" (February 24, 1992), PB92-963343.
11. 29 CFR §1910.120, HAZWOPER Regulations
12. 40 CFR Part 311, Worker Protection

1.3 ROLES AND RESPONSIBILITIES

Because of the urgency of emergency and time-critical removal actions, EPA OSCs/RPMs or U.S. Coast Guard OSCs generally retain the lead for conducting or overseeing these actions. For non-time-critical removal actions, it may be appropriate for the State to take the lead in conducting the removal action or taking enforcement actions. Regardless of who takes the lead, the OSC/RPM is responsible for determining whether technical assistance is needed from another agency and arranging for that assistance.

In carrying out a non-time-critical removal action, the OSC/RPM directs or reviews the work of other agencies, PRPs, and contractors to ensure compliance with CERCLA and the NCP; reviews all decision documents, enforcement orders, and workplans; oversees all expenditures of EPA funds; and ensures that all staff working on the response know site operating and safety procedures. The following section briefly describes the types of responsibilities specific to non-time-critical removal actions.

Regional Decision Team

The RDT convenes to consider response options at the point when assessment information is adequate to support decision-making. The RDT, a new concept under SACM, ensures effective coordination, communication, and integration of Superfund program authority, expertise, resources, and tools. For non-time-critical removal actions, the RDT should assist in assessing the

opportunity for response and in initiating the preparation of the EE/CA Approval Memorandum, the EE/CA, and the Action Memorandum. The RDT assists in determining whether proposed actions are time-critical or non-time-critical or whether the site requires remedial action. RDT involvement in emergency removal action and the more time-critical removal action decision-making may be limited based on the time available before initiating action. Also, RDT involvement in removal assessments and decision-making may vary from Region to Region.

State Involvement

Pursuant to 40 CFR Subpart O, section 35.6200, when a planning period of more than 6 months is available, States, political subdivisions, and Indian Tribes may apply for a removal Cooperative Agreement (CA) to lead a non-time-critical removal action. When a State does not participate in conducting and/or financially supporting a Fund-lead non-time-critical removal action, the RDT should first determine the urgency of the situation, and then, depending on the outcome of the urgency assessment, determine whether the non-time-critical removal action should proceed despite lack of State involvement. Headquarters will remain involved under SACM for approving consistency exemptions from the $2 million removal limit at sites not on the National Priorities List (NPL).

Potentially Responsible Party (PRP) Involvement

One of EPA's primary objectives for any Superfund action is to have the parties responsible for the release of hazardous substances be accountable for the response. CERCLA authorizes EPA to negotiate settlements, issue orders to compel response, or sue PRPs to repay response costs when the Fund has been used to finance removal actions. Because non-time-critical removal actions permit a planning period of at least 6 months, there is time for enforcement planning before the start of on-site activity. As with other removals, the OSC/RPM should work with Regional technical enforcement staff to identify PRPs, initiate actions to obtain PRP response, and conduct negotiations to enter into settlement agreements (see section 1.5).

Responsibility for Post-Removal Site Control (PRSC)

In some cases, PRSC activities will be necessary to ensure the continuing effectiveness of a completed non-time-critical removal action. Examples of these activities are relighting gas flares, replacing filters, and collecting leachate. Superfund program policy for completing removal actions states that protracted and costly long-term PRSC is more appropriately conducted by the affected State or local government or PRPs. If the OSC/RPM believes that PRSC may be necessary, the OSC/RPM should obtain a commitment from the State or local government or PRP to perform and fund necessary PRSC actions prior to initiating a response. Such commitments could be part of a settlement document with a PRP or take the form of a letter agreement or Memorandum of Understanding (MOU) with State or local governments. If the OSC/RPM is unable to obtain such an agreement, removal options that involve continuing PRSC should be avoided where other options are feasible.

1.3 ROLES AND RESPONSIBILITIES (CONTINUED)

For More Information:

1. NCP:
   §300.500-300.525, State Involvement in Removal Actions
   §300.525, State Involvement in Hazardous Substance Response
2. 40 CFR Part 35, Subpart O, Cooperative Agreements and Superfund State Contracts for Superfund Response Actions
3. 40 CFR §35.6200-6205, Removal Response Cooperative Agreements
4. 40 CFR §35.6240-6255, Support Agency Cooperative Agreements
5. OSWER Publication 9203.1-05I, Volume 1, Number 5, "SACM Regional Decision Teams—Interim Guidance" (December 1992), PB93-963266.
6. OSWER Publication 9360.2-02, "Policy on Management of Post-Removal Site Control" (December 3, 1990), PB91-921326/CCE.
7. OSWER Publication 9360.3-06, "Superfund Removal Procedures—Removal Enforcement Guidance for On-Scene Coordinators" (April 1992), PB92-963409.

1.4 RESOURCES

A number of resources can provide technical assistance to the lead agency carrying out a non-time-critical removal action. These include national, Regional, and specialized response teams; contractors; other Federal agencies; and State and local governments. Section 300.145 of the NCP describes special teams and other assistance available to OSCs/RPMs.

In addition, Superfund's Long-Term Contracting Strategy (LTCS) (OSWER Publication 9242.6-07, "Approval of Long-Term Contracting Strategy for Superfund [Superfund Management Review: Recommendations E.2]" [August 1990]), PB90-273822/CCE, provides OSCs/RPMs with mechanisms for greater flexibility in selecting contract support and improves oversight and cost management by giving the Regions full responsibility for contracts management. This strategy provides a road map to Superfund contractor support. The LTCS anticipated many of the underlying principles of SACM. For example, the increase in early action responses will be aided by the newly created Emergency and Rapid Response Services (ERRS) contracts. The LTCS also combines site assessment and removal technical assistance functions under single Superfund Technical Assessment and Response Team (START) contracts. The LTCS envisions that the Agency's non-time-critical removal actions will be performed using Response Action Contracts (RACs). Available contracting vehicles and capacities will affect the strategy for conducting both early and long-term actions under SACM. The process of developing these and other new contracts has begun and will continue over the next several years, consistent with the phase-in of SACM.

Currently, a variety of contractor resources is available to OSCs/RPMs. OSWER Publication 9200.5-402A, "Contracting and Subcontracting Guide to the Superfund Program" (May 1992), EPA/540/G-91/012, PR-923, lists available contractor firms in each Region and individuals to contact for information on available contracts.

1.4 RESOURCES (CONTINUED)

For More Information:

1. NCP §300.145, Special Teams and Other Assistance Available to OSCs/RPMs
2. OSWER Publication 9200.5-402A, "Contracting and Subcontracting Guide to the Superfund Program" (May 1992), EPA/540/G-91/012, PR 923.
3. OSWER Publication 9240.01-01D, "User's Guide to the Contract Laboratory Program" (January 1991), EPA/540/P-91/002, PB91-921278.
4. OSWER Publication 9242.2-01B, "Emergency Response Cleanup Services (ERCS) Contracts: User's Manual" (October 1987), PB90-191966/CCE.
5. OSWER Publication 9242.2-02, "Site-Specific Contracting for Removals" (April 10, 1989), PB91-215053/CCE.
6. OSWER Publication 9242.6-01, "ARCS Work Assignment Management, Field Guide" (January 1989), PB91-214965/CCE.
7. OSWER Publication 9242.6-07, "Approval of Long-Term Contracting Strategy for Superfund (Superfund Management Review: Recommendations E.2)" (August 1990), PB90-273822/CCE.
8. OSWER Publication 9360.6-08, "Technical Assistance Team (TAT) Contracts Users' Manual" (October 1991), PB92-963407.

1.5 ENFORCEMENT AND COST RECOVERY

PRP Search and Identification

EPA expects much of the early site assessment activities to be Fund-lead. However, changes to PRP-lead can occur during site assessment, prior to the EE/CA, or prior to initiating the non-time-critical removal action. The increased pace of response under SACM's integrated assessment process may require that the enforcement team work faster and devote more resources to PRP search and identification early in the process. This may lead to changes in PRP search methodology and, therefore, require less time to complete the PRP search than the current process.

Notice Letters

For time-critical and emergency removal actions, the time available to conduct enforcement activities will be limited, and notice letters will typically be issued simply to notify the PRP of its potential liability ~~or to~~ encourage informal negotiations. However, in many instances, formal negotiations may be more appropriate for non-time-critical removal actions. Regions may use CERCLA section 122(e) special notice letters for non-time-critical removal actions whenever practicable unless use of such procedures would interfere with the Agency's ability to implement a response in an expeditious manner. When deciding the appropriateness of using CERCLA section 122(e) special notice procedures, OSCs should consider whether viable PRPs have been identified, and whether identified PRPs are expected to respond favorably to the invitation to negotiate.

Issuance of the CERCLA section 122(e) special notice letter triggers a 60- to 120-day moratorium on on-site response activities under CERCLA section 104(a), including conducting the RI/FS. However, this does not mean that all activity related to the non-time-critical removal falls under the moratorium. Pursuant to section 122(e)(2)(A), the Agency may commence any

additional studies or investigations authorized under section 104(b) during the negotiation period. Since EE/CAs are considered CERCLA section 104(b) studies, preparation of the EE/CA may continue during the moratorium. Under this moratorium, if the PRP does not provide EPA with a good faith offer, the moratorium ends after 60 days.

Whenever EPA decides to forego use of CERCLA section 122(e) special notice procedures, CERCLA section 122(a) requires EPA to notify the PRP in writing of the reasons why formal negotiations are inappropriate. OSCs issuing such notice should refer to Appendix D, which presents a model Notice of Decision Not to Use Special Notice Procedures.

PRP Negotiation

Preparing certain documents before negotiations ensures that EPA will enter negotiations with a well-defined plan for PRP or agency response. One of the goals of negotiations is to develop an Administrative Order on Consent (AOC). The AOC may contain a workplan as an attachment. The AOC also might require the PRP to draft a detailed workplan as a first deliverable. AOCs should contain reimbursement provisions for past costs and oversight costs, where appropriate. If the initial removal assessment indicates that a non-time-critical removal action should be taken, the Region could negotiate an order with the PRPs for the EE/CA and include the eventual non-time-critical removal action in the order under CERCLA section 106 authority.

For non-time-critical removal actions, sufficient time is usually available to negotiate consent agreements with the PRP. However, if the PRP does not respond to notice letters or refuses to sign an AOC, EPA has the authority to proceed with a Fund-lead response or under CERCLA section 106, where an imminent and substantial endangerment exists, to issue a Unilateral Administrative Order (UAO) requiring a PRP to perform the removal action.

It is generally anticipated that by using SACM's phased PRP search approach, as described in OSWER Publication 9203.1-05I, Volume I, Number 3, "Enforcement Under SACM—Interim Guidance" (December 1992), PB93-963264, there will be sufficient time before initiating non-time-critical removal actions to allow those actions to be PRP-lead. For example, if the RDT decides, based on the early results of a PRP search, to initiate a Fund-lead EE/CA to support a non-time-critical removal action, the Region can continue PRP search activities during the EE/CA. After completing the EE/CA, the RDT can decide, based on supplemental PRP data, to seek PRP participation in conducting the non-time-critical removal action.

Cost Recovery

The statute of limitations for cost recovery for removal actions is 3 years from the completion of the removal action, unless a consistency exemption to the statutory limits under CERCLA section 104(c)(1)(C) has been approved. (In these circumstances, the statute of limitations is 6 years from the date of the last exemption.) A consistency exemption may be sought if the continued response action under CERCLA removal authorities is appropriate and consistent with the remedial action to be taken (see OSWER Publication 9360.0-12A, "Final Guidance on Implementation of the 'Consistency' Exemption to the Statutory Limits on Removal Actions" [June 12, 1989], PB90-274465/CCE). EPA's past costs should be sought in negotiations with PRPs, when appropriate. A decision not to pursue cost recovery must be documented in a Removal Action Cost Recovery Close-Out Memorandum prepared in consultation with the Office of Regional Counsel (ORC).

1.5 ENFORCEMENT AND COST RECOVERY (CONTINUED)

For More Information:

1 CERCLA:
§106, Abatement Actions
§122(e), Special Notice Procedures

2. OSWER Publication 9200.3-01H-1, "Superfund Program Implementation Manual 1993" (June 1993), PB92-963276.
3. OSWER Publication 9203.1-05I, Volume 1, Number 3, "Enforcement Under SACM—Interim Guidance" (December 1992), PB93-963264.
4. OSWER Publication 9360.0-12A, "Final Guidance on Implementation of the 'Consistency' Exemption to the Statutory Limits on Removal Actions" (June 12, 1989), PB90-274465/CCE.
5. OSWER Publication 9360.2-04, "Authorization for Regional Administrators to Approve Consistency Exemption at NPL Sites" (February 24, 1992), PB92-963343.
6. OSWER Publication 9360.3-01, "Superfund Removal Procedures—Action Memorandum Guidance" (December 1990), EPA/540/P-90/004, PB90-274473.
7. OSWER Publication 9360.3-06, "Superfund Removal Procedures—Removal Enforcement Guidance for On-Scene Coordinators" (April 1992), PB92-963409.
8. OSWER Publication 9832.0-1A, "Procedures for Documenting Costs for CERCLA Section 107 Actions" (January 30, 1985), PB91-138958/CCE.
9. OSWER Publication 9832.1, "Cost Recovery Actions Under CERCLA" (August 26, 1983), PB91-138966/CCE.
10. OSWER Publication 9832.11, "Guidance on Documenting Decisions Not to Task Cost Recovery Actions" (June 7, 1988), PB91-139048/CCE.
11. OSWER Publication 9832.13, "Superfund Cost Recovery Strategy" (July 29, 1988), PB91-139063/CCE.
12. OSWER Publication 9833.0-1A, "Guidance on CERCLA Section 106(a) Unilateral Administrative Orders for Remedial Designs and Remedial Actions" (March 13, 1990), PB91-139089/CCE.
13. OSWER Publication 9834.10, "Interim Guidance on Notice Letters, Negotiations, and Information Exchange" (October 19, 1987), PB91-139253/CCE.
14. OSWER Publication 9834.10-1b, "Model Notice Letters" (February 7, 1989), PB91-139279/CCE.
15. OSWER Publication 9837.2B, "Enforcement Project Management Handbook: FY1993 Update" (May 1993), PB93-963602.
16. Superfund Indirect Cost Manual, Financial Management Division, Office of the Comptroller (July 1991).

1.6 PUBLIC INVOLVEMENT AND THE ADMINISTRATIVE RECORD

As with all CERCLA actions, early and frequent involvement of the public, including involvement above and beyond the requirements, is crucial to expedited cleanups under SACM.

1.6 PUBLIC INVOLVEMENT AND THE ADMINISTRATIVE RECORD (CONTINUED)

Public involvement activities in Superfund promote communication between members of the public, including PRPs, and the lead government agency responsible for removal or remedial actions. Public involvement activities should be tailored to the needs of the community as well as to the technical action schedule.

Section 113(k)(2) of CERCLA provides for involving communities affected by response decisions at Superfund sites. Public involvement in the Superfund program, as a whole, consists of public outreach activities conducted throughout the planning and implementation of Superfund removal and remedial responses.

Since removal actions generally proceed quickly, there is less time to plan or conduct public participation activities than during remedial responses. Sections 300.415(m) and 300.820 of the NCP specify two forms of public participation for all removal actions:

- Community relations activities--designed to integrate the information needs of the community into the communications approach or community relations plan for the site.

- Administrative record activities—designed to chronicle the basis for the response selection and serve as a vehicle for public participation in the removal action.

Community Relations Requirements

The NCP and CERCLA outline a variety of community relations requirements to promote communication. The following are requirements for non-time-critical removal actions:

- Designate Community Relations Spokesperson. This person shall inform the community of actions taken, respond to inquiries, and provide information concerning the release.

- Conduct Community Interviews. Before completing the EE/CA, the lead agency must conduct community interviews to gather background information for the Community Relations Plan (CRP). The purpose of these interviews is to solicit information about community concerns, information needs, and how or when citizens would like to be involved in the removal action.

- Prepare CRP. Pursuant to sections 300.415(m)(4), 300.415(m)(4)(i), and 300.415(m)(3)(ii) of the NCP, a CRP must be prepared before the EE/CA is completed. The CRP is a site-specific document that relates the community relations techniques and approaches deemed appropriate and relevant to the site.

- Establish Information Repository. The information repository must be established no later than the signing of the EE/CA Approval Memorandum (see Chapter 2). The repository is a project file or collection of materials relating to the specific Superfund site and to the Superfund program in general. The administrative record file is included in the repository.

- Provide Public Notice of Availability of EE/CA. A public notice describing the Agency's preferred alternative and EE/CA results (see Chapter 2) and announcing

its availability for review and comment must be published in a major local newspaper. The EE/CA is part of the administrative record file.

Administrative Record Requirements

The administrative record file, a subset of the site file, is the body of documents EPA uses to form the basis for the selection of a response. It should not be confused with the administrative record, which is not complete until a response action has been selected. The administrative record file, as provided in section 300.820 of the NCP, may include site-specific data and comments, documents which were considered or relied on to select the removal action, guidance documents, technical references, and documents that reflect the views of the public, including PRPs, concerning the selection of a removal action. A strong administrative record helps ensure cost recovery, helps uphold EPA's remedy selection, and helps limit litigation-related information gathering discovery. For non-time-critical removal actions, the EE/CA Approval Memorandum, the EE/CA, and the Action Memorandum are critical components of the administrative record file. The administrative record closes once the decision document, in the case of a non-time-critical removal action the Action Memorandum, is signed. The record will reopen if the Action Memorandum is amended. The required administrative record activities for non-time-critical removal actions are:

- Establish the Administrative Record File. The administrative record file must be established no later than the signing of the EE/CA Approval Memorandum. The OSC/RPM, as the lead for on-site activity, is responsible for compiling and maintaining the administrative record in accordance with the NCP. The administrative record file must be made available for public inspection and copying when the EE/CA is made available for public comment at a central location at or near the site.

- Publish Notice of Availability of the Administrative Record File. A public notice must be published when the EE/CA is placed in the administrative record file and is available for comment. Additionally, if the notice also is used to announce a public comment period on the EE/CA, then it must state that upon timely receipt of a request (defined in the NCP preamble as generally within 2 weeks after the public comment period starts, but it may be considered valid if received within the 30-day period), the comment period will be extended a minimum of 15 additional days.

- Hold Public Comment Period. For non-time-critical removal actions, the NCP requires a 30-day public comment period on the EE/CA and any supporting documentation (including fact sheets or other documents summarizing the alternatives under consideration) at the time the EE/CA is made available for public comment.

- Develop Written Response to Significant Comments. After the public comment period is over, the OSC/RPM is required to prepare a written response to significant comments received during the comment period. The response to comments should be included in the administrative record file.

1.6 PUBLIC INVOLVEMENT AND THE ADMINISTRATIVE RECORD (CONTINUED)

For More Information:

1. CERCLA §113(k)(2), Participation Procedures
2. NCP:
   §300.415(m), Community Relations in Removal Actions
   §300.810, Contents of the Administrative Record File
   §300.820, Administrative Record File for a Removal Action
   §300.825, Record Requirements After the Decision Document is Signed
3. OSWER Publication 9230.0-03C, "Community Relations in Superfund: A Handbook" (January 1992), EPA/540/R-92/009, PB92-963341.
4. OSWER Publication 9360.3-05, "Superfund Removal Procedures—Public Participation Guidance for On-Scene Coordinators: Community Relations and the Administrative Record" (June 1992), PB92-963416.
5. OSWER Publication 9833.3A-1, "Final Guidance on Administrative Records for Selection of CERCLA Response Actions" (December 3, 1990), PB91-139121/CCE.
6. OSWER Publication 9836.0-1A, "Community Relations During Enforcement Activities and Development of the Administrative Record" (November 3, 1988), PB91-139519/CCE.

1.7 ACTION MEMORANDUM

An Action Memorandum provides a concise, written record of the decision to select an appropriate removal action. Exhibit 2, on the following page, provides an outline of the information that should be included in the Action Memorandum. As the primary decision document, it substantiates the need for a removal action, identifies the proposed action, and explains the rationale for the removal action selection. In this respect, the Action Memorandum for removal actions parallels the function of the Record of Decision (ROD), which documents the final action plan for a remedial response; however, the Action Memorandum is not as elaborate as the ROD. An Action Memorandum may also reserve the appropriate funding needed for the proposed removal action.

Action Memoranda follow a standard format. Specific topics must be addressed in the Action Memorandum to demonstrate that the release meets statutory and NCP requirements for a removal action. For non-time-critical removal actions, an EE/CA summary or the EE/CA Executive Summary, the EE/CA Approval Memorandum or a summary thereof, and a summary of the written comments on the EE/CA for alternative actions considered for non-time critical removal actions should be part of the "Proposed Actions and Estimated Costs" section of the Action Memorandum. In addition, a copy of the EE/CA, or the Executive Summary, and the Agency's response to significant public comments on the EE/CA should be attachments to the Action Memorandum and become part of the administrative record file.

EXHIBIT 2
Action Memorandum Outline

I. Purpose

II. Site Conditions and Background
- A. Site Description
  1. Removal site evaluation
  2. Physical location
  3. Site characteristics
  4. Release or threatened release into the environment of a hazardous substance, or pollutant, or contaminant
  5. NPL status
  6. Maps, pictures, and other graphic representations
- B. Other Actions
  1. Previous actions
  2. Current actions
- C. State and Local Authorities' Roles
  1. State and local actions to date
  2. Potential for continued State/local response

III. Threats to Public Health or Welfare or the Environment, and Statutory and Regulatory Authorities
- A. Threats to Public Health or Welfare
- B. Threats to the Environment

IV. Endangerment Determination (see page 16 of Action Memorandum Guidance)*

V. Proposed Actions and Estimated Costs
- A. Proposed Actions
  1. Proposed action description
  2. Contribution to remedial performance
  3. Description of alternative technologies
  4. Engineering Evaluation/Cost Analysis (EE/CA)
  5. Applicable or relevant and appropriate requirements (ARARs)
  6. Project schedule
- B. Estimated Costs

VI. Expected Change in the Situation Should Action Be Delayed or Not Taken

VII. Outstanding Policy Issues

VIII. Enforcement

IX. Recommendation

Enforcement Addendum

Attachments

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* OSWER Publication 9360.3-01, "Superfund Removal Procedures—Action Memorandum Guidance" (December 1990), EPA/540/P-90/004, PB90-274473.

1.7 ACTION MEMORANDUM (CONTINUED)

For More Information:

OSWER Publication 9360.3-01, "Superfund Removal Procedures—Action Memorandum Guidance" (December 1990), EPA/540/P-90/004, PB90-274473.

1.8 ON-SCENE COORDINATOR REPORTS

As currently stated in section 300.165 of the NCP, within 1 year after completion of removal activities involving a major release, or when requested by the Regional Response Team (RRT), the OSC/RPM must submit to the RRT a complete report on the removal operation and the actions taken. A copy of the report must also be sent to the Secretary of the National Response Team (NRT). The report shall record the situation as it developed, the actions taken, the resources committed, and the problems encountered.

There is an established format for OSC reports set out in section 300.165 of the NCP. The report must contain the following:

- Summary of Events—a chronological narrative of all events, including:
  - Location of the hazardous substance
  - Cause of the discharge or release
  - Initial situation
  - Efforts to obtain response by responsible parties
  - Organization of the response, including State participation
  - Resources committed
  - Content and time of notice to natural resources trustees
  - Federal or State trustee damage assessment activities and efforts to replace or restore damaged natural resources
  - Details of any threat abatement action taken
  - Treatment/disposal/alternative technology approaches pursued and followed
  - Public information/community relations activities.
- Effectiveness of removal actions taken by:
  - Responsible party(ies)
  - State and local entities
  - Federal agencies and special teams
  - Contractors, private groups, and volunteers (if applicable).
- Difficulties encountered—a list of items that affected the response, with particular attention to issues of intergovernmental coordination.

1.8 ON-SCENE COORDINATOR REPORTS (CONTINUED)

- Recommendations, including:
  - Means to prevent a recurrence of the discharge or release
  - Improvement of response actions
  - Recommended changes in the NCP, regional contingency plan, area contingency plan, OSC contingency plan or other local emergency response plans.

CHAPTER 2

CONDUCTING THE ENGINEERING EVALUATION/COST ANALYSIS (EE/CA)

2.1 OVERVIEW

In 1987, the Emergency Response Division began development of the first draft guidance on Engineering Evaluations/Cost Analyses (EE/CAs) for non-time-critical removal actions. Because issuance of a final EE/CA guidance was delayed pending the outcome of issues related to the NCP revisions, in 1988 a draft outline was distributed to assist the Regions in preparing EE/CAs. This chapter replaces the 1988 memo to help the Regions in fulfilling the goals of the EE/CA, which are to:

- Satisfy environmental review requirements for removal actions
- Satisfy administrative record requirements for improved documentation of removal action selection
- Provide a framework for evaluating and selecting alternative technologies.

Non-time-critical removal actions will be the appropriate response for a variety of sites and will range in scope from small-scale, low-cost actions to complicated multi-media response actions requiring exemptions from the statutory time and/or dollar limits. Non-time-critical removal actions may be interim or final actions; they may be the first and only action at a site, or one of a series of planned response actions. The scope of the non-time-critical removal action will determine the detail of the EE/CA. The EE/CA is a flexible document tailored to the scope, goals, and objectives of the non-time-critical removal action. It should contain only those data necessary to support the selection of a response alternative, and rely upon existing documentation whenever possible.

The range of site characteristics affecting the non-time-critical removal action forms a continuum. At one end are sites where the non-time-critical removal action is the first and only action expected at a site and where no other data are available. In this case, the EE/CA should provide definitive information on the source, nature, and extent of contamination, and risks presented by the site. At the other end of the continuum are sites where the non-time-critical removal action is one of a series of response actions, where a completed RI is or will be available, and where the nature and extent of contamination and the risk presented by the site have been or will be determined. In this case, the EE/CA would be similar to a focused FS, concentrating on the analysis of perhaps two or three appropriate alternatives and providing reference to existing information on the nature and extent of contamination and risks.

Many non-time-critical removal actions may occur at sites with characteristics that fall within these extremes. OSCs/RPMs should tailor the EE/CA to match the specific goals and objectives of the non-time-critical removal action planned for a given site. The goals of the removal should be based on the relevant factor(s) listed in sections 300.415(b)(2)(i)-(viii) of the NCP. The relevant factors should be cited in the EE/CA Approval Memorandum as justification for conducting the EE/CA. The scope of the action takes into account two major considerations: the physical portion of the site to be addressed and whether the action represents a final or interim step toward addressing a particular exposure pathway.

2.1 OVERVIEW (CONTINUED)

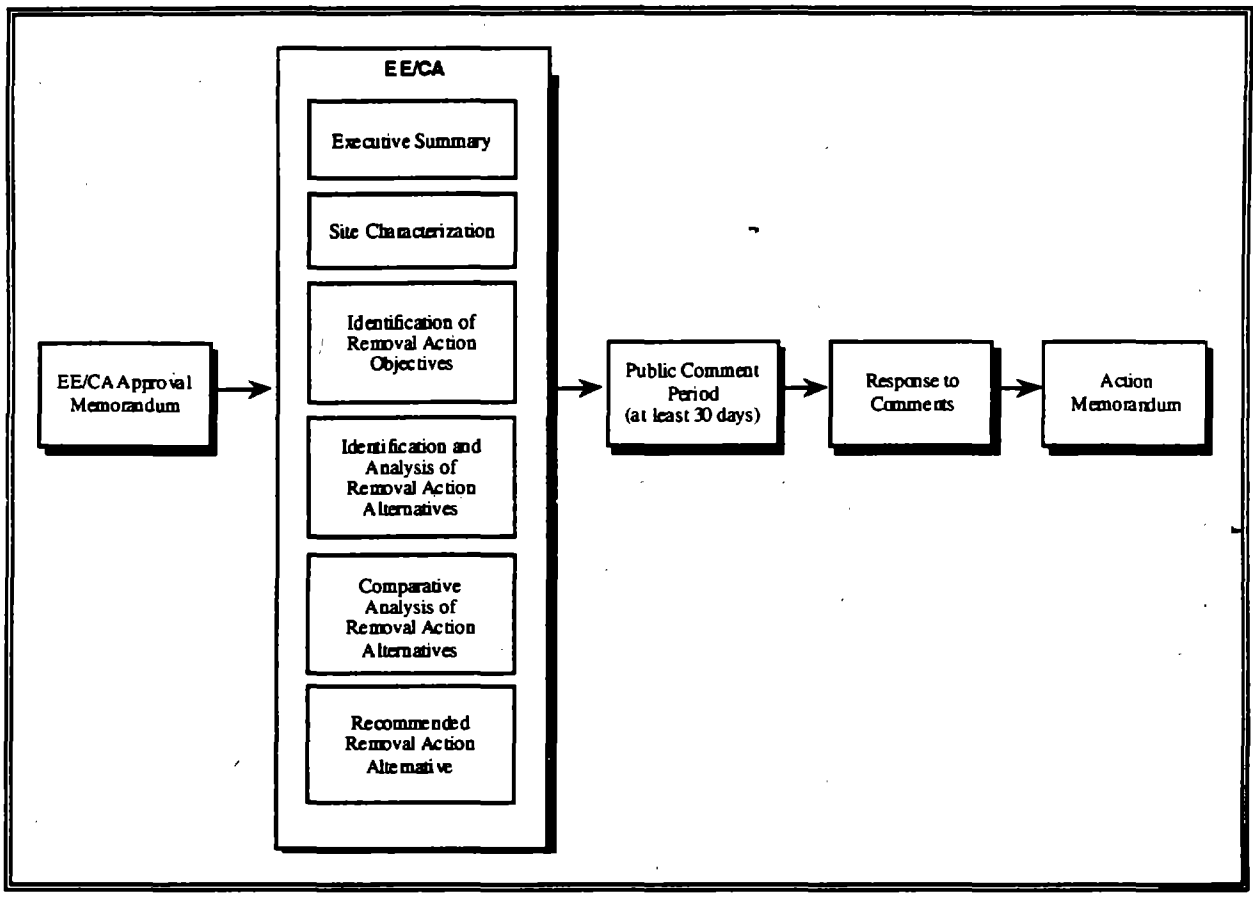
Specific objectives are then developed for the site. Removal action objectives generally consist of environmental medium-specific goals for protecting human health and the environment. The objectives should be as specific as possible, but not so specific that the range of alternatives that can be developed is unduly limited. Removal action objectives should identify, for example, the contaminants of concern and exposure route(s) and receptor(s).

The scope of the non-time-critical removal action (e.g., an interim action conducted during an ongoing remedial effort) and the specific objectives determine the information to be collected during the EE/CA. Accordingly, qualitative risk information that identifies pathways of concern and concentrations of contaminants above standards could have been documented at the site during the RI, and may be referred to in the EE/CA; a separate risk assessment is not necessary to support the non-time-critical removal action. Data to characterize the nature and extent of contamination should be limited to those needed to support the specific objectives of the non-time-critical removal action, supplementing existing data (e.g., the existing RI/FS) to the extent appropriate. Finally, an initial screening of alternatives generally will not be necessary; only a few viable alternatives relevant to the EE/CA objectives should be identified and analyzed.

As noted in Chapter 1, an EE/CA must be completed for all non-time-critical removal actions under CERCLA as required by section 300.415(b)(4)(i) of the NCP. The goals of the EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. Thus, an EE/CA serves an analogous function, but is more streamlined than the RI/FS conducted for remedial actions. Soliciting and responding to public comments on the administrative record, including the EE/CA, is required by section 300.820(a) of the NCP. (See Appendix C for a side-by-side comparison of the EE/CA process and the RI/FS process.)

The results of the EE/CA, along with EPA's response decision, are summarized in the Action Memorandum. The costs of performing an EE/CA, which is considered a CERCLA section 104(b)(1) study, are not counted toward the $2 million statutory limit on removal actions. Exhibit 3, on the following page, depicts the process for developing an EE/CA.

EXHIBIT 3
EE/CA Development Process



This chapter provides guidance on the components of the EE/CA Approval Memorandum, as shown in Exhibit 4, on the following page, and the EE/CA, as shown in Exhibit 5. The chapter discusses and provides checklists for each section of the EE/CA; however, each section can be modified to satisfy special requirements of the removal action or to justify the selection of a specific alternative.

For More Information:

1. CERCLA §104(b)(1), Information; Studies and Investigations
2. NCP:
   §300.415, Removal Action
   §300.415(b)(2), Appropriateness Factors
   §300.415(b)(4)(i), EE/CA Requirement

2.1 OVERVIEW (CONTINUED)

EXHIBIT 4
EE/CA Approval Memorandum

- ❑ Subject
- ❑ Background
- ❑ Threat to Public Health, Welfare, or the Environment (Includes Expected Change If No Action Taken)
- ❑ Imminent and Substantial Endangerment If Present
- ❑ Enforcement Actions
- ❑ Proposed Project/Oversight and Cost
- ❑ Approval/Disapproval

2.2 EE/CA APPROVAL MEMORANDUM

In general, the EE/CA Approval Memorandum is prepared once the need for a non-time-critical removal action has been determined; a removal site evaluation may have been completed, or if the site is on the NPL, information may also be available from other sources. The EE/CA Approval Memorandum is not a part of the EE/CA, but is part of the administrative record for the site.

The EE/CA Approval Memorandum serves important functions. First, it secures management approval and funding approval to conduct the EE/CA or, for PRP-lead actions, to provide oversight of EE/CAs. If the action is PRP-lead, provisions for oversight funding will be contained in an administrative order and should be included in an Approval Memorandum. Second, the memorandum documents that the situation meets the NCP criteria for initiating a removal action and that the required action is non-time-critical. Third, it provides a finding of an actual or threatened release from the site and, if present, a finding of an imminent and substantial endangerment, or refers to a document establishing such a determination. The Approval Memorandum also provides general information pertaining to the site background; threats to public health, welfare, or the environment posed by the site (including expected changes in the site situation if no action is taken or if the action is delayed); enforcement activities related to the site; and estimated EE/CA costs.

The EE/CA Approval Memorandum should indicate a current or potential threat to public health, welfare, or the environment. The memorandum should focus on providing sufficient information that such a threat or potential threat could exist, while the EE/CA will provide the information for EPA to determine that such a threat or potential threat actually exists. The preliminary identification of exposures is based on information obtained from the PA or SI and possibly other previous investigations. The OSC/RPM should develop a conceptual site model as a starting point for this analysis. The model identifies potential releases, potential areas of contamination, chemicals of concern, possible routes of exposure, possible routes of contaminant transport, and potential exposure pathways.

This potential for exposure indicates the likelihood of meeting the NCP criteria for taking a removal action, which in turn justifies the need for conducting the EE/CA. For example, risk consideration can identify the possibility of exposure of nearby populations, animals, or the food chain to hazardous substances, pollutants, or contaminants. Similarly, this preliminary risk

2.2 EE/CA APPROVAL MEMORANDUM (CONTINUED)

information may also indicate the possibility of contamination of drinking water or sensitive environments or other situations or factors that may pose threats to public health, welfare, or the environment.

The Regional Administrator (or authorized designee) evaluates the EE/CA Approval Memorandum and provides authorization. Funds expended to prepare an EE/CA Approval Memorandum are CERCLA 104(b)(1) monies and are not counted toward the $2 million statutory limit for removal actions.

For More Information:

1. CERCLA §104(b)(i), Information; Studies and Investigations.
2. NCP:
   §300.415(m)(4)(i), Community Relations
   §300.415(b)(4), EE/CA Requirement

EXHIBIT 5
EE/CA Outline

- ❑ Executive Summary
- ❑ Site Characterization
  - ❑ Site description and background
  - ❑ Previous removal actions
  - ❑ Source, nature, and extent of contamination
  - ❑ Analytical data
  - ❑ Streamlined risk evaluation
- ❑ Identification of Removal Action Objectives
  - ❑ Statutory limits on removal actions
  - ❑ Determination of removal scope
  - ❑ Determination of removal schedule
  - ❑ Planned remedial activities
- ❑ Identification and Analysis of Removal Action Alternatives
  - ❑ Effectiveness
  - ❑ Implementability
  - ❑ Cost
- ❑ Comparative Analysis of Removal Action Alternatives
- ❑ Recommended Removal Action Alternative

2.3 EE/CA EXECUTIVE SUMMARY

The EE/CA Executive Summary provides a general overview of the contents of the EE/CA. It should contain a brief discussion of the site and the current or potential threat posed by site

2.3 EE/CA EXECUTIVE SUMMARY (CONTINUED)

conditions. The Executive Summary should also identify the scope and objectives of the removal action, as well as the removal action alternatives. Finally, this section of the EE/CA should provide information on the recommended removal action alternative.

The Executive Summary is intended to make the contents of the EE/CA more accessible to review by the public, and is analogous in this respect to the Proposed Plan used in the remedial process. This summary can then be used in the Action Memorandum, which should include a description of the EE/CA.

2.4 SITE CHARACTERIZATION

The EE/CA should summarize available data on the physical, demographic, and other characteristics of the site and surrounding areas. These data may be available from a removal site evaluation, from previous investigations, or from other EPA activities at the site (e.g., work in preparation for NPL listing). Documents providing information for the EE/CA should be placed in the administrative record for the site. Whatever the source, the data on the site must provide background engineering information for analysis of removal alternatives. Because of the CERCLA preference for treatment over containment or land disposal, it is important that alternatives that employ treatment and that yield permanent solutions be fully evaluated for non-time-critical removal actions and early remedial actions. Furthermore, potential differences between early action and long-term action data quality objectives and risk assessment goals should be reconciled as early as possible. Therefore, EPA should coordinate activities of the OSC/RPM with those of the site assessment manager, risk assessor, and enforcement/legal staff to ensure appropriate data are collected to characterize the site.

Information about the site may be readily available from many sources, including:

- Scoring packages for NPL sites
- Removal site evaluations
- Remedial PA/SI reports
- EE/CA Approval Memoranda
- RI/FSs
- RODs
- State and local government reports
- The Agency for Toxic Substances and Disease Registry (ATSDR) or State public health agencies
- State Historic Preservation Officer
- Environmental Impact Statements (EISs)
- CERCLA section 104(e) information requests
- Newspaper articles
- Resource Conservation and Recovery Act (RCRA) enforcement actions
- Published engineering evaluations and technical reference documents
- Documents from other Federal agencies, such as U.S. Geological Survey (USGS) maps and Federal Emergency Management Agency evacuation reports
- Company records
- Employee interviews
- EPCRA—Toxic Release Inventory data.

2.4 SITE CHARACTERIZATION (CONTINUED)

Site Description and Background

The site description includes current and historical information. This information may help identify hazardous substances, pollutants, or contaminants of concern, or areas of the site requiring additional sampling. In gathering this information, OSCs/RPMs should review State, local, and Federal permit files, construction records, and local deed records for information on previous owners to determine materials produced, stored, or disposed of at the site. CERCLA section 104(e) information requests should also be considered. In addition, interviews should be conducted, as necessary, with neighbors of the site or past employees who can describe past operational practices or identify other past employees. The site background may include historical and aerial photographs. The EE/CA should document these data to convey a clear understanding of the nature of the site.

The site description section of the EE/CA should include the following types of information where available and as appropriate to the site-specific conditions and the scope of the removal action:

- Site location
  - Street address and crossroads
  - USGS topographic map quadrangle
  - Latitude/longitude
- Type of facility and operational status
  - Materials manufactured, stored, or disposed on-site
  - Estimated quantities of contaminants and potential hazards
  - Years of operation
  - Present/prior site use
  - Regulatory history, including previous responses, investigations, and litigation by State, local, and Federal agencies
- Structures/topography
  - Facility size/dimensions
  - Boundary descriptions
  - Land cover/vegetation/stresses to topography
  - Utilities/transportation features
  - Buildings
  - Surface water bodies/conveyances
  - Drainage channels/pathways
  - Historically/archaeologically significant features
  - Sewer lines/manholes
  - Stormwater drainage pipes
  - Open ditches/canals
  - Power lines/pipelines
- Geology/soil information
  - Depth to aquifer
  - Soil types (surface and vadose zones)
  - Local geological formulations
  - Surface water hydrology and hydrogeology

2.4 SITE CHARACTERIZATION (CONTINUED)

- Surrounding land use and populations
  - Residential, industrial, or commercial land use
  - Possible pathways of exposure
  - Identification of sensitive populations
  - Estimate of population densities within potentially affected radius
  - Description of drinking water sources
  - National Historic Preservation Act considerations

- Sensitive ecosystems
  - Wetlands, wildlife breeding areas
  - Wild and scenic rivers
  - Connection to the human food chain or food chains of other organisms
  - Sensitive and/or endangered species
  - Coastal zones

- Meteorology
  - Rainfall/snowfall
  - Temperature ranges
  - Wind conditions

Previous Removal Actions

The site characterization section of the EE/CA should also describe any previous removal actions at the site. Exhibit 6, on the following page, shows useful information that may be obtained from a previous removal action and its applicability to the current EE/CA. Previous information, if relevant, may be organized as follows:

- The scope and objectives of the previous removal action
- The amount of time spent on the previous removal action
- The amount of money spent on the previous removal action
- The nature and extent of hazardous substances, pollutants, or contaminants treated or controlled during the previous removal action
- The technologies used and/or treatment levels used for the previous removal action.

Like all documents that serve as the basis for Superfund decisions, EE/CAs are subject to public review and must be part of the administrative record. Although confidential and enforcement-sensitive documents are typically not relied upon in selecting response actions, when they are relied upon they should be contained in a separate confidential portion of both the EE/CA and the administrative record. Confidential information includes the following:

- Trade secrets, commercial or financial information
- State secrets
- Confidential informant files
- Privacy Act privileged information, attorney-client privileged information, and attorney work product privileged information
- Information exempted by other statutes.

Enforcement-sensitive information that generally should not be placed in the administrative record file includes:

- Financial status of PRPs
- Record of previous negotiations with PRPs and the results
- Investigatory files relating to law enforcement
- Additional information on enforcement history, strategy, discussion, and recommendations.

EXHIBIT 6
Information From Previous Removal Actions Applicable To Current EE/CA

Information From Previous Removals	Applicability To Current EE/CA
Nature and Extent of Contaminants	This information may allow the OSC/RPM to narrow the scope of evaluation to certain areas of the site or to specific analyses.
Treatability of Compounds	Previous use of a technology may affect the decision to use the same technology again.
Equipment/Utilities at Site	If the previous removal action resulted in supplies and equipment being left at the site or provision of specific utilities (e.g., electrical power, sewer line), this information may affect the choice of treatment/control options employed.
Site-Specific Conditions	Lessons learned from a previous removal action are valuable to the current EE/CA. Specific examples could include seasonal weather patterns affecting technology applications or site access limitations because of vehicle transportation routes.

Source, Nature, and Extent of Contamination

To the extent possible, site characterization data should be gathered during the removal site evaluation to support the EE/CA, unless such data were gathered in prior investigations. Existing information may be useful in determining the location(s) of contamination at a particular site. This information may include:

- Location(s) of the hazardous substance(s), pollutant(s), or contaminant(s)
- Quantity, volume, size, or magnitude of the contamination
- Physical and chemical attribute(s) of the hazardous substance(s), pollutant(s), or contaminant(s)
- Target(s) potentially affected by the site.

2.4 SITE CHARACTERIZATION (CONTINUED)

The source of the contamination for a removal action is often well defined. However, if the source, nature, and extent of contamination cannot be readily identified, the OSC/RPM should survey the area. Contamination sources and locations can often be determined by:

- Using nonanalytical methods, including geophysical surveys, which may indicate the presence of buried objects, such as drums
- Examining aerial photographs (especially those taken over a period of time), which may indicate land areas or drainage patterns that have been disturbed
- Reviewing past operations and information from the Toxic Release Inventory and interviewing past or current employees, which may help determine the source of contamination.

If contamination is found in a containment vessel (e.g., under- or above-ground storage tanks, drums, lagoons), the integrity of the vessels should be determined. The integrity may have an impact on the selection of the removal action.

Analytical Data

The analytical data section presents quantifiable data collected for the EE/CA. This section begins with existing data and expands as additional data are collected. When sufficient data are collected, significant findings should be presented in a narrative discussion. The actual data can be presented in tables, either within the section or in an appendix, or incorporated by reference to the document containing the data.

Sampling should typically be performed in accordance with accepted EPA and Contract Laboratory Program (CLP) protocols. Where feasible, sampling should be coordinated through the integrated assessment approach of SACM. Where a SACM approach is used, appropriate data quality objectives should be used for decisions in support of remedial and removal actions. If the site is not already on the NPL, sample collection and analysis should generally ensure that data generated will also support assessment of whether NPL listing and remedial action are appropriate.

Analytical data from studies conducted by EPA or other groups (e.g., State or local health or environmental authorities or PRPs) are useful in characterizing the site. Reviewing any soil, water, or waste analyses will help OSCs/RPMs determine the precision, accuracy, representativeness, completeness, and comparability of previous sampling. These parameters can be evaluated by examining the results of routine quality control procedures, such as replicate samples and/or analyses, replicate spiked samples and/or analyses, field blanks, method blanks, and analysis of standard reference materials.

To reflect SACM's integrated assessment approach, future guidance will further address data collection and analysis to support removal actions, early remedial actions, and long-term actions. The Environmental Response Team (ERT) is currently developing integrated guidance on air, waste, and water sampling, and ecological assessment. All data used to justify a non-time-critical action should be supported by quality control data. Furthermore, these data should be

evaluated based on quality assurance documentation. Following this quality assurance and control process, data can be compared to existing health- or risk-based standards to determine the nature of the threat to public health, welfare, or the environment.

Streamlined Risk Evaluation

The streamlined risk evaluation is a new type of evaluation, intermediate in scope between the limited risk evaluation undertaken for emergency removal actions and the conventional baseline assessment normally conducted for remedial actions. This streamlined risk evaluation can help justify taking a removal action and identify what current or potential exposures should be prevented. The risk evaluation uses sampling data from the site to identify the chemicals of concern, provides an estimate of how and to what extent people might be exposed to these chemicals, and provides an assessment of the health effects associated with these chemicals. A streamlined risk evaluation projects the potential risk of health problems occurring if no cleanup action is taken at a site. Therefore, the results of the streamlined risk evaluation help EPA decide whether to take a cleanup action at the site, what exposures need to be addressed by the action, and in some cases define appropriate cleanup levels.

In planning a non-time-critical removal action, OSCs/RPMs should consult with the Regional risk assessors on potential action and cleanup levels. The risk evaluation at the site should remain the responsibility of EPA. Since removal and remedial action cleanup levels may differ, all early action decisions should consider the possible long-term action and corresponding cleanup levels. The OSC/RPM should ensure that all risk assessment activities are consistent with any future remedial action remaining to be taken (or potential for listing, if the site is not on the NPL) to achieve consistent risk goals. OSCs/RPMs should refer to OSWER Publication 9285.7-01B, "Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part A, Interim Final" (December 1989), EPA/540/1-89/002, PB90-155581, for guidance on conducting risk evaluations.

For the EE/CA, the streamlined risk evaluation should focus on the specific problem that the removal action is intended to address. For example, if the non-time-critical removal action is to install a ground water containment system, the risk evaluation should address risk due to consumption and use of ground water. If the action is intended to address a particular source of contamination, the risk evaluation should address the risks related only to that source of contamination.

To assist in focusing the risk evaluation on specific site problems, OSCs/RPMs should rely on the conceptual site model and data developed during site characterization. A risk evaluation that identifies only contaminants of concern in the affected media, contaminant concentrations, and the toxicity associated with the chemical can be sufficient to justify taking an action. In some situations, exposure pathways can be identified as an obvious threat to human health or the environment by comparing EE/CA contaminant concentrations to standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. These may include non-zero Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs) for ground water or leachate, or State air quality standards for contaminants that may volatilize or be entrained by the wind. When potential ARARs for chemicals of concern do not exist for a specific contaminant, risk-based chemical concentrations should be used.

2.4 SITE CHARACTERIZATION (CONTINUED)

Where standards for one or more contaminants in a given medium are clearly exceeded, a removal action is generally warranted, and further quantitative assessment that considers all chemicals, their potential additive effects, or additivity of multiple exposure pathways, are generally not necessary. In cases where standards are not clearly exceeded, or where the available information is deficient or of questionable quality, a more thorough risk assessment may be advisable before deciding whether to take a removal action.

In most, if not all, PRP-and State-lead actions with no RI/FS or other site evaluation and little likelihood of future EPA remedial action, a conventional risk assessment will be necessary to evaluate all potential pathways. If more substantial information or data are needed regarding risks posed at a site (e.g., due to insufficient data quality from prior site work), OSCs/RPMs should not hesitate to request supplementary risk information before any type of response action is selected, being careful to justify any additional work that may be required. However, only in the case where the non-time-critical action will be the only Fund-lead action expected at the site should OSCs/RPMs consider performing a risk assessment that addresses all potential exposure pathways.

For More Information:

1. CERCLA §104(e), Information Gathering and Access
2. OSWER Publication 9200.2-16FS, "Quality Assurance for Superfund Environmental Data Collection Activities" (February 1993), PB93-963273.
3. OSWER Publication 9285.7-01B, "Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual, Part A, Interim Final" (December 1989), EPA/540/1-89/002, PB90-155581.
4. OSWER Publication 9360.4-01, "Quality Assurance/Quality Control Guidance for Removal Activities—Sampling QA/QC Plan and Data Validation Procedures (Interim Final)" (April 1990), EPA/540/G-90/004, PB90-274481.
5. OSWER Publication 9360.4-02, "Compendium of ERT Soil Sampling and Surface Geophysics Procedures" (January 1991), EPA/540/P-91/006, PB91-921273.
6. OSWER Publication 9360.4-03, "Compendium of ERT Surface Water and Sediment Sampling Procedures" (January 1991), EPA/540/P-91/005, PB91-921274.
7. OSWER Publication 9360.4-05, "Compendium of ERT Air Sampling Procedures" (May 1992), PB92-963406.
8. OSWER Publication 9360.4-06, "Compendium of ERT Ground Water Sampling Procedures" (January 1991), EPA/540/P-91/007, PB91-921275.
9. OSWER Publication 9360.4-07, "Compendium of ERT Waste Sampling Procedures" (January 1991), EPA/540/P-91/008, PB91-921276.
10. OSWER Publication 9360.4-08, "Compendium of ERT Toxicity Testing Procedures" (January 1991), EPA/540/P-91/009, PB91-921271.
11. OSWER Publication 9360.4-10, "Removal Program—Representative Soil Sampling Guidance" (November 1991), PB92-963408.

2.5 IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES

Identifying the scope, goals, and objectives for a removal action is a critical step in the EE/CA and in the conduct of non-time-critical removal actions. At any release, regardless of whether the site is on the NPL, where the lead agency determines there is a threat to public health, welfare, or the environment, a removal action may be taken to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release.

The following example illustrates this process at an NPL site with an ongoing RI/FS, and where an opportunity exists to conduct a non-time-critical removal action. The non-time-critical removal action will minimize migration of contaminated ground water and contaminants from subsurface soil but is considered an interim action because it is expected that the remedial action will ultimately address the area of concern.

In this example, the goal of the non-time-critical removal action is to minimize migration of contaminated ground water and to begin to reduce contaminants in the soil that are the source of ground water contamination. This goal corresponds to section 300.415(b)(2)(iv) of the NCP, which identifies "high levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface, that may migrate" as a factor to be considered in determining the appropriateness of a removal action.

Five specific objectives are then developed for the site:

- Minimize migration of contaminated ground water through installation of a containment system
- Initiate removal of volatile organic compounds from contaminated soils through in-situ treatment
- Dewater areas necessary to treat effectively the decontaminated soils
- Install and operate appropriate treatment systems for ground water and vapor generated by containment, dewatering, and soil treatment that will prevent unacceptable discharges or emissions.
- Dispose of waste streams from the removal action.

These objectives should be achieved by meeting specified cleanup levels while working within the statutory limits and attaining ARARs to the extent practicable. Exhibit 7 provides a checklist of factors to consider in developing EE/CA objectives.

Statutory Limits on Removal Actions

Because the EE/CA is a public document and readers may not be aware of the statutory limits on removal actions, the objectives section of the EE/CA should briefly explain the $2 million and 12-month statutory limits for Fund-financed removal actions pursuant to section 104(c)(1) of CERCLA. If the need for an exemption is determined early in the action, the details should be described in the EE/CA as well as in the Action Memorandum requesting the exemption.

2.5 IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES (CONTINUED)

Determination of Removal Scope

The EE/CA should help define the scope of the removal action. The scope of the action could be, for example, total site cleanup, site stabilization, or surface cleanup of hazardous substances. It is critical that removal actions at non-NPL sites consider the potential for future listing to ensure the goals of the removal are consistent with any potential long-term remediation. When a non-time-critical removal action will be the only or last action taken to clean up a potential NPL site, the EE/CA should provide adequate documentation that activities performed at the site are sufficient to meet completion requirements.

Specific objectives vary with the type of removal. If cleanup levels are necessary as part of a specific objective, OSCs/RPMs employ several methods to determine these levels. Examples of current practice include applying an appropriate Federal or State ARAR, consulting a Regional risk assessor, or requesting support from ATSDR or ERT.

Specific objectives that clearly define the scope of the removal action are particularly important when the site poses multiple hazards and the response actions will be conducted in phases. OSCs/RPMs should always consider how the removal action would best contribute to the efficient performance of any remedial action to be taken, as required under CERCLA section 104(a)(2). OSWER Publication 9360.0-13, "Guidance on Implementation of the 'Contribute to Remedial Performance' Provision" (April 6, 1987), provides additional guidance on implementing CERCLA section 104(a)(2). For example, if EPA or the State plans to begin a long-term remedial action at the site in 2 years, the removal action should be designed to ensure that the site is stabilized until remedial action begins. The threats that meet the NCP removal criteria should be fully addressed, if possible, given the statutory limits on removal actions.

Determination of Removal Schedule

The general schedule for removal activities, including both the start and completion time for the non-time-critical removal action, should be part of the EE/CA. (A time-critical or emergency removal action may occur at any point from the planning phase to the completion of a non-time-critical removal action.) Although EE/CAs are only required when a planning period of at least 6 months is available, the nature of the threat may still dictate that action be initiated within 12 months or some other specific time period. The start date may also be influenced by weather, PRP negotiations, or Regional resources. For example, Regions should consult with Headquarters prior to taking any early action requiring funding beyond the Region's allowance. Also, weather can affect the schedule if the removal is to be implemented before winter. The time available before the removal action can be a significant factor in evaluating alternative technologies, since implementing technologies can necessitate considerable lead time.

The completion time should also be estimated for the removal action, considering the nature of the threat. It may be necessary to achieve beneficial results within a certain time frame to ensure adequate protection of public health and the environment. The time needed to sample treated wastes or other media prior to disposal should be factored into the schedule. Another important factor influencing the removal schedule is the statutory limit on Fund-financed removal actions. For Fund-lead sites not expected to qualify for either the emergency or consistency exemptions, the OSC/RPM should select a removal action alternative that can be implemented within the statutory limits. For Fund-lead sites expected to qualify for an exemption, the objective should be to select a

2.5 IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES (CONTINUED)

removal action alternative that can be implemented within a reasonable time limit. Factors such as weather and the availability of Regional resources may also affect the completion time.

The flexibility in the removal schedule can vary greatly from site to site. Some sites may require a strict schedule, while others allow wider latitude in start and completion times. For a PRP-lead site the 1-year statutory restriction on removal actions is not applicable. In such cases, it may be advisable to establish a removal schedule in an administrative order. The schedule established for a site can be an important decision criterion to evaluate removal action alternatives based on their implementation times.

For More Information:

1. CERCLA:
   §104(a)(2), Removal Action
   §104(c)(1), Statutory Limits
2. NCP §300.415(b)(2)(i)-(viii), Appropriateness Factors
3. OSWER Publication 9360.0-13, "Guidance on Implementation of the 'Contribute to Remedial Performance' Provision" (April 6, 1987).

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Based on the analysis of the nature and extent of contamination and on the cleanup objectives developed in the previous section, the OSC/RPM should identify and assess a limited number of alternatives appropriate for addressing the removal action objectives. If the information a Region typically uses to evaluate action alternatives is not sufficient, or if data quality is suspect, OSCs/RPMs should collect any additional technical information needed. If EPA is conducting oversight activities at the site, PRPs or State agencies may provide the information.

Treatment Technologies

Whenever practicable, the alternatives selection process should consider the CERCLA preference for treatment over conventional containment or land disposal approaches to address the principal threat at a site. Although CERCLA section 121(b) appears to apply only to remedial actions, the overall strategy scheme leads to the conclusion that this preference is also an appropriate goal for removal actions. Removal actions, however, cannot conform entirely to requirements for remedial actions because of site related time constraints and statutory limits on remedial actions. To identify alternatives, the OSC/RPM can draw from EPA experience with the particular technologies and contaminants involved, as well as technical advice from ERT, Office of Research and Development's (ORD)-START, the Technology Innovation Office (TIO), the Superfund Innovative Technology Evaluation program, EPA laboratories and task forces, technology vendors, and other sources.

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

While treatability studies often need not be performed for proven technologies, in many cases a study is necessary to assure the attainment of treatment objectives. An EE/CA often allows time to plan and conduct a treatability study.

OSCs/RPMs should refer to OSWER Publication 9380.0-17, "Furthering the Use of Innovative Treatment Technologies in OSWER Programs" (August 1991), EPA/540/2-90/004, PB91-921366, for further guidance on assessing treatment options.

Based on the available information, only the most qualified technologies that apply to the media or source of contamination should be discussed in the EE/CA. The use of presumptive remedy guidance can in many cases provide an immediate focus to the discussion and selection of alternatives, speeding the process by limiting the universe of effective alternatives for the non-time-critical removal action. Presumptive remedies involve the use of remedial technologies that have been selected in the past at similar sites or for similar contaminants. By evaluating technologies that have been consistently selected at similar sites, a presumption can be developed that a particular remedy or set of remedies is appropriate for a specific site type. EPA is developing several presumptive remedies for a variety of response situations. Currently, information is available for wood treater sites in OSWER Publications 9355.0-46FS and 9355.0-46, "Technology Selection Guide for Wood Treater Sites" (May 1993), PB93-963505. This information was previously cited as OSWER Publications 9360.0-46FS and 9360.0-46. OSWER guidance is under development for solvent and municipal landfill sites.

A limited number of alternatives, including any identified presumptive remedies, should be selected for detailed analysis. Each of the alternatives should be described with enough detail so that the entire treatment process can be understood. For example, if one of the alternatives is incineration, information on whether the incineration will occur on-site or off-site should be provided, as well as the volume of waste to be treated, the disposition of the treatment residuals, and any ARARs that would affect significantly the action, such as the land disposal restrictions. The technical implementability of this set of potentially applicable alternatives can then be evaluated based on readily available information from the site characterization phase. Specific technologies may not be applicable to the treatment of wastes in the concentration and form found at the site, and so may be disregarded. The OSC/RPM, however, must avoid even the appearance that a technology has been pre-selected. All selected technologies should be fully considered.

Treatment Technology Information Sources

Appendix D from OSWER Publication 9355.3-01, "Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) Under CERCLA" (October 1988), EPA/540/G-89/004, PB89-184626, provides a bibliography on various treatment technologies. In addition, EPA's Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing technology research, development, and demonstration programs. OSWER Publication 9380.3-03, "Inventory of Treatability Study Vendors" (March 1990), EPA/540/2-90/003a, PB91-228395, helps link the researcher and the user community.

Three additional databases can assist OSCs/RPMs in evaluating the effectiveness and availability of various treatment technologies. The Alternative Treatment Technology Information Center (ATTIC) is an on-line computer database that may be accessed with a personal computer and modem by calling 301-670-3808. ATTIC is a comprehensive, automated system that

integrates hazardous waste data into a centralized, searchable resource. Data about hazardous waste treatment technologies are found in many forms in this system, including:

- Literature search databases
- Expert lists
- Treatability databases
- Fate and transport databases
- Cost models
- Case histories
- Expert systems.

The central ATTIC database contains more than 1,400 technical documents collected in a key-word-searchable format. ORD Publication EPA/600/M-91/049, "Alternative Treatment Technology Information Center–ATTIC Brochure" (August 1991) provides additional information.

Another database operated by TIO is the Technology Vendor Information System for Innovative Treatment Technologies (VISITT). This database facilitates communication between technology vendors and government and private cleanup personnel and describes the capabilities and experience vendors have with innovative technologies. The database is useful in developing engineering studies and designs. The VISITT Hotline at 1-800-245-4505 can provide OSCs/RPMs with additional user information.

The Cleanup Information Bulletin Board (CLU-IN) provides electronic message capabilities, directories, on-line bulletins, and other cross-database files on innovative technologies. Special interest groups exist within the system specifically for OSCs/RPMs. CLU-IN can be accessed with a computer, modem line, and telecommunications software by calling 301-589-8366.

Defined alternatives are evaluated against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Subcriteria to be evaluated under each of the criteria are identified in Exhibit 7 on the following page.

Effectiveness

The effectiveness of an alternative refers to its ability to meet the objective within the scope of the removal action. This section of the EE/CA should evaluate each alternative against the scope of the removal action and against each specific objective for final disposition of the wastes and the level of cleanup desired. These objectives should be discussed in terms of protectiveness of public health and the environment.

Overall Protection of Public Health and the Environment

How well each alternative protects public health and the environment should be discussed in a consistent manner. This discussion draws on assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

EXHIBIT 7
Objectives/Criteria To Be Used In Comparative Analysis of Alternatives

- ❑ Effectiveness
  - ❑ Protectiveness
    - ❑ Protective of public health and community
    - ❑ Protective of workers during implementation
    - ❑ Protective of the environment
    - ❑ Complies with ARARs
  - ❑ Ability to Achieve Removal Objectives
    - ❑ Level of treatment/containment expected
    - ❑ No residual effect concerns
    - ❑ Will maintain control until long-term solution implemented
- ❑ Implementability
  - ❑ Technical Feasibility
    - ❑ Construction and operational considerations
    - ❑ Demonstrated performance/useful life
    - ❑ Adaptable to environmental conditions
    - ❑ Contributes to remedial performance
    - ❑ Can be implemented in 1 year
  - ❑ Availability
    - ❑ Equipment
    - ❑ Personnel and services
    - ❑ Outside laboratory testing capacity
    - ❑ Off-site treatment and disposal capacity
    - ❑ PRSC
  - ❑ Administrative Feasibility
    - ❑ Permits required
    - ❑ Easements or right-of-ways required
    - ❑ Impact on adjoining property
    - ❑ Ability to impose institutional controls
    - ❑ Likelihood of obtaining an exemption from statutory limits (if needed)
- ❑ Cost
  - ❑ Capital cost
  - ❑ PRSC cost
  - ❑ Present worth cost

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

The discussion should focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control, or eliminate risks at the site through the use of treatment, engineering, or institutional controls. This evaluation should identify any unacceptable short-term impacts.

Compliance with ARARs and Other Criteria, Advisories, and Guidance

Section 300.415(i) of the NCP requires that Fund-financed removal actions under CERCLA section 104 and removal actions pursuant to CERCLA section 106 attain ARARs under Federal or State environmental laws or facility siting laws, to the extent practicable considering the urgency of the situation and the scope of the removal. At certain sites, ARARs may form the basis of the removal action objectives.

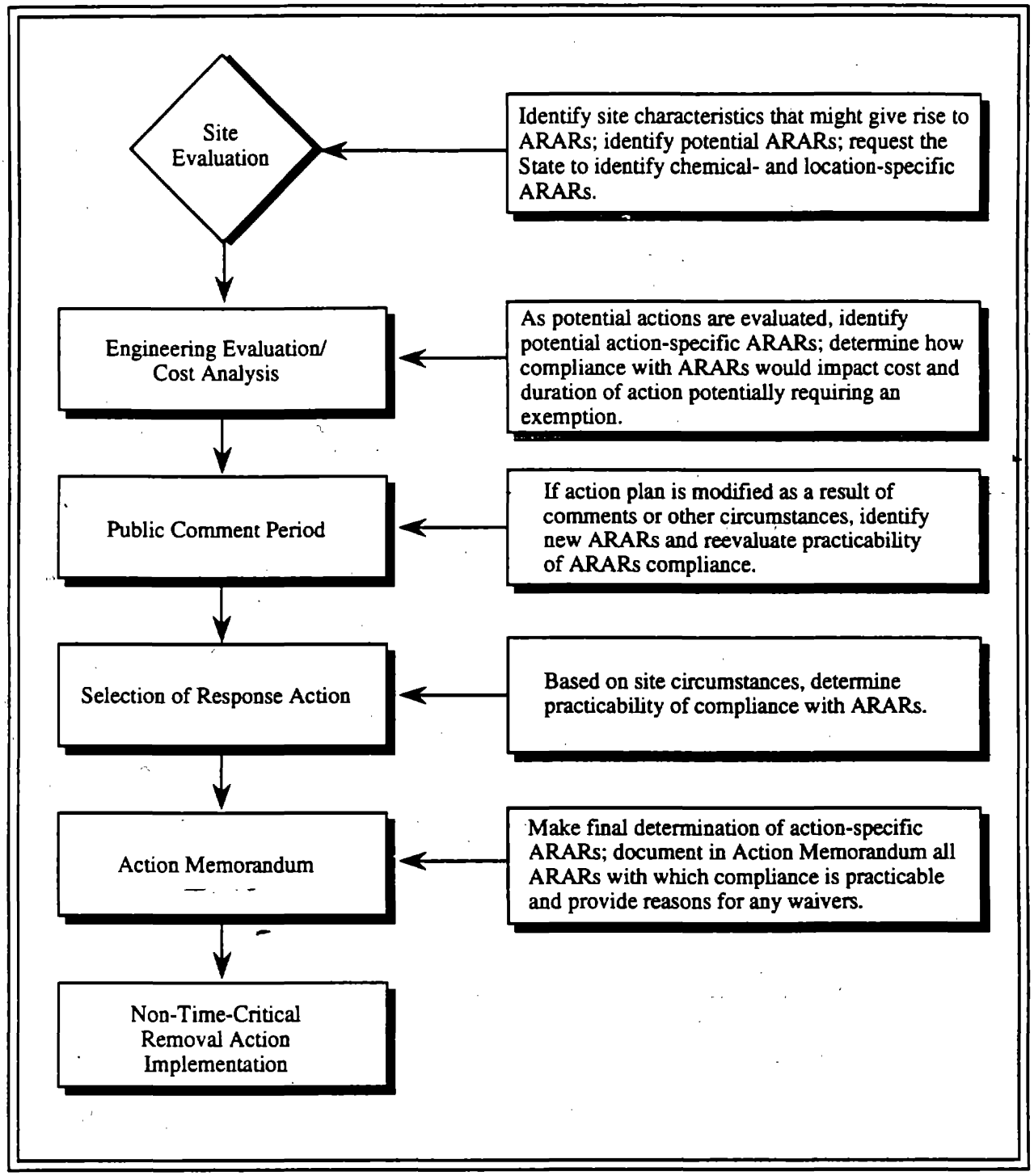
The detailed analysis should summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets those requirements. To ensure a full consideration of potential ARARs, OSCs/RPMs may choose to employ a summary table to list potential ARARs. OSCs/RPMs will then be able to quickly identify particular requirements in order to plan for compliance or eliminate requirements not of concern for a given site or alternative.

Since the evaluation of a site will produce data relatively quickly on the location of a release and on the chemical constituents of concern, chemical-specific ARARs and location-specific ARARs should be identified as promptly as possible upon request by the OSC/RPM. Therefore, only State standards that are promulgated, identified by the State in a timely manner, and more stringent than Federal requirements may be applicable or relevant and appropriate. Action-specific ARARs should be identified later in the process after qualified cleanup technologies are chosen for analysis in the EE/CA. The process for identifying and evaluating ARARs during non-time-critical removal actions is shown in Exhibit 8 on the following page.

In addition to ARARs, EPA may, as appropriate, identify other Federal or State advisories, criteria, or guidance to be considered (TBC) for a particular release. TBCs are not required by the NCP; rather, TBCs are meant to complement the use of ARARs. Because ARARs do not exist for every chemical or circumstance, TBCs may be very useful in determining what is protective of a site or how to carry out certain actions or requirements. A list of TBCs, such as the EPA Spill Cleanup Policy, Health Effects Assessments, EPA's Ground Water Protection Strategy, and advisories issued by the Fish and Wildlife Service and the National Marine Fisheries Service under the Fish and Wildlife Coordination Act, can be found in the NCP Proposed Rule Preamble, 53 FR 51449-51450 (December 21, 1988).

The EnviroText Retrieval System, a joint project of EPA, DOE, DOD, the Department of Justice, and the U.S. Army, will be a user-friendly, full-text library search system of multimedia environmental laws. On-line service as a pilot program is expected to start in Fall 1993, and should assist greatly in considering potential ARARs at any given site.

EXHIBIT 8
Identification and Evaluation of ARARs During Non-Time-Critical Removal Actions



2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

Long-Term Effectiveness and Permanence

This evaluation assesses the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes at the site. The following components should be considered for each alternative:

- Magnitude of Risk. This criterion looks at the effectiveness of the alternative and assesses the risk from waste and residuals remaining at the conclusion of site activities. This component also evaluates whether the alternative contributes to future remedial objectives. If the non-time-critical removal action is an interim step and is expected to be followed by remedial action, this factor could be reduced in scope or deleted, if appropriate. If the non-time-critical action is the last action anticipated for a site or release, then the magnitude of risk should be fully evaluated for the action.

- Adequacy and Reliability of Controls. A completed removal action may require PRSC, those response activities necessary to sustain the integrity of a Fund-financed removal action following its conclusion (see Chapter 1). After the removal is completed, PRSC costs may be paid by the PRP, State or local government, or the remedial program.

Reduction of Toxicity, Mobility, or Volume Through Treatment

EPA's policy of preference for treatment (i.e., for technologies that will permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element) requires evaluation based upon the following subfactors for a particular alternative:

- The treatment process(es) employed and the material(s) it will treat
- The amount of the hazardous materials to be destroyed or treated
- The degree of reduction expected in toxicity, mobility, or volume
- The degree to which the treatment will be irreversible
- The type and quantity of residuals that will remain after treatment
- Whether the alternative will satisfy the preference for treatment.

The ability of the treatment technology to reduce the principal threats posed by the release, including the extent to which the toxicity, mobility, or volume of the contaminants are reduced (either alone or in combination) may be subject to time and applicability restraints, and may be beyond the scope of an interim removal action when remedial action is indicated.

Short-Term Effectiveness

The short-term effectiveness criterion addresses the effects of the alternative during implementation before the removal objectives have been met. Alternatives should also be evaluated with respect to their effects on human health and the environment following implementation. The following factors should be addressed as appropriate for each alternative:

- Protection of the Community. This factor addresses any risk to the affected community that results from implementation of the proposed action, whether from

air quality impacts, fugitive dusts, transportation of hazardous materials, or other sources.

- Protection of the Workers. This factor assesses any threats to site workers and the effectiveness and reliability of protective measures that would be taken.
- Environmental Impacts. This factor evaluates the potential adverse environmental impacts from the implementation of each alternative. The factor also assesses the reliability of mitigation measures in preventing or reducing the potential impacts.
- Time Until Response Objectives Are Achieved. This factor estimates the time needed to achieve protection for the site itself or for individual elements or threats associated with the site.

Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The following factors should be considered under this criterion.

Technical Feasibility

The EE/CA must assess the ability of the technology to implement the remedy. Technical difficulties were initially identified during development of alternatives and should be addressed again in detail for the alternative as a whole. Each alternative should be evaluated for implementation factors such as assembling, staffing, and operating the alternative within the time frames in the removal schedule.

The reliability of the technology is also of concern, as technical problems associated with implementation may delay the schedule. Each alternative should be evaluated for technology maturity, prior use under similar conditions for similar wastes, and possible difficulty in operation once it is constructed. Operational difficulties could include the frequency or complexity of equipment maintenance or controls, the need for raw materials, or the need for a large technical staff. Potential impacts on the local community during construction operations should also be evaluated.

The EE/CA should consider environmental conditions not only with respect to the operation phase of the alternative, but also to the set-up and construction phase. Certain technologies may be difficult to construct or operate in remote locations. Climate or terrain may severely impact or eliminate specific alternatives from consideration. For example, an alternative that uses an oil/water separator or sedimentation tank may be unusable at freezing temperatures. Temperature and time of year may directly impact a technology's ability to reach a specific site. For example, a rainy season may make roads to the site inaccessible. Not only will local terrain affect the ability to locate an alternative, but it may also affect performance. For example, a site located in a valley may be susceptible to inversions or limited air currents, therefore making incineration unacceptable.

Potential future remedial actions should also be discussed. Remedial action or a non-time-critical removal action that completely cleans up an NPL site may trigger the five-year review

requirements of CERCLA section 121(c). This evaluation should also consider the operation of PRSC measures or operation and maintenance (O & M). This discussion should depict how difficult it would be for EPA to implement these future remedial actions. This is particularly applicable to an interim action where additional action is expected.

If the site will be receiving long-term remedial treatment, the EE/CA must determine if each alternative contributes to the efficient performance of any anticipated remedial activities. CERCLA section 104(a)(2) states that a removal action should, to the extent practicable, contribute to the efficient performance of any long-term remedial action with respect to the release or threatened release concerned. Removal actions that do contribute may be eligible for an exemption from the $2 million/12-month statutory limit on removal actions. OSWER Publication 9360.0-12A, "Final Guidance on Implementation of the 'Consistency' Exemption to the Statutory Limits on Removal Actions" (June 12, 1989), PB90-274465/CCE, states that removal actions should be designed to avoid wasteful, repetitive, short-term actions that do not contribute to the efficient, cost-effective performance of a long-term remedial action.

In some cases, it may not be easy to demonstrate removal action consistency with future remedial action. Remedial actions often cannot be anticipated when an EE/CA is being developed for a non-time-critical removal action. It may be difficult to show with reasonable certainty that a removal option would be consistent with a future remedial action. Section 104(a)(2) of CERCLA provides for discretion in using the practicability standard. Accordingly, OSCs/RPMs should avail themselves of this discretion when developing and evaluating removal action alternatives that would provide for partial cleanups of sites.

The ability to monitor the effectiveness of the alternative may also be considered in the EE/CA. These monitoring considerations would generally not be evaluated for Fund-lead non-time-critical removal actions where remedial work was planned.

Administrative Feasibility

The administrative feasibility factor evaluates those activities needed to coordinate with other offices and agencies. The administrative feasibility of each alternative should be evaluated, including the need for off-site permits, adherence to applicable nonenvironmental laws, and concerns of other regulatory agencies. Factors that should be considered include, but are not limited to, the following:

- Statutory Limits. Each alternative should be evaluated for its compliance with the statutory limits on removal actions. If an alternative requires a statutory exemption from the $2 million or 12-month limit, the EE/CA should evaluate whether the site qualifies. If the time or money needed to implement the alternative will exceed the statutory limit for removal actions, an exemption request, which is part of the Action Memorandum, should be submitted to Headquarters for review as soon as possible. Headquarters approval is only required for non-NPL consistency waivers and for emergency waivers (money, not time).

- Permits and Waivers. The EE/CA should evaluate whether each alternative will require off-site permits (e.g., building permits). Other factors that may affect the administrative feasibility include the need for easements, right-of-way agreements, or zoning variances.

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

Availability of Services and Materials

The EE/CA must determine if off-site treatment, storage, and disposal capacity, equipment, personnel, services and materials, and other resources necessary to implement an alternative will be available in time to maintain the removal schedule. Availability of funds to meet PRSC requirements is also a factor. Several important availability factors are:

- Personnel and Technology. Using the removal action schedule as a guide, the EE/CA should determine whether a specific alternative will be available from the manufacturer. Other technologies may require a large number of skilled laborers or specialists (e.g., welders, pipe fitters, chemical engineers) that may not be readily available if the site is remote, thus impacting the ability to assemble the removal action alternative.

- Off-Site Treatment, Storage, and Disposal. If off-site removal and treatment of the waste is being considered, the EE/CA should address the adequacy of off-site capacity. If the site is in a remote location, this type of service may not be available or may be extremely costly because of transportation expenses. OSCs/RPMs should review OSWER Publication 9834.11, "Revised Procedures for Implementing Off-Site Response Actions" (November 13, 1987), PB91-139282/CCE, before evaluating this option. The OSC/RPM and Regional off-site contact should discuss whether there are treatment facilities in compliance with the off-site policy that can accept the type of CERCLA waste at the site. [A final rule addressing this issue is expected in 1993.]

- Services and Materials. This factor involves considering such services as laboratory testing capacity and turnaround for chemical analyses, adequate supplies and equipment for on-site activities, or installation of extra utilities (e.g., power lines, sewer connections).

- Prospective Technologies. This factor assesses whether specific technologies are generally available for the site. Promising technologies sometimes require further development before they can be applied at full-scale. The EE/CA should indicate when a technology would be available for full-scale use. Also, if time allows, the OSC/RPM may be able to develop specifications to allow competitive bidding for a treatment contract. This would be of particular use in developing innovative technologies.

State (Support Agency) Acceptance

The State (or support agency in the case of State-lead sites) may have technical and administrative concerns. Since States may review the alternatives, their concerns should be considered in determining the recommended alternative in the EE/CA and in the final selection of the alternative in the Action Memorandum.

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

Community Acceptance

As with State acceptance, community acceptance of an alternative will be considered when making a recommendation in the EE/CA and in the final selection of the alternative in the Action Memorandum.

Cost

Each removal action alternative should be evaluated to determine its projected costs. The evaluation should compare each alternative's capital and PRSC costs. The present worth of alternatives that will last longer than 12 months should be calculated. In certain cases, OSCs/RPMs may conduct a sensitivity analysis of the present worth calculations.

To compare the cost of each alternative, the direct and indirect capital costs and the PRSC costs of each alternative should be projected. OSWER Publication 9360.0-02C, "Removal Cost Management System: Version 3.2" (May 1990), EPA/540/P-90/003, PB90-272691, provides guidance on performing cost projections and daily cost tracking. The following items are considered capital costs and PRSC costs:

- Direct capital costs
  - Construction costs
  - Equipment and material costs
  - Land and site acquisition costs
  - Buildings and services costs
  - Relocation expenses
  - Transport and disposal costs
  - Analytical costs
  - Contingency allowances
  - Treatment and operating costs
- Indirect capital costs
  - Engineering and design expenses
  - Legal fees and license or permit costs
  - Start-up and shakedown costs
- Annual PRSC costs
  - Operational costs
  - Maintenance costs
  - Auxiliary materials and energy
  - Disposal of residuals
  - Monitoring costs
  - Support costs.

Many sources of cost information exist, including the ERCS contract price list, vendor estimates, and estimates for similar projects. For items not currently on the ERCS list and for projects where outside bids are being considered, cost estimates more than 12 months old should be updated using an appropriate economic index, such as the Engineering News Record Construction Cost Index for construction costs, the Marshall and Stevens Index for treatment facility costs, the American City and County Municipal Cost Index for manpower costs, and the

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

Producer Price Index for Finished Goods, published by the U.S. Department of Labor in the Monthly Labor Review. All these information sources can be found in Regional and/or public libraries.

After identifying and estimating the costs, OSCs/RPMs should calculate the present worth for removal action alternatives that will last longer than 12 months. Present worth analysis evaluates expenditures that occur over different time periods by discounting all future costs, usually PRSC costs, to a common base year, usually the present year. Present worth analysis produces a single figure representing the amount of money that, if invested in the base year and dispersed as needed, would cover all costs associated with the alternative. This analysis is particularly important when comparing technologies with different operating lifetimes. The final present worth figure and the assumptions used in calculating that figure should be included in the EE/CA. The detailed computations should be attached as an appendix to the EE/CA.

For alternatives that include only PRSC after 1 year from the start of the removal action, the total cost of the option over the full life of the project should be calculated. In comparing alternatives, however, OSCs/RPMs should use the cost of the option to EPA for 1 year, provided that all PRSC costs will be assumed by another party after 1 year. OSWER Publication 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit Cost Analysis" (June 25, 1993) provides information on discount rates for present worth calculations.

In addition, OSCs/RPMs should determine whether a sensitivity analysis is warranted. A sensitivity analysis assesses the effect that variations in specific assumptions associated with design, implementation, operation, discount rate, and effective life of an alternative can have on the present worth. The sensitivity of such costs to uncertainties can be observed by varying the cost assumptions and noting their effect on the present worth. A sensitivity analysis might be appropriate when uncertainties exist about the amount of waste present, how quickly a technology can perform, or the future price of cleanup services.

For More Information:

1. CERCLA:
   §104(a), Removal Action
   §121, Cleanup Standards
   §311(b), Alternative or Innovative Treatment Technology Research and Demonstration Programs
2. NCP §300.415(i), ARARs Attainment
3. Office of Policy Analysis (OPA) Publication, "Guidelines for Performing Regulatory Impact Analysis" (December 1983).
4. ORD Publication EPA/600/M-91/049, "Alternative Treatment Technology Information Center–ATTIC Brochure" (August 1991).
5. OSWER Publication 9234.1-01, "CERCLA Compliance with Other Laws Manual. Part 1 (Interim Final)" (August 1988), EPA/540/G-89/006, PB90-272535.
6. OSWER Publication 9234.1-02, "CERCLA Compliance with Other Laws Manual. Part 2: Clean Air Act and Other Environmental Statutes and State Requirements" (August 1989), EPA/540/G-89/009, PB90-148461.

2.6 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES (CONTINUED)

7. OSWER Publications 9355.0-46FS and 9355.0-46, "Technology Selection Guide for Wood Treater Sites" (May 1993), PB93-963505, also previously cited as OSWER Publication 9360.0-46FS and 9360.0-46.
8. OSWER Publication 9355.3-01, "Guidance For Conducting Remedial Investigations and Feasibility Studies (RI/FS) Under CERCLA" (October 1988), EPA/540/G-89/004, PB89-184626.
9. OSWER Publication 9355.3-20, "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit Cost Analysis" (June 25, 1993), PB93-963297.
10. OSWER Publication 9360.3-02, "Superfund Removal Procedures—Guidance on the Consideration of ARARs During Removal Actions" (August 1991), PB92-963401/CCE.
11. OSWER Publication 9360.0-02C, "Removal Cost Management System: Version 3.2" (May 1990), EPA/540/P-90/003, PB90-272691.
12. OSWER Publication 9360.0-12A, "Final Guidance on Implementation of the 'Consistency' Exemption to the Statutory Limits on Removal Actions" (June 12, 1989), PB90-274465/CCE.
13. OSWER Publication 9380.0-17, "Furthering the Use of Innovative Treatment Technologies in OSWER Programs" (August 1991), EPA/540/2-90/004, PB91-921366.
14. OSWER Publication 9380.3-03, "Inventory of Treatability Study Vendors" (March 1990), EPA/540/2-90/003a, PB91-228395.
15. OSWER Publication 9834.11, "Revised Procedures for Implementing Off-site Response Actions" (November 13, 1987), PB91-139287/CCE.*
16. OSWER Publication 9834.11a, "Off-Site Policy RFA or Equivalent Investigation Requirement at RCRA Treatment and Storage Facilities" (January 4, 1988), PB91-139295/CCE.*

* *A final rule addressing this issue is expected in 1993.*

2.7 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Once the alternatives have been described and individually assessed against the criteria, a comparative analysis should be conducted to evaluate the relative performance of each alternative in relation to each of the criteria. This is in contrast to the preceding analysis in which each alternative was analyzed independently without consideration of other alternatives. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect the remedy selection can be identified.

2.8 RECOMMENDED REMOVAL ACTION ALTERNATIVE

The EE/CA should identify the action that best satisfies the evaluation criteria based on the comparative analysis in the previous section. This description should briefly describe the evaluation process used to develop the recommended action. For both Fund-lead and PRP-lead EE/CAs, EPA should determine the recommended action. This determination may be placed in the administrative record file concurrently with the EE/CA. This section of the EE/CA may enhance public involvement efforts by describing clearly why the alternative was recommended. Because the EE/CA is open to public comment and evaluation and because EPA is required to prepare

2.8 RECOMMENDED REMOVAL ACTION ALTERNATIVE (CONTINUED)

a written response to significant comments, the recommended alternative may not always be the final alternative selected in the Action Memorandum. The Action Memorandum and the administrative record should provide enough detail to justify the final alternative selected.

Appendix A

References

OPA Publication, "Guidelines for Performing Regulatory Impact Analysis" (December 1983).

ORD Publication EPA/600/M-91/049, "Alternative Treatment Technology Information Center–ATTIC Brochure" (August 1991).

OSWER Publication 9200.2-02, "Accelerated Response at NPL Sites Guidance" (December 15, 1988), PB90-258302/CCE.

OSWER Publication 9200.2-16FS, "Quality Assurance for Superfund Environmental Data Collection Activities" (February 1993), PB93-963273.

OSWER Publication 9200.3-01H-1, "Superfund Program Implementation Manual Fiscal Year 1993" (June 1993), PB92-963276.

OSWER Publication 9200.5-402A, "Contracting and Subcontracting Guide to the Superfund Program" (May 1992). EPA/540/G-91/012, PR-923.

OSWER Publication 9203.1-02I, "Superfund Accelerated Cleanup Bulletin: Presumptive Remedies for Municipal Landfill Sites, Volume 1, Number 1" (April 1992), PB92-963367.

OSWER Publication 9203.1-03, "Guidance on Implementation of the Superfund Accelerated Cleanup Model (SACM) under CERCLA and the NCP" (July 7, 1992), PB93-963252.

OSWER Publication 9203.1-03A, "Exercising Flexibility Through the Superfund Accelerated Cleanup Model (SACM)" (October 26, 1992), PB93-963253.

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- Volume 1, Number 1, "Status of Key SACM Program Management Issues—Interim Guidance" PB93-963262.
- Volume 1, Number 2, "Early Action and Long-Term Action Under SACM—Interim Guidance" PB93-963263.
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- Volume 1, Number 4, "Assessing Sites Under SACM—Interim Guidance" PB93-963265.
- Volume 1, Number 5, "SACM Regional Decision Teams—Interim Guidance" PB93-963266.

OSWER Publication 9230.0-03C "Community Relations in Superfund: A Handbook" (January 1992), EPA/540/R-92/009, PB92-963341.

OSWER Publication 9234.1-01, "CERCLA Compliance with Other Laws Manual, Part 1 (Interim Final)" (August 1988), EPA/540/G-89/006, PB90-272535.

OSWER Publication 9234.1-02, "CERCLA Compliance with Other Laws Manual, Part 2: Clean Air Act and Other Environmental Statutes and State Requirements" (August 1989), EPA/540/G-89/009, PB90-148461.

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OSWER Publication 9242.2-02, "Site-Specific Contracting for Removals" (April 10, 1989), PB91-215053/CCE.

OSWER Publication 9242.6-01, "ARCS Work Assignment Management, Field Guide" (January 1989), PB91-214965/CCE.

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OSWER Publication 9285.1-03, "Standard Operating Safety Guides" (June 1992), PB92-963414.

OSWER Publication 9285.7-01B, "Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part A, Interim Final" (December 1989), EPA/540/1-89/002, PB90-155581.

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OSWER Publication 9360.4-08, "Compendium of ERT Toxicity Testing Procedures" (January 1991), EPA/540/P-91/009, PB91-921271.

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Appendix B

Key Words Index

Action Memorandum....4-5, 8, 14-15, 20, 31, 38, 42-43, 46

Administrative Order on Consent (AOC).... 11

Administrative record....6, 13-15, 20, 24, 26, 46

Approval Memorandum....5-6, 15-17, 19, 21-23

Applicable or relevant and appropriate requirements (ARARs)....29, 31-32, 34-38

Confidential information....26-27

Contracts management....9-10

Cooperative Agreement....8

Cost recovery.... 11

Environmental Response Team (ERT)....28, 32

Memorandum of Understanding (MOU)....8

Notice letter.... 10

OSC reports.... 17-18

Public involvement.... 5-6, 12-15, 43

Post-removal site control (PRSC)....5, 8, 39, 42-44

Potentially responsible parties (PRPs)....8, 10-11, 22, 26-27, 39

Preliminary assessment (PA)....4, 22

Present worth analysis.... 43-44

Previous removal actions.... 26-27

Regional Decision Teams (RDT).... 3, 7-8, 11

Remedial Investigation/Feasibility Study (RI/FS)....2, 19-20

Removal action objectives.... 4, 20, 31

Removal schedule.... 32-33

Key Words Index (Continued)

Removal scope 32

Removal site evaluation (RSE) 4

Site characterization 24-30

Site closeout 5, 11

Site description 25-26

Site inspection (SI) 4, 24

Statutory limits 6, 8, 11, 19-20, 31, 33, 41

Streamlined risk evaluation 29-30

Superfund Accelerated Cleanup Model (SACM) 2-3, 7-8, 10-11, 28

Unilateral Administrative Order (UAO) 11

Appendix C

Comparison of EE/CA to RI/FS

EE/CA Process

1. **EE/CA Approval Memorandum**
   - Secure management approval and funding for EE/CA
   - Include finding of actual or threatened release and, if present, an imminent and substantial endangerment and general site information and costs
   - Document that situation meets NCP criteria and action is non-time-critical

EE/CA

2. **EE/CA Executive Summary**
   - Identifies threat
   - Describes removal action objectives
   - Summarizes recommended action

3. **Site Characterization**
   - Collect site description and background
   - Identify previous removal actions
   - Determine source, nature, and extent of contamination
   - Collect analytical data
   - Perform streamlined risk evaluation
   - Identify contaminant- and location-specific ARARs

4. **Identification of Removal Action Objectives**
   - Evaluate statutory limits
   - Determine scope of removal action
   - Determine schedule of removal action

RI/FS Process*

1a. **Pre-RI/FS Scoping**
   - Collect existing data
   - Visit site/identify areas of concern
   - Generate statement of work

1b. **RI/FS Scoping**
   - Collect/analyze existing data
   - Determine need for/implement additional studies
   - Develop preliminary remedial action alternatives/objectives
   - Evaluate need for treatability studies
   - Begin preliminary identification of ARARs
   - Identify data needs/data quality objectives
   - Design data collection program
   - Develop work plan
   - Identify health and safety protocols

REMEDIAL INVESTIGATION

2. **Site Characterization**
   - Investigate site physical characteristics
   - Define sources of contamination
   - Determine nature and extent of contamination
   - Conduct laboratory analyses
   - Conduct data analyses
   - Conduct baseline risk assessment
   - Identify contaminant- and location-specific ARARs
   - Define remedial action goals
   - Draft RI Report

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* OSWER Publication 9355.3-01, "Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) Under CERCLA" (October 1988), EPA/540/G-89/004, PB89-184626

Appendix C

Comparison of EE/CA to RI/FS (Continued)

EE/CA Process	RI/FS Process*
	FEASIBILITY STUDY
5. Identification and Analysis of Removal Action Alternatives • Identify treatment technologies (presumptive remedy and treatability studies, as appropriate) • Evaluate effectiveness – Overall protection of human health and the environment – Compliance with ARARs – Long-term effectiveness and permanence – Reduction of toxicity, mobility, or volume through treatment – Short-term effectiveness • Evaluate implementability – Technical feasibility – Administrative feasibility – Availability of services and materials – State acceptance – Community acceptance • Evaluate cost	**3a. Development of Alternatives** • Remedial action objectives • General response actions • Volumes or areas of media • Screen technology and process options • Process options identification • Technology alternatives • Action-specific ARARs **3b. Screening of Alternatives** • Effectiveness • Implementability • Cost • Innovative technologies **3c. Performance of Treatability Studies** • Data requirements • Bench- or pilot-scale study • Treatability test work plan • Documentation of results **4. Detailed Analysis of Alternatives** • Overall protection of human health and environment • Compliance w/ARARs • Long-term effectiveness and performance • Reduction of toxicity, mobility, or volume through treatment • Short-term effectiveness • Implementability • Cost • State acceptance • Community acceptance (analyze alternatives against these nine criteria)
6. Comparative Analysis of Removal Action Alternatives (See criteria above) Compare alternatives	**5. Comparative Analysis** (See criteria above) Compare alternatives
7. Recommended Removal Action Alternative (summarized in Action Memorandum) [Public comment period on EE/CA of at least 30 days]	**6. Preferred Remedial Alternative (summarized in Proposed Plan)** [Public comment period of at least 30 days]

* OSWER Publication 9355.3-01, "Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) Under CERCLA" (October 1988), EPA/540/G-89/004, PB89-184626

Appendix D

Model Notice of Decision Not To Use Special Notice Procedures*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region []

[ADDRESS]

NOTICE OF DECISION NOT TO USE SPECIAL NOTICE PROCEDURES
URGENT LEGAL MATTER**
CERTIFIED MAIL: RETURN RECEIPT REQUESTED

[Date]

[Name and Address of Potentially Responsible Party]
[c/o Registered Agent or Contact Person]

Re: [Name of Site]
[Address or location of Site] (the "Site")

Dear [Name of PRP if an individual; "sir or madam" otherwise]:

This letter notifies you that the United States Environmental Protection Agency (EPA) has determined not to use special notice procedures pursuant to Section 122(e) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), at the above-referenced site regarding the [RI/FS] [RI/FS for operable unit] [RD/RA] [RD/RA for operable unit].

NOTICE OF POTENTIAL LIABILITY

As indicated in the general notice letter previously sent to you, EPA has evaluated information in connection with the investigation of the site. EPA has information indicating that you may be a potentially responsible party (PRP) as defined at Section 107(a) of the CERCLA, 42 U.S.C. 9607(a), with respect to hazardous substances at this site. Potentially responsible parties under CERCLA include current and former owners and operators of the site as well as persons who arranged for disposal or treatment of hazardous substances sent to the site, or persons who accepted hazardous substances for transport to the site.

DECISION NOT TO USE SPECIAL NOTICE

In this instance EPA has decided that it is inappropriate to invoke the Section 122(e) special notice procedures. EPA believes that using such special notice procedures would not facilitate an agreement between EPA and the PRPs and would not expedite the response action at the site. (Provide specific reasons why the special notice procedures would not facilitate an agreement and

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* Model letter from OSWER Publication 9834.10-1b, "Model Notice Letters" (Feb. 7, 1989), PB91-139279/CCE.

** This letter may need to be modified if a general notice letter has not been sent to include some of the information typically conveyed in that letter.

would not expedite a response. Examples may include where past dealings with the PRPs strongly indicate they are unlikely to negotiate a settlement, where EPA believes the PRPs have not been negotiating informally to this point in good faith, or where PRPs lack the resources to conduct response activities.)

The decision not to use the special notice procedure does not preclude you from entering into discussions with EPA regarding your participation in response activities at the site. The decision simply means that EPA will not use the special notice procedures to govern any future discussions. EPA encourages all PRP offers regarding settlement of this matter and cleanup of this site.

ADMINISTRATIVE RECORD

Pursuant to CERCLA Section 113(k), EPA must establish an administrative record that contains documents that form the basis of EPA's decision on the selection of a response action for a site. The administrative record files, which contain the documents related to the response action selected for this site, [will be] [are] available to the public for inspection and comment. The primary location is generally the EPA Regional office. [Include specific information regarding the location and availability of the record file.]

EPA CONTACT

If you or your attorney have any questions pertaining to this matter, please direct them to _____.

Sincerely,

Attachments

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				3.00E-04	O						1.36E+09		1	0.1	Acephate	30560-19-1					7.0E+01	3.0E+02		5.7E+01
		2.20E-06	I			9.00E-03	I	V		1.07E+05	1.36E+09	8.72E+03	1		Acetaldehyde	75-07-0			1.1E+03	1.1E+03			2.5E+02	2.5E+02
				2.00E-02	I						1.36E+09		1	0.1	Acetochlor	34256-82-1					4.7E+03	2.0E+04		3.8E+03
				9.00E-01	I			V		1.14E+05	1.36E+09	1.37E+04	1		Acetone	67-64-1					2.1E+05			2.1E+05
						2.00E-03	X				1.36E+09		1	0.1	Acetone Cyanohydrin	75-86-5							8.5E+06	8.5E+06
						6.00E-02	I	V		1.28E+05	1.36E+09	1.30E+04	1		Acetonitrile	75-05-8							2.4E+03	2.4E+03
				1.00E-01	I			V		2.52E+03	1.36E+09	5.97E+04	1		Acetophenone	98-86-2					2.3E+04			2.3E+04
3.80E+00	C	1.30E-03	C								1.36E+09		1	0.1	Acetylaminofluorene, 2-	53-96-3	1.8E+01	6.5E+01	2.9E+05	1.4E+01				
				5.00E-04	I	2.00E-05	I	V		2.27E+04	1.36E+09	6.91E+03	1		Acrolein	107-02-8					1.2E+02		4.3E-01	4.3E-01
5.00E-01	I	1.00E-04	I	2.00E-03	I	6.00E-03	I		M		1.36E+09		1	0.1	Acrylamide	79-06-1	3.1E+01	1.2E+02	1.4E+06	2.4E+01	4.7E+02	2.0E+03	2.6E+07	3.8E+02
				5.00E-01	I	2.00E-04	P	V		1.09E+05	1.36E+09	9.53E+04	1		Acrylic Acid	79-10-7					1.2E+05		6.0E+01	6.0E+01
5.40E-01	I	6.80E-05	I	9.00E-05	T	2.00E-03	I	V		1.13E+04	1.36E+09	7.69E+03	1		Acrylonitrile	107-13-1	1.3E+02		3.2E+01	2.5E+01	2.1E+01		4.8E+01	1.5E+01
						6.00E-03	P				1.36E+09		1	0.1	Adiponitrile	111-69-3							2.6E+07	2.6E+07
5.60E-02	C			1.00E-02	I						1.36E+09		1	0.1	Alachlor	15972-60-8	1.2E+03	4.4E+03		9.7E+02	2.3E+03	9.9E+03		1.9E+03
				1.00E-03	I						1.36E+09		1	0.1	Aldicarb	116-06-3					2.3E+02	9.9E+02		1.9E+02
				1.00E-03	I						1.36E+09		1	0.1	Aldicarb Sulfone	1646-88-4					2.3E+02	9.9E+02		1.9E+02
											1.36E+09		1	0.1	Aldicarb sulfoxide	1646-87-3								
1.70E+01	I	4.90E-03	I	3.00E-05	I			V			1.36E+09	1.72E+06	1		Aldrin	309-00-2	4.1E+00		9.8E+01	3.9E+00	7.0E+00			7.0E+00
				4.00E-03	P	1.00E-04	X	V		1.11E+05	1.36E+09	3.42E+04	1		Allyl Alcohol	107-18-6					9.4E+02		1.1E+01	1.1E+01
2.10E-02	C	6.00E-06	C			1.00E-03	I	V		1.42E+03	1.36E+09	1.58E+03	1		Allyl Chloride	107-05-1	3.3E+03		7.4E+01	7.2E+01			5.0E+00	5.0E+00
				1.00E+00	P	5.00E-03	P				1.36E+09		1		Aluminum	7429-90-5					2.3E+05		2.1E+07	2.3E+05
				4.00E-04	I						1.36E+09		1		Aluminum Phosphide	20859-73-8					9.4E+01			9.4E+01
				9.00E-03	I						1.36E+09		1	0.1	Ametryn	834-12-8					2.1E+03	8.9E+03		1.7E+03
2.10E+01	C	6.00E-03	C								1.36E+09		1	0.1	Aminobiphenyl, 4-	92-67-1	3.3E+00	1.2E+01	6.4E+04	2.6E+00				
				8.00E-02	P						1.36E+09		1	0.1	Aminophenol, m-	591-27-5					1.9E+04	7.9E+04		1.5E+04
				4.00E-03	X						1.36E+09		1	0.1	Aminophenol, o-	95-55-6					9.4E+02	4.0E+03		7.6E+02
				2.00E-02	P						1.36E+09		1	0.1	Aminophenol, p-	123-30-8					4.7E+03	2.0E+04		3.8E+03
				2.50E-03	I						1.36E+09		1	0.1	Amitraz	33089-61-1					5.9E+02	2.5E+03		4.7E+02
						5.00E-01	I	V					1		Ammonia	7664-41-7								
				2.00E-03	X						1.36E+09		1	0.1	Ammonium Picrate	131-74-8					4.7E+02	2.0E+03		3.8E+02
				2.00E-01	I						1.36E+09		1		Ammonium Sulfamate	7773-06-0					4.7E+04			4.7E+04
						3.00E-03	X	V		1.37E+04	1.36E+09	2.62E+04	1		Amyl Alcohol, tert-	75-85-4							2.5E+02	2.5E+02
5.70E-03	I	1.60E-06	C	7.00E-03	P	1.00E-03	I				1.36E+09		1	0.1	Aniline	62-53-3	1.2E+04	4.3E+04	2.4E+08	9.5E+03	1.6E+03	6.9E+03	4.3E+06	1.3E+03
4.00E-02	P			2.00E-03	X						1.36E+09		1	0.1	Anthraquinone, 9,10-	84-65-1	1.7E+03	6.2E+03		1.4E+03	4.7E+02	2.0E+03		3.8E+02
				4.00E-04	I	3.00E-04	A				1.36E+09		0.15		Antimony (metallic)	7440-36-0					9.4E+01		1.3E+06	9.4E+01
				5.00E-04	H						1.36E+09		0.15		Antimony Pentoxide	1314-60-9					1.2E+02			1.2E+02
				4.00E-04	H						1.36E+09		0.15		Antimony Tetroxide	1332-81-6					9.4E+01			9.4E+01
						2.00E-04	I				1.36E+09		0.15		Antimony Trioxide	1309-64-4							8.5E+05	8.5E+05
1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C				1.36E+09		1	0.03	Arsenic, Inorganic	7440-38-2	7.7E+01	5.5E+02	8.9E+04	6.8E+01	1.2E+02	9.9E+02	6.4E+04	1.0E+02
				3.50E-06	C	5.00E-05	I				1.36E+09		1		Arsine	7784-42-1					8.2E-01		2.1E+05	8.2E-01
													1		Asbestos (units in fibers)	1332-21-4								
				3.60E-01	O						1.36E+09		1	0.1	Asulam	3337-71-1					8.4E+04	3.6E+05		6.8E+04
2.30E-01	C			3.00E-03	A						1.36E+09		1	0.1	Atrazine	1912-24-9	3.0E+02	1.1E+03		2.4E+02	7.0E+02	3.0E+03		5.7E+02
8.80E-01	C	2.50E-04	C								1.36E+09		1	0.1	Auramine	492-80-8	7.9E+01	2.8E+02	1.5E+06	6.2E+01				
				4.00E-04	I						1.36E+09		1	0.1	Avermectin B1	65195-55-3					9.4E+01	4.0E+02		7.6E+01
				3.00E-03	A	1.00E-02	A				1.36E+09		1	0.1	Azinphos-methyl	86-50-0					7.0E+02	3.0E+03	4.3E+07	5.7E+02
1.10E-01	I	3.10E-05	I					V			1.36E+09	5.23E+05	1		Azobenzene	103-33-3	6.3E+02		4.7E+03	5.6E+02				
				1.00E+00	P	7.00E-06	P				1.36E+09		1	0.1	Azodicarbonamide	123-77-3					2.3E+05	9.9E+05	3.0E+04	2.6E+04
				2.00E-01	I	5.00E-04	H				1.36E+09		0.07		Barium	7440-39-3					4.7E+04		2.1E+06	4.6E+04
				5.00E-03	O			V			1.36E+09	3.07E+05	1		Benfluralin	1861-40-1					1.2E+03			1.2E+03
				5.00E-02	I						1.36E+09		1	0.1	Benomyl	17804-35-2					1.2E+04	4.9E+04		9.5E+03
				2.00E-01	I						1.36E+09		1	0.1	Bensulfuron-methyl	83055-99-6					4.7E+04	2.0E+05		3.8E+04
				3.00E-02	I						1.36E+09		1	0.1	Bentazon	25057-89-0					7.0E+03	3.0E+04		5.7E+03
4.00E-03	P			1.00E-01	I			V		1.16E+03	1.36E+09	2.25E+04	1		Benzaldehyde	100-52-7	1.7E+04			1.7E+04	2.3E+04			2.3E+04
5.50E-02	I	7.80E-06	I	4.00E-03	I	3.00E-02	I	V		1.82E+03	1.36E+09	3.54E+03	1		Benzene	71-43-2	1.3E+03		1.3E+02	1.2E+02	9.4E+02		3.3E+02	2.5E+02
						4.00E-03	C	V		1.82E+02	1.36E+09	1.23E+04	1		Benzene, Trimethyl	25551-13-7							1.5E+02	1.5E+02
1.00E-01	X			3.00E-04	X						1.36E+09		1	0.1	Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	7.0E+02	2.5E+03		5.4E+02	7.0E+01	3.0E+02		5.7E+01
				1.00E-03	P			V		1.26E+03	1.36E+09	1.94E+04	1		Benzenethiol	108-98-5					2.3E+02			2.3E+02
2.30E+02	I	6.70E-02	I	3.00E-03	I				M		1.36E+09		1	0.1	Benzidine	92-87-5	6.7E-02	2.6E-01	2.1E+03	5.3E-02	7.0E+02	3.0E+03		5.7E+02
				4.00E+00	I						1.36E+09		1	0.1	Benzoic Acid	65-85-0					9.4E+05	4.0E+06		7.6E+05
1.30E+01	I							V		3.24E+02	1.36E+09	6.76E+04	1		Benzotrichloride	98-07-7	5.3E+00			5.3E+00				
				1.00E-01	P						1.36E+09		1	0.1	Benzyl Alcohol	100-51-6					2.3E+04	9.9E+04		1.9E+04
1.70E-01	I	4.90E-05	C	2.00E-03	P	1.00E-03	P	V		1.46E+03	1.36E+09	2.55E+04	1		Benzyl Chloride	100-44-7	4.1E+02		1.5E+02	1.1E+02	4.7E+02		8.0E+01	6.8E+01
		2.40E-03	I	2.00E-03	I	2.00E-05	I				1.36E+09		0.007		Beryllium and compounds	7440-41-7			1.6E+05	1.6E+05	4.7E+02		8.5E+04	4.7E+02
				9.00E-03	P						1.36E+09		1	0.1	Bifenox	42576-02-3					2.1E+03	8.9E+03		1.7E+03
				1.50E-02	I						1.36E+09		1	0.1	Biphenthrin	82657-04-3					3.5E+03	1.5E+04		2.8E+03
8.00E-03	I			5.00E-01	I	4.00E-04	X	V			1.36E+09	1.14E+05	1		Biphenyl, 1,1'-	92-52-4	8.7E+03			8.7E+03	1.2E+05		1.4E+02	1.4E+02
				4.00E-02	I			V		1.02E+03	1.36E+09	3.50E+04	1		Bis(2-chloro-1-methylethyl) ether	108-60-1					9.4E+03			9.4E+03
				3.00E-03	P						1.36E+09		1	0.1	Bis(2-chloroethoxy)methane	111-91-1					7.0E+02	3.0E+03		5.7E+02
1.10E+00	I	3.30E-04	I					V		5.05E+03	1.36E+09	4.25E+04	1		Bis(2-chloroethyl)ether	111-44-4	6.3E+01		3.6E+01	2.3E+01				
2.20E+02	I	6.20E-02	I					V		4.22E+03	1.36E+09	1.88E+03	1		Bis(chloromethyl)ether	542-88-1	3.2E-01		8.5E-03	8.3E-03				
				5.00E-02	I						1.36E+09		1	0.1	Bisphenol A	80-05-7					1.2E+04	4.9E+04		9.5E+03
				2.00E-01	I	2.00E-02	H				1.36E+09		1		Boron And Borates Only	7440-42-8					4.7E+04		8.5E+07	4.7E+04
				2.00E+00	P	2.00E-02	P	V			1.36E+09		1		Boron Trichloride	10294-34-5					4.7E+05		8.5E+07	4.7E+05
				4.00E-02	C	1.30E-02	C	V			1.36E+09		1		Boron Trifluoride	7637-07-2					9.4E+03		5.5E+07	9.4E+03
7.00E-01	I	1.40E-04	C	4.00E-03	I						1.36E+09		1		Bromate	15541-45-4	9.9E+01		2.7E+06	9.9E+01	9.4E+02			9.4E+02
				1.00E-04	X	6.00E-05	X	V		2.38E+03	1.36E+09	5.92E+03	1		Bromo-2-chloroethane, 1-	107-04-0					2.3E+01		1.1E+00	1.1E+00
				3.00E-04	X			V		8.96E+02	1.36E+09	1.12E+04	1		Bromo-3-fluorobenzene, 1-	1073-06-9					7.0E+01			7.0E+01
				3.00E-04	X			V		3.23E+02	1.36E+09	1.14E+04	1		Bromo-4-fluorobenzene, 1-	460-00-4					7.0E+01			7.0E+01
				1.70E-03	C						1.36E+09		1	0.1	Bromoacetic acid	79-08-3					4.0E+02	1.7E+03		3.2E+02
				8.00E-03	I	6.00E-02	I	V		6.79E+02	1.36E+09	8.37E+03	1		Bromobenzene	108-86-1					1.9E+03		1.6E+03	8.6E+02
						4.00E-02	X	V		4.04E+03	1.36E+09	3.58E+03	1		Bromochloromethane	74-97-5							4.5E+02	4.5E+02
6.20E-02	I	3.70E-05	C	8.00E-03	P			V		9.32E+02	1.36E+09	3.97E+03	1		Bromodichloromethane	75-27-4	1.1E+03		3.0E+01	2.9E+01	1.9E+03			1.9E+03

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
7.90E-03	I	1.10E-06	I	2.00E-02	I			V		9.15E+02	1.36E+09	9.70E+03	1		Bromoform	75-25-2	8.8E+03		2.5E+03	1.9E+03	4.7E+03			4.7E+03
				1.40E-03	I	5.00E-03	I	V		3.59E+03	1.36E+09	1.40E+03	1		Bromomethane	74-83-9					3.3E+02		2.2E+01	2.1E+01
				5.00E-03	H			V			1.36E+09	1.24E+05	1		Bromophos	2104-96-3					1.2E+03			1.2E+03
		3.70E-06	C			1.00E-01	A	V		9.66E+02	1.36E+09	2.14E+03	1		Bromopropane, 1-	106-94-5			1.6E+02	1.6E+02			6.7E+02	6.7E+02
1.03E-01	O			1.50E-02	O						1.36E+09		1	0.1	Bromoxynil	1689-84-5	6.7E+02	2.4E+03		5.3E+02	3.5E+03	1.5E+04		2.8E+03
1.03E-01	O			1.50E-02	O			V			1.36E+09	4.74E+05	1		Bromoxynil Octanoate	1689-99-2	6.7E+02			6.7E+02	3.5E+03			3.5E+03
6.00E-01	C	3.00E-05	I			2.00E-03	I	V		6.67E+02	1.36E+09	8.66E+02	1		Butadiene, 1,3-	106-99-0	1.2E+02		8.1E+00	7.6E+00			5.4E+00	5.4E+00
				1.00E-01	I			V		7.64E+03	1.36E+09	3.00E+04	1		Butanol, N-	71-36-3					2.3E+04			2.3E+04
5.00E-04	I			4.00E-01	I	5.00E+00	I	V			1.36E+09	2.87E+04	1		Butyl Alcohol, t-	75-65-0	1.4E+05			1.4E+05	9.4E+04		4.5E+05	7.8E+04
				2.00E+00	P	3.00E+01	P	V		2.13E+04	1.36E+09	2.92E+04	1		Butyl alcohol, sec-	78-92-2					4.7E+05		2.7E+06	4.0E+05
				5.00E-02	I			V			1.36E+09	8.63E+04	1		Butylate	2008-41-5					1.2E+04			1.2E+04
2.00E-04	C	5.70E-08	C								1.36E+09		1	0.1	Butylated hydroxyanisole	25013-16-5	3.5E+05	1.2E+06	6.7E+09	2.7E+05				
3.60E-03	P			3.00E-01	P						1.36E+09		1	0.1	Butylated hydroxytoluene	128-37-0	1.9E+04	6.9E+04		1.5E+04	7.0E+04	3.0E+05		5.7E+04
				5.00E-02	P			V		1.08E+02	1.36E+09	8.14E+03	1		Butylbenzene, n-	104-51-8					1.2E+04			1.2E+04
				1.00E-01	X			V		1.45E+02	1.36E+09	7.35E+03	1		Butylbenzene, sec-	135-98-8					2.3E+04			2.3E+04
				1.00E-01	X			V		1.83E+02	1.36E+09	7.36E+03	1		Butylbenzene, tert-	98-06-6					2.3E+04			2.3E+04
				2.00E-02	A						1.36E+09		1	0.1	Cacodylic Acid	75-60-5					4.7E+03	2.0E+04		3.8E+03
		1.80E-03	I	1.00E-04	A	1.00E-05	A				1.36E+09		0.025	0.001	Cadmium (Diet)	7440-43-9			2.1E+05	2.1E+05	2.3E+01	2.5E+02	4.3E+04	2.1E+01
		1.80E-03	I	1.00E-04	A	1.00E-05	A						0.05	0.001	Cadmium (Water)	7440-43-9								
				5.00E-01	I	2.20E-03	C				1.36E+09		1	0.1	Caprolactam	105-60-2					1.2E+05	4.9E+05	9.4E+06	9.4E+04
1.50E-01	C	4.30E-05	C	2.00E-03	I						1.36E+09		1	0.1	Captafol	2425-06-1	4.6E+02	1.6E+03	8.9E+06	3.6E+02	4.7E+02	2.0E+03		3.8E+02
2.30E-03	C	6.60E-07	C	1.30E-01	I						1.36E+09		1	0.1	Captan	133-06-2	3.0E+04	1.1E+05	5.8E+08	2.4E+04	3.1E+04	1.3E+05		2.5E+04
				1.00E-01	I						1.36E+09		1	0.1	Carbaryl	63-25-2					2.3E+04	9.9E+04		1.9E+04
				5.00E-03	I						1.36E+09		1	0.1	Carbofuran	1563-66-2					1.2E+03	4.9E+03		9.5E+02
				1.00E-01	I	7.00E-01	I	V		7.38E+02	1.36E+09	1.17E+03	1		Carbon Disulfide	75-15-0					2.3E+04		2.6E+03	2.3E+03
7.00E-02	I	6.00E-06	I	4.00E-03	I	1.00E-01	I	V		4.58E+02	1.36E+09	1.49E+03	1		Carbon Tetrachloride	56-23-5	9.9E+02		7.0E+01	6.5E+01	9.4E+02		4.7E+02	3.1E+02
						1.00E-01	P	V		5.89E+03	1.36E+09	6.46E+02	1		Carbonyl Sulfide	463-58-1							2.0E+02	2.0E+02
				1.00E-02	I						1.36E+09		1	0.1	Carbosulfan	55285-14-8					2.3E+03	9.9E+03		1.9E+03
				1.00E-01	I						1.36E+09		1	0.1	Carboxin	5234-68-4					2.3E+04	9.9E+04		1.9E+04
						9.00E-04	I				1.36E+09		1		Ceric oxide	1306-38-3							3.8E+06	3.8E+06
				1.00E-01	I			V			1.36E+09	1.45E+05	1		Chloral Hydrate	302-17-0					2.3E+04			2.3E+04
				1.50E-02	I						1.36E+09		1	0.1	Chloramben	133-90-4					3.5E+03	1.5E+04		2.8E+03
											1.36E+09		1	0.1	Chloramines, Organic	E701235								
4.03E-01	H										1.36E+09		1	0.1	Chloranil	118-75-2	1.7E+02	6.1E+02		1.3E+02				
				5.00E-04	G			V			1.36E+09	1.49E+06	1	0.04	Chlordane (alpha)	5103-71-9					1.2E+02	1.2E+03		1.1E+02
				5.00E-04	G			V			1.36E+09	1.49E+06	1	0.04	Chlordane (gamma)	5103-74-2					1.2E+02	1.2E+03		1.1E+02
3.50E-01	I	1.00E-04	I	5.00E-04	I	7.00E-04	I	V			1.36E+09	1.53E+06	1	0.04	Chlordane (technical mixture)	12789-03-6	2.0E+02	1.8E+03	4.3E+03	1.7E+02	1.2E+02	1.2E+03	3.3E+03	1.0E+02
1.00E+01	I	4.60E-03	C	3.00E-04	I						1.36E+09		1	0.1	Chlordecone (Kepone)	143-50-0	7.0E+00	2.5E+01	8.3E+04	5.4E+00	7.0E+01	3.0E+02		5.7E+01
				7.00E-04	A						1.36E+09		1	0.1	Chlorfenvinphos	470-90-6					1.6E+02	6.9E+02		1.3E+02
				9.00E-02	O						1.36E+09		1	0.1	Chlorimuron, Ethyl-	90982-32-4					2.1E+04	8.9E+04		1.7E+04
				1.00E-01	I	1.45E-04	A	V		2.78E+03	1.36E+09	1.22E+03	1		Chlorine	7782-50-5					2.3E+04		5.5E-01	5.5E-01
				3.00E-02	I	2.00E-04	I	V			1.36E+09		1		Chlorine Dioxide	10049-04-4					7.0E+03		8.5E+05	7.0E+03
				3.00E-02	I						1.36E+09		1		Chlorite (Sodium Salt)	7758-19-2					7.0E+03			7.0E+03
						5.00E+01	I	V		1.15E+03	1.36E+09	1.03E+03	1		Chloro-1,1-difluoroethane, 1-	75-68-3							1.6E+05	1.6E+05
		3.00E-04	I	2.00E-02	H	2.00E-02	I	V		7.86E+02	1.36E+09	1.08E+03	1		Chloro-1,3-butadiene, 2- (Chloroprene)	126-99-8			1.0E+00	1.0E+00	4.7E+03		6.7E+01	6.6E+01
4.60E-01	H										1.36E+09		1	0.1	Chloro-2-methylaniline HCl, 4-	3165-93-3	1.5E+02	5.4E+02		1.2E+02				
1.00E-01	P	7.70E-05	C	3.00E-03	X						1.36E+09		1	0.1	Chloro-2-methylaniline, 4-	95-69-2	7.0E+02	2.5E+03	5.0E+06	5.4E+02	7.0E+02	3.0E+03		5.7E+02
2.70E-01	X							V		1.18E+04	1.36E+09	1.62E+04	1		Chloroacetaldehyde, 2-	107-20-0	2.6E+02			2.6E+02				
				3.50E-03	C						1.36E+09		1	0.1	Chloroacetic Acid	79-11-8					8.2E+02	3.5E+03		6.6E+02
						3.00E-05	I				1.36E+09		1	0.1	Chloroacetophenone, 2-	532-27-4							1.3E+05	1.3E+05
2.00E-01	P			5.00E-04	P						1.36E+09		1	0.1	Chloroaniline, p-	106-47-8	3.5E+02	1.2E+03		2.7E+02	1.2E+02	4.9E+02		9.5E+01
				2.00E-02	I	5.00E-02	P	V		7.61E+02	1.36E+09	6.45E+03	1		Chlorobenzene	108-90-7					4.7E+03		1.0E+03	8.3E+02
				1.00E-01	X						1.36E+09		1	0.1	Chlorobenzene sulfonic acid, p-	98-66-8					2.3E+04	9.9E+04		1.9E+04
1.10E-01	C	3.10E-05	C	2.00E-02	I						1.36E+09		1	0.1	Chlorobenzilate	510-15-6	6.3E+02	2.2E+03	1.2E+07	4.9E+02	4.7E+03	2.0E+04		3.8E+03
				3.00E-02	X						1.36E+09		1	0.1	Chlorobenzoic Acid, p-	74-11-3					7.0E+03	3.0E+04		5.7E+03
		8.60E-06	C	3.00E-03	P	3.00E-01	P	V		2.90E+02	1.36E+09	6.76E+03	1		Chlorobenzotrifluoride, 4-	98-56-6			2.2E+02	2.2E+02	7.0E+02		6.3E+03	6.3E+02
				4.00E-02	P			V		7.28E+02	1.36E+09	1.76E+03	1		Chlorobutane, 1-	109-69-3					9.4E+03			9.4E+03
						5.00E+01	I	V		1.68E+03	1.36E+09	9.38E+02	1		Chlorodifluoromethane	75-45-6							1.5E+05	1.5E+05
				2.00E-02	P			V		1.11E+05	1.36E+09	7.81E+04	1		Chloroethanol, 2-	107-07-3					4.7E+03			4.7E+03
3.10E-02	C	2.30E-05	I	1.00E-02	I	1.95E-03	T	V		2.54E+03	1.36E+09	2.63E+03	1		Chloroform	67-66-3	2.2E+03		3.2E+01	3.2E+01	2.3E+03		1.6E+01	1.6E+01
						9.00E-02	I	V		1.32E+03	1.36E+09	1.18E+03	1		Chloromethane	74-87-3							3.3E+02	3.3E+02
2.40E+00	C	6.90E-04	C					V		9.32E+03	1.36E+09	5.33E+03	1		Chloromethyl Methyl Ether	107-30-2	2.9E+01		2.2E+00	2.0E+00				
3.00E-01	P			3.00E-03	P	1.00E-05	X				1.36E+09		1	0.1	Chloronitrobenzene, o-	88-73-3	2.3E+02	8.2E+02		1.8E+02	7.0E+02	3.0E+03	4.3E+04	5.6E+02
6.00E-02	P			7.00E-04	P	2.00E-03	P				1.36E+09		1	0.1	Chloronitrobenzene, p-	100-00-5	1.2E+03	4.1E+03		9.0E+02	1.6E+02	6.9E+02	8.5E+06	1.3E+02
				5.00E-03	I			V		2.74E+04	1.36E+09	1.39E+05	1		Chlorophenol, 2-	95-57-8					1.2E+03			1.2E+03
						4.00E-04	C	V		6.17E+02	1.36E+09	4.68E+03	1		Chloropicrin	76-06-2							5.9E+00	5.9E+00
1.70E-02	C			1.50E-02	I						1.36E+09		1	0.1	Chlorothalonil	1897-45-6	4.1E+03	1.5E+04		3.2E+03	3.5E+03	1.5E+04		2.8E+03
				2.00E-02	I			V		9.07E+02	1.36E+09	8.12E+03	1		Chlorotoluene, o-	95-49-8					4.7E+03			4.7E+03
				2.00E-02	X			V		2.53E+02	1.36E+09	7.29E+03	1		Chlorotoluene, p-	106-43-4					4.7E+03			4.7E+03
2.40E+02	C	6.90E-02	C								1.36E+09		1	0.1	Chlorozotocin	54749-90-5	2.9E-01	1.0E+00	5.5E+03	2.3E-01				
				5.00E-03	O						1.36E+09		1	0.1	Chlorpropham	101-21-3					1.2E+03	4.9E+03		9.5E+02
				1.00E-03	A						1.36E+09		1	0.1	Chlorpyrifos	2921-88-2					2.3E+02	9.9E+02		1.9E+02
				1.00E-02	H						1.36E+09		1	0.1	Chlorpyrifos Methyl	5598-13-0					2.3E+03	9.9E+03		1.9E+03
				5.00E-02	O						1.36E+09		1	0.1	Chlorsulfuron	64902-72-3					1.2E+04	4.9E+04		9.5E+03
				1.00E-02	I						1.36E+09		1	0.1	Chlorthal-dimethyl	1861-32-1					2.3E+03	9.9E+03		1.9E+03
				8.00E-04	H						1.36E+09		1	0.1	Chlorthiophos	60238-56-4					1.9E+02	7.9E+02		1.5E+02
						6.00E-05	C				1.36E+09		0.013		Chromium(III) (Soluble Compounds)	16065-83-1							2.6E+05	2.6E+05
				1.50E+00	I						1.36E+09		0.013		Chromium(III), Insoluble Salts	16065-83-1					3.5E+05			3.5E+05
5.00E-01	C	8.40E-02	G	3.00E-03	I	1.00E-04	I		M		1.36E+09		0.025		Chromium(VI)	18540-29-9	3.1E+01		1.6E+03	3.0E+01	7.0E+02		4.3E+05	7.0E+02
											1.36E+09		0.013		Chromium, Total	7440-47-3								
				1.30E-02	I						1.36E+09		1	0.1	Clofentezine	74115-24-5					3.1E+03	1.3E+04		2.5E+03
		9.00E-03	P	3.00E-04	P	6.00E-06	P				1.36E+09		1		Cobalt	7440-48-4			4.2E+04	4.2E+04	7.0E+01		2.6E+04	7.0E+01
		6.20E-04	I					V	M				1		Coke Oven Emissions	E649830								

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				4.00E-02	H						1.36E+09		1		Copper	7440-50-8					9.4E+03			9.4E+03
				5.00E-02	I	6.00E-01	C				1.36E+09		1	0.1	Cresol, m-	108-39-4					1.2E+04	4.9E+04	2.6E+09	9.5E+03
				5.00E-02	I	6.00E-01	C				1.36E+09		1	0.1	Cresol, o-	95-48-7					1.2E+04	4.9E+04	2.6E+09	9.5E+03
				2.00E-02	P	6.00E-01	C				1.36E+09		1	0.1	Cresol, p-	106-44-5					4.7E+03	2.0E+04	2.6E+09	3.8E+03
				1.00E-01	A						1.36E+09		1	0.1	Cresol, p-chloro-m-	59-50-7					2.3E+04	9.9E+04		1.9E+04
				1.00E-01	A	6.00E-01	C				1.36E+09		1	0.1	Cresols	1319-77-3					2.3E+04	9.9E+04	2.6E+09	1.9E+04
1.90E+00	H			1.00E-03	P			V		1.66E+04	1.36E+09	1.89E+04	1		Crotonaldehyde, trans-	123-73-9	3.7E+01			3.7E+01	2.3E+02			2.3E+02
				1.00E-01	I	4.00E-01	I	V		2.68E+02	1.36E+09	6.21E+03	1		Cumene	98-82-8					2.3E+04		7.8E+03	5.8E+03
2.20E-01	C	6.30E-05	C								1.36E+09		1	0.1	Cupferron	135-20-6	3.2E+02	1.1E+03	6.1E+06	2.5E+02				
8.40E-01	H			2.00E-03	H						1.36E+09		1	0.1	Cyanazine	21725-46-2	8.3E+01	2.9E+02		6.5E+01	4.7E+02	2.0E+03		3.8E+02
															Cyanides									
				1.00E-03	I	9.00E-03	C				1.36E+09		1		~Calcium Cyanide	592-01-8					2.3E+02		3.8E+07	2.3E+02
				5.00E-03	I						1.36E+09		1		~Copper Cyanide	544-92-3					1.2E+03			1.2E+03
				6.00E-04	I	8.00E-04	G	V		9.54E+05	1.36E+09	5.33E+04	1		~Cyanide (CN-)	57-12-5					1.4E+02		1.3E+02	6.9E+01
				1.00E-03	I			V			1.36E+09		1		~Cyanogen	460-19-5					2.3E+02			2.3E+02
				9.00E-02	I			V			1.36E+09		1		~Cyanogen Bromide	506-68-3					2.1E+04			2.1E+04
				5.00E-02	I			V			1.36E+09		1		~Cyanogen Chloride	506-77-4					1.2E+04			1.2E+04
				6.00E-04	I	8.00E-04	I	V		1.00E+07	1.36E+09	5.22E+04	1		~Hydrogen Cyanide	74-90-8					1.4E+02		1.3E+02	6.8E+01
				2.00E-03	I	9.00E-03	C				1.36E+09		1		~Potassium Cyanide	151-50-8					4.7E+02		3.8E+07	4.7E+02
				5.00E-03	I						1.36E+09		0.04		~Potassium Silver Cyanide	506-61-6					1.2E+03			1.2E+03
				1.00E-01	I						1.36E+09		0.04		~Silver Cyanide	506-64-9					2.3E+04			2.3E+04
				1.00E-03	I	9.00E-03	C				1.36E+09		1		~Sodium Cyanide	143-33-9					2.3E+02		3.8E+07	2.3E+02
				2.00E-04	P						1.36E+09		1		~Thiocyanates	E1790665					4.7E+01			4.7E+01
				2.00E-04	X			V			1.36E+09		1		~Thiocyanic Acid	463-56-9					4.7E+01			4.7E+01
				5.00E-02	I						1.36E+09		1		~Zinc Cyanide	557-21-1					1.2E+04			1.2E+04
						6.00E+00	I	V		1.17E+02	1.36E+09	1.04E+03	1		Cyclohexane	110-82-7							2.0E+04	2.0E+04
2.00E-02	X			2.00E-02	X						1.36E+09		1	0.1	Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	3.5E+03	1.2E+04		2.7E+03	4.7E+03	2.0E+04		3.8E+03
				5.00E+00	I	7.00E-01	P	V		5.11E+03	1.36E+09	4.17E+04	1		Cyclohexanone	108-94-1					1.2E+06		9.1E+04	8.5E+04
				5.00E-03	P	1.00E+00	X	V		2.83E+02	1.36E+09	1.46E+03	1		Cyclohexene	110-83-8					1.2E+03		4.6E+03	9.3E+02
				2.00E-01	I			V		2.93E+05	1.36E+09	7.46E+04	1		Cyclohexylamine	108-91-8					4.7E+04			4.7E+04
				2.50E-02	I						1.36E+09		1	0.1	Cyfluthrin	68359-37-5					5.9E+03	2.5E+04		4.7E+03
				5.00E-01	O						1.36E+09		1	0.1	Cyromazine	66215-27-8					1.2E+05	4.9E+05		9.5E+04
				3.00E-02	I						1.36E+09		1	0.1	Dalapon	75-99-0					7.0E+03	3.0E+04		5.7E+03
1.80E-02	C	5.10E-06	C	1.50E-01	I						1.36E+09		1	0.1	Daminozide	1596-84-5	3.9E+03	1.4E+04	7.5E+07	3.0E+03	3.5E+04	1.5E+05		2.8E+04
7.00E-04	I			7.00E-03	I						1.36E+09		1	0.1	Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	9.9E+04	3.5E+05		7.8E+04	1.6E+03	6.9E+03		1.3E+03
				4.00E-05	I						1.36E+09		1	0.1	Demeton	8065-48-3					9.4E+00	4.0E+01		7.6E+00
1.20E-03	I			6.00E-01	I						1.36E+09		1	0.1	Di(2-ethylhexyl)adipate	103-23-1	5.8E+04	2.1E+05		4.5E+04	1.4E+05	5.9E+05		1.1E+05
6.10E-02	H										1.36E+09		1	0.1	Diallate	2303-16-4	1.1E+03	4.1E+03		8.9E+02				
				7.00E-04	A						1.36E+09		1	0.1	Diazinon	333-41-5					1.6E+02	6.9E+02		1.3E+02
8.00E-01	P	6.00E-03	P	2.00E-04	P	2.00E-04	I	V	M	9.79E+02	1.36E+09	3.20E+04	1		Dibromo-3-chloropropane, 1,2-	96-12-8	1.9E+01		5.4E-01	5.3E-01	4.7E+01		2.0E+01	1.4E+01
2.50E-01	C			3.00E-04	C						1.36E+09		1	0.1	Dibromoacetic acid	631-64-1	2.8E+02	9.9E+02		2.2E+02	7.0E+01	3.0E+02		5.7E+01
				4.00E-04	X			V		1.59E+02	1.36E+09	1.93E+04	1		Dibromobenzene, 1,3-	108-36-1					9.4E+01			9.4E+01
				1.00E-02	I			V			1.36E+09	2.20E+04	1		Dibromobenzene, 1,4-	106-37-6					2.3E+03			2.3E+03
8.40E-02	I			2.00E-02	I			V		8.02E+02	1.36E+09	7.95E+03	1		Dibromochloromethane	124-48-1	8.3E+02			8.3E+02	4.7E+03			4.7E+03
2.00E+00	I	6.00E-04	I	9.00E-03	I	9.00E-03	I	V		1.34E+03	1.36E+09	8.64E+03	1		Dibromoethane, 1,2-	106-93-4	3.5E+01		4.0E+00	3.6E+00	2.1E+03		2.4E+02	2.2E+02
						4.00E-03	X	V		2.82E+03	1.36E+09	5.64E+03	1		Dibromomethane (Methylene Bromide)	74-95-3							7.1E+01	7.1E+01
				3.00E-04	P						1.36E+09		1	0.1	Dibutyltin Compounds	E1790661					7.0E+01	3.0E+02		5.7E+01
				3.00E-02	I						1.36E+09		1	0.1	Dicamba	1918-00-9					7.0E+03	3.0E+04		5.7E+03
											1.36E+09		1	0.1	Dichloramine	3400-09-7								
		4.20E-03	P					V		5.54E+02	1.36E+09	3.21E+03	1		Dichloro-2-butene, 1,4-	764-41-0			2.1E-01	2.1E-01				
		4.20E-03	P					V		5.19E+02	1.36E+09	1.11E+04	1		Dichloro-2-butene, cis-1,4-	1476-11-5			7.4E-01	7.4E-01				
		4.20E-03	P					V		7.60E+02	1.36E+09	1.11E+04	1		Dichloro-2-butene, trans-1,4-	110-57-6			7.4E-01	7.4E-01				
5.00E-02	I			4.00E-03	I						1.36E+09		1	0.1	Dichloroacetic Acid	79-43-6	1.4E+03	4.9E+03		1.1E+03	9.4E+02	4.0E+03		7.6E+02
				9.00E-02	I	2.00E-01	H	V		3.76E+02	1.36E+09	1.17E+04	1		Dichlorobenzene, 1,2-	95-50-1					2.1E+04		7.3E+03	5.4E+03
5.40E-03	C	1.10E-05	C	7.00E-02	A	8.00E-01	I	V			1.36E+09	1.04E+04	1		Dichlorobenzene, 1,4-	106-46-7	1.3E+04		2.7E+02	2.6E+02	1.6E+04		2.6E+04	1.0E+04
4.50E-01	I	3.40E-04	C								1.36E+09		1	0.1	Dichlorobenzidine, 3,3'-	91-94-1	1.5E+02	5.5E+02	1.1E+06	1.2E+02				
				9.00E-03	X						1.36E+09		1	0.1	Dichlorobenzophenone, 4,4'-	90-98-2					2.1E+03	8.9E+03		1.7E+03
				2.00E-01	I	1.00E-01	X	V		8.45E+02	1.36E+09	8.41E+02	1		Dichlorodifluoromethane	75-71-8					4.7E+04		2.6E+02	2.6E+02
2.40E-01	I	6.90E-05	C	5.00E-04	A						1.36E+09		1	0.1	Dichlorodiphenyldichloroethane, p,p'- (DDD)	72-54-8	2.9E+02	1.0E+03	5.5E+06	2.3E+02	1.2E+02	4.9E+02		9.5E+01
3.40E-01	I	9.70E-05	C	5.00E-04	A			V			1.36E+09	2.10E+06	1		Dichlorodiphenyldichloroethylene, p,p'- (DDE)	72-55-9	2.0E+02		6.1E+03	2.0E+02	1.2E+02			1.2E+02
3.40E-01	I	9.70E-05	I	5.00E-04	I						1.36E+09		1	0.03	Dichlorodiphenyltrichloroethane, p,p'- (DDT)	50-29-3	2.0E+02	2.4E+03	3.9E+06	1.9E+02	1.2E+02	1.6E+03		1.1E+02
5.70E-03	C	1.60E-06	C	2.00E-01	P			V		1.69E+03	1.36E+09	2.08E+03	1		Dichloroethane, 1,1-	75-34-3	1.2E+04		3.7E+02	3.6E+02	4.7E+04			4.7E+04
9.10E-02	I	2.60E-05	I	6.00E-03	X	7.00E-03	P	V		2.98E+03	1.36E+09	4.57E+03	1		Dichloroethane, 1,2-	107-06-2	7.6E+02		4.9E+01	4.6E+01	1.4E+03		1.0E+02	9.4E+01
				5.00E-02	I	2.00E-01	I	V		1.19E+03	1.36E+09	1.16E+03	1		Dichloroethylene, 1,1-	75-35-4					1.2E+04		7.2E+02	6.8E+02
				2.00E-03	I	4.00E-02	X	V		2.37E+03	1.36E+09	2.50E+03	1		Dichloroethylene, cis-1,2-	156-59-2					4.7E+02		3.1E+02	1.9E+02
				2.00E-02	I	4.00E-02	X	V		1.85E+03	1.36E+09	1.75E+03	1		Dichloroethylene, trans-1,2-	156-60-5					4.7E+03		2.2E+02	2.1E+02
				3.00E-03	I						1.36E+09		1	0.1	Dichlorophenol, 2,4-	120-83-2					7.0E+02	3.0E+03		5.7E+02
				1.00E-02	I						1.36E+09		1	0.05	Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					2.3E+03	2.0E+04		2.1E+03
3.70E-02	P	3.70E-06	P	4.00E-02	P	4.00E-03	I	V		1.36E+03	1.36E+09	3.79E+03	1		Dichloropropane, 1,2-	78-87-5	1.9E+03		2.9E+02	2.5E+02	9.4E+03		4.7E+01	4.7E+01
				2.00E-02	P			V		1.49E+03	1.36E+09	6.76E+03	1		Dichloropropane, 1,3-	142-28-9					4.7E+03			4.7E+03
				3.00E-03	I						1.36E+09		1	0.1	Dichloropropanol, 2,3-	616-23-9					7.0E+02	3.0E+03		5.7E+02
1.00E-01	I	4.00E-06	I	3.00E-02	I	2.00E-02	I	V		1.57E+03	1.36E+09	3.55E+03	1		Dichloropropene, 1,3-	542-75-6	7.0E+02		2.5E+02	1.8E+02	7.0E+03		2.2E+02	2.2E+02
2.90E-01	I	8.30E-05	C	5.00E-04	I	5.00E-04	I				1.36E+09		1	0.1	Dichlorvos	62-73-7	2.4E+02	8.5E+02	4.6E+06	1.9E+02	1.2E+02	4.9E+02	2.1E+06	9.5E+01
				3.00E-05	O						1.36E+09		1	0.1	Dicrotophos	141-66-2					7.0E+00	3.0E+01		5.7E+00
				8.00E-02	P	3.00E-04	X	V		2.56E+02	1.36E+09	4.11E+03	1		Dicyclopentadiene	77-73-6					1.9E+04		3.9E+00	3.9E+00
1.60E+01	I	4.60E-03	I	5.00E-05	I						1.36E+09		1	0.1	Dieldrin	60-57-1	4.3E+00	1.5E+01	8.3E+04	3.4E+00	1.2E+01	4.9E+01		9.5E+00
		3.00E-04	C			5.00E-03	I						1	0.1	Diesel Engine Exhaust	E17136615								
				2.00E-03	P	2.00E-04	P				1.36E+09		1	0.1	Diethanolamine	111-42-2					4.7E+02	2.0E+03	8.5E+05	3.8E+02
				3.00E-02	P	1.00E-04	P				1.36E+09		1	0.1	Diethylene Glycol Monobutyl Ether	112-34-5					7.0E+03	3.0E+04	4.3E+05	5.6E+03
				6.00E-02	P	3.00E-04	P				1.36E+09		1	0.1	Diethylene Glycol Monoethyl Ether	111-90-0					1.4E+04	5.9E+04	1.3E+06	1.1E+04
				1.00E-03	P			V		1.12E+05	1.36E+09	1.39E+05	1		Diethylformamide	617-84-5					2.3E+02			2.3E+02
3.50E+02	C	1.00E-01	C								1.36E+09		1	0.1	Diethylstilbestrol	56-53-1	2.0E-01	7.1E-01	3.8E+03	1.6E-01				
				8.30E-02	O						1.36E+09		1	0.1	Difenzoquat	43222-48-6					1.9E+04	8.2E+04		1.6E+04

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				2.00E-02	I						1.36E+09		1	0.1	Diflubenzuron	35367-38-5					4.7E+03	2.0E+04		3.8E+03
						4.00E+01	I	V		1.43E+03	1.36E+09	1.15E+03	1		Difluoroethane, 1,1-	75-37-6							1.4E+05	1.4E+05
						3.00E+01	X	V		6.91E+02	1.36E+09	7.58E+02	1		Difluoropropane, 2,2-	420-45-1							7.1E+04	7.1E+04
4.40E-02	C	1.30E-05	C					V			1.36E+09	1.23E+05	1		Dihydrosafrole	94-58-6	1.6E+03		2.7E+03	9.9E+02				
						7.00E-01	P	V		2.26E+03	1.36E+09	3.06E+03	1		Diisopropyl Ether	108-20-3							6.7E+03	6.7E+03
				8.00E-02	I			V		5.30E+02	1.36E+09	3.81E+04	1		Diisopropyl Methylphosphonate	1445-75-6					1.9E+04			1.9E+04
				2.18E-02	O						1.36E+09		1	0.1	Dimethipin	55290-64-7					5.1E+03	2.2E+04		4.1E+03
				2.20E-03	O						1.36E+09		1	0.1	Dimethoate	60-51-5					5.2E+02	2.2E+03		4.2E+02
1.60E+00	P										1.36E+09		1	0.1	Dimethoxybenzidine, 3,3'-	119-90-4	4.3E+01	1.5E+02		3.4E+01				
1.70E-03	P			6.00E-02	P						1.36E+09		1	0.1	Dimethyl methylphosphonate	756-79-6	4.1E+04	1.5E+05		3.2E+04	1.4E+04	5.9E+04		1.1E+04
4.60E+00	C	1.30E-03	C								1.36E+09		1	0.1	Dimethylamino azobenzene [p-]	60-11-7	1.5E+01	5.4E+01	2.9E+05	1.2E+01				
5.80E-01	H										1.36E+09		1	0.1	Dimethylaniline HCl, 2,4-	21436-96-4	1.2E+02	4.3E+02		9.4E+01				
2.00E-01	P			2.00E-03	X						1.36E+09		1	0.1	Dimethylaniline, 2,4-	95-68-1	3.5E+02	1.2E+03		2.7E+02	4.7E+02	2.0E+03		3.8E+02
2.70E-02	P			2.00E-03	I			V		8.30E+02	1.36E+09	3.13E+04	1		Dimethylaniline, N,N-	121-69-7	2.6E+03			2.6E+03	4.7E+02			4.7E+02
1.10E+01	P										1.36E+09		1	0.1	Dimethylbenzidine, 3,3'-	119-93-7	6.3E+00	2.2E+01		4.9E+00				
				1.00E-01	P	3.00E-02	I	V		1.06E+05	1.36E+09	1.28E+05	1		Dimethylformamide	68-12-2					2.3E+04		1.2E+04	7.9E+03
				1.00E-04	X	2.00E-06	X	V		1.72E+05	1.36E+09	2.77E+04	1		Dimethylhydrazine, 1,1-	57-14-7					2.3E+01		1.7E-01	1.7E-01
5.50E+02	C	1.60E-01	C					V		1.89E+05	1.36E+09	1.68E+05	1		Dimethylhydrazine, 1,2-	540-73-8	1.3E-01		2.9E-01	8.8E-02				
				2.00E-02	I						1.36E+09		1	0.1	Dimethylphenol, 2,4-	105-67-9					4.7E+03	2.0E+04		3.8E+03
				6.00E-04	I						1.36E+09		1	0.1	Dimethylphenol, 2,6-	576-26-1					1.4E+02	5.9E+02		1.1E+02
				1.00E-03	I						1.36E+09		1	0.1	Dimethylphenol, 3,4-	95-65-8					2.3E+02	9.9E+02		1.9E+02
4.50E-02	C	1.30E-05	C					V		4.73E+02	1.36E+09	5.48E+03	1		Dimethylvinylchloride	513-37-1	1.5E+03		1.2E+02	1.1E+02				
				8.00E-05	X						1.36E+09		1	0.1	Dinitro-o-cresol, 4,6-	534-52-1					1.9E+01	7.9E+01		1.5E+01
				2.00E-03	I						1.36E+09		1	0.1	Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					4.7E+02	2.0E+03		3.8E+02
				4.00E-04	X	2.00E-03	X				1.36E+09		1	0.1	Dinitroaniline, 3,5-	618-87-1					9.4E+01	4.0E+02	8.5E+06	7.6E+01
				1.00E-04	P						1.36E+09		1	0.1	Dinitrobenzene, 1,2-	528-29-0					2.3E+01	9.9E+01		1.9E+01
				1.00E-04	I						1.36E+09		1	0.1	Dinitrobenzene, 1,3-	99-65-0					2.3E+01	9.9E+01		1.9E+01
				1.00E-04	P						1.36E+09		1	0.1	Dinitrobenzene, 1,4-	100-25-4					2.3E+01	9.9E+01		1.9E+01
				2.00E-03	I						1.36E+09		1	0.1	Dinitrophenol, 2,4-	51-28-5					4.7E+02	2.0E+03		3.8E+02
6.80E-01	I										1.36E+09		1	0.1	Dinitrotoluene Mixture, 2,4/2,6-	E1615210	1.0E+02	3.6E+02		8.0E+01				
3.10E-01	C	8.90E-05	C	2.00E-03	I						1.36E+09		1	0.102	Dinitrotoluene, 2,4-	121-14-2	2.2E+02	7.8E+02	4.3E+06	1.7E+02	4.7E+02	1.9E+03		3.8E+02
1.50E+00	P			3.00E-04	X						1.36E+09		1	0.099	Dinitrotoluene, 2,6-	606-20-2	4.6E+01	1.7E+02		3.6E+01	7.0E+01	3.0E+02		5.7E+01
				1.00E-04	X						1.36E+09		1	0.006	Dinitrotoluene, 2-Amino-4,6-	35572-78-2					2.3E+01	1.6E+03		2.3E+01
				1.00E-04	X						1.36E+09		1	0.009	Dinitrotoluene, 4-Amino-2,6-	19406-51-0					2.3E+01	1.1E+03		2.3E+01
4.50E-01	X			9.00E-04	X						1.36E+09		1	0.1	Dinitrotoluene, Technical grade	25321-14-6	1.5E+02	5.5E+02		1.2E+02	2.1E+02	8.9E+02		1.7E+02
				1.00E-03	I						1.36E+09		1	0.1	Dinoseb	88-85-7					2.3E+02	9.9E+02		1.9E+02
1.00E-01	I	5.00E-06	I	3.00E-02	I	3.00E-02	I	V		1.16E+05	1.36E+09	3.96E+04	1		Dioxane, 1,4-	123-91-1	7.0E+02		2.2E+03	5.3E+02	7.0E+03		3.7E+03	2.4E+03
															Dioxins									
6.20E+03	I	1.30E+00	I								1.36E+09		1	0.03	~Hexachlorodibenzo-p-dioxin, Mixture	34465-46-8	1.1E-02	1.3E-01	2.9E+02	1.0E-02				
1.30E+05	C	3.80E+01	C	7.00E-10	I	4.00E-08	C	V			1.36E+09	1.96E+06	1	0.03	~TCDD, 2,3,7,8-	1746-01-6	5.3E-04	6.3E-03	1.4E-02	4.8E-04	1.6E-04	2.3E-03	2.5E-01	1.5E-04
				3.00E-02	I						1.36E+09		1	0.1	Diphenamid	957-51-7					7.0E+03	3.0E+04		5.7E+03
						4.00E-04	X	V			1.36E+09	8.06E+04	1		Diphenyl Ether	101-84-8							1.0E+02	1.0E+02
				8.00E-04	X						1.36E+09		1	0.1	Diphenyl Sulfone	127-63-9					1.9E+02	7.9E+02		1.5E+02
				1.00E-01	O						1.36E+09		1	0.1	Diphenylamine	122-39-4					2.3E+04	9.9E+04		1.9E+04
8.00E-01	I	2.20E-04	I								1.36E+09		1	0.1	Diphenylhydrazine, 1,2-	122-66-7	8.7E+01	3.1E+02	1.7E+06	6.8E+01				
				2.20E-03	I						1.36E+09		1	0.1	Diquat	2764-72-9					5.2E+02	2.2E+03		4.2E+02
7.40E+00	C	2.10E-03	C								1.36E+09		1	0.1	Direct Black 38	1937-37-7	9.4E+00	3.3E+01	1.8E+05	7.3E+00				
7.40E+00	C	2.10E-03	C								1.36E+09		1	0.1	Direct Blue 6	2602-46-2	9.4E+00	3.3E+01	1.8E+05	7.3E+00				
6.70E+00	C	1.90E-03	C								1.36E+09		1	0.1	Direct Brown 95	16071-86-6	1.0E+01	3.7E+01	2.0E+05	8.1E+00				
				4.00E-05	I						1.36E+09		1	0.1	Disulfoton	298-04-4					9.4E+00	4.0E+01		7.6E+00
				1.00E-02	I			V			1.36E+09	4.54E+04	1		Dithiane, 1,4-	505-29-3					2.3E+03			2.3E+03
				2.00E-03	I						1.36E+09		1	0.1	Diuron	330-54-1					4.7E+02	2.0E+03		3.8E+02
				2.00E-02	O						1.36E+09		1	0.1	Dodine	2439-10-3					4.7E+03	2.0E+04		3.8E+03
				5.00E-02	O			V			1.36E+09	1.17E+05	1		EPTC	759-94-4					1.2E+04			1.2E+04
				6.00E-03	I			V			1.36E+09	4.10E+05	1		Endosulfan	115-29-7					1.4E+03			1.4E+03
				6.00E-03	P						1.36E+09		1	0.1	Endosulfan Sulfate	1031-07-8					1.4E+03	5.9E+03		1.1E+03
				2.00E-02	I						1.36E+09		1	0.1	Endothall	145-73-3					4.7E+03	2.0E+04		3.8E+03
				3.00E-04	I						1.36E+09		1	0.1	Endrin	72-20-8					7.0E+01	3.0E+02		5.7E+01
9.90E-03	I	1.20E-06	I	6.00E-03	P	1.00E-03	I	V		1.05E+04	1.36E+09	1.89E+04	1		Epichlorohydrin	106-89-8	7.0E+03		4.4E+03	2.7E+03	1.4E+03		5.9E+01	5.7E+01
						2.00E-02	I	V		1.53E+04	1.36E+09	7.66E+03	1		Epoxybutane, 1,2-	106-88-7							4.8E+02	4.8E+02
				4.00E-02	P						1.36E+09		1	0.1	Ethanol, 2-(2-methoxyethoxy)-	111-77-3					9.4E+03	4.0E+04		7.6E+03
				5.00E-03	I						1.36E+09		1	0.1	Ethephon	16672-87-0					1.2E+03	4.9E+03		9.5E+02
				5.00E-04	I						1.36E+09		1	0.1	Ethion	563-12-2					1.2E+02	4.9E+02		9.5E+01
				1.00E-01	P	6.00E-02	P	V		2.38E+04	1.36E+09	6.15E+04	1		Ethoxyethanol Acetate, 2-	111-15-9					2.3E+04		1.2E+04	7.7E+03
				9.00E-02	P	4.00E-02	P	V		1.06E+05	1.36E+09	9.84E+04	1		Ethoxyethanol, 2-	110-80-5					2.1E+04		1.2E+04	7.8E+03
				7.00E-01	P	7.00E-02	P	V		1.08E+04	1.36E+09	8.62E+03	1		Ethyl Acetate	141-78-6					1.6E+05		1.9E+03	1.9E+03
				5.00E-03	P	8.00E-03	P	V		2.50E+03	1.36E+09	6.34E+03	1		Ethyl Acrylate	140-88-5					1.2E+03		1.6E+02	1.4E+02
						4.00E+00	P	V		2.12E+03	1.36E+09	1.29E+03	1		Ethyl Chloride (Chloroethane)	75-00-3							1.6E+04	1.6E+04
				2.00E-01	I			V		1.01E+04	1.36E+09	3.12E+03	1		Ethyl Ether	60-29-7					4.7E+04			4.7E+04
						3.00E-01	P	V		1.10E+03	1.36E+09	5.77E+03	1		Ethyl Methacrylate	97-63-2							5.4E+03	5.4E+03
		8.00E-08	I	1.00E+00	I	4.00E+01	I	V		2.87E+03	1.36E+09	3.67E+03	1		Ethyl Tertiary Butyl Ether (ETBE)	637-92-3			1.3E+04	1.3E+04	2.3E+05		4.6E+05	1.6E+05
				1.00E-05	I						1.36E+09		1	0.1	Ethyl-p-nitrophenyl Phosphonate	2104-64-5					2.3E+00	9.9E+00		1.9E+00
1.10E-02	C	2.50E-06	C	5.00E-02	P	1.00E+00	I	V		4.80E+02	1.36E+09	5.67E+03	1		Ethylbenzene	100-41-4	6.3E+03		6.4E+02	5.8E+02	1.2E+04		1.8E+04	7.1E+03
				7.00E-02	P						1.36E+09		1	0.1	Ethylene Cyanohydrin	109-78-4					1.6E+04	6.9E+04		1.3E+04
				9.00E-02	P			V		1.89E+05	1.36E+09	1.80E+05	1		Ethylene Diamine	107-15-3					2.1E+04			2.1E+04
				8.00E-01	A	4.00E-01	C				1.36E+09		1	0.1	Ethylene Glycol	107-21-1					1.9E+05	7.9E+05	1.7E+09	1.5E+05
				1.00E-01	I	1.60E+00	I				1.36E+09		1	0.1	Ethylene Glycol Monobutyl Ether	111-76-2					2.3E+04	9.9E+04	6.8E+09	1.9E+04
3.10E-01	C	3.00E-03	I			3.00E-02	C	V	M	1.21E+05	1.36E+09	6.09E+03	1		Ethylene Oxide	75-21-8	4.9E+01		2.1E-01	2.0E-01			5.7E+02	5.7E+02
4.50E-02	C	1.30E-05	C	8.00E-05	I						1.36E+09		1	0.1	Ethylene Thiourea	96-45-7	1.5E+03	5.5E+03	2.9E+07	1.2E+03	1.9E+01	7.9E+01		1.5E+01
6.50E+01	C	1.90E-02	C					V		1.54E+05	1.36E+09	2.39E+04	1		Ethyleneimine	151-56-4	1.1E+00		3.5E-01	2.7E-01				
				3.00E+00	I						1.36E+09		1	0.1	Ethylphthalyl Ethyl Glycolate	84-72-0					7.0E+05	3.0E+06		5.7E+05
				2.50E-04	I						1.36E+09		1	0.1	Fenamiphos	22224-92-6					5.9E+01	2.5E+02		4.7E+01
				2.50E-02	I						1.36E+09		1	0.1	Fenpropathrin	39515-41-8					5.9E+03	2.5E+04		4.7E+03

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				2.50E-02	I						1.36E+09		1	0.1	Fenvalerate	51630-58-1					5.9E+03	2.5E+04		4.7E+03
				1.30E-02	I						1.36E+09		1	0.1	Fluometuron	2164-17-2					3.1E+03	1.3E+04		2.5E+03
				4.00E-02	C	1.30E-02	C				1.36E+09		1		Fluoride	16984-48-8					9.4E+03		5.5E+07	9.4E+03
				6.00E-02	I	1.30E-02	C				1.36E+09		1		Fluorine (Soluble Fluoride)	7782-41-4					1.4E+04		5.5E+07	1.4E+04
				8.00E-02	I						1.36E+09		1	0.1	Fluridone	59756-60-4					1.9E+04	7.9E+04		1.5E+04
				4.00E-02	O						1.36E+09		1	0.1	Flurprimidol	56425-91-3					9.4E+03	4.0E+04		7.6E+03
				2.00E-03	O						1.36E+09		1	0.1	Flusilazole	85509-19-9					4.7E+02	2.0E+03		3.8E+02
				5.00E-01	O						1.36E+09		1	0.1	Flutolanil	66332-96-5					1.2E+05	4.9E+05		9.5E+04
				1.00E-02	I						1.36E+09		1	0.1	Fluvalinate	69409-94-5					2.3E+03	9.9E+03		1.9E+03
				9.00E-02	O						1.36E+09		1	0.1	Folpet	133-07-3					2.1E+04	8.9E+04		1.7E+04
				1.00E-02	O						1.36E+09		1	0.1	Fomesafen	72178-02-0					2.3E+03	9.9E+03		1.9E+03
				2.00E-03	I						1.36E+09		1	0.1	Fonofos	944-22-9					4.7E+02	2.0E+03		3.8E+02
2.10E-02	C	1.30E-05	I	2.00E-01	I	9.82E-03	A	V		4.24E+04	1.36E+09	7.77E+04	1		Formaldehyde	50-00-0	3.3E+03		1.7E+03	1.1E+03	4.7E+04		2.4E+03	2.3E+03
				9.00E-01	P	3.00E-04	X	V		1.06E+05	1.36E+09	9.30E+04	1		Formic Acid	64-18-6					2.1E+05		8.7E+01	8.7E+01
				2.50E+00	O						1.36E+09		1	0.1	Fosetyl-AL	39148-24-8					5.9E+05	2.5E+06		4.7E+05
															Furans									
				1.00E-03	X			V			1.36E+09	1.56E+05	1		~Dibenzofuran	132-64-9					2.3E+02			2.3E+02
				1.00E-03	I			V		6.22E+03	1.36E+09	2.62E+03	1		~Furan	110-00-9					2.3E+02			2.3E+02
				9.00E-01	I	2.00E+00	I	V		1.65E+05	1.36E+09	1.20E+04	1		~Tetrahydrofuran	109-99-9					2.1E+05		7.5E+04	5.5E+04
3.80E+00	H										1.36E+09		1	0.1	Furazolidone	67-45-8	1.8E+01	6.5E+01		1.4E+01				
				3.00E-03	I	5.00E-02	H	V		1.01E+04	1.36E+09	4.86E+04	1		Furfural	98-01-1					7.0E+02		7.6E+03	6.4E+02
1.50E+00	C	4.30E-04	C								1.36E+09		1	0.1	Furium	531-82-8	4.6E+01	1.6E+02	8.9E+05	3.6E+01				
3.00E-02	I	8.60E-06	C								1.36E+09		1	0.1	Furmecyclox	60568-05-0	2.3E+03	8.2E+03	4.4E+07	1.8E+03				
				6.00E-03	O						1.36E+09		1	0.1	Glufosinate, Ammonium	77182-82-2					1.4E+03	5.9E+03		1.1E+03
				1.00E-01	A	8.00E-05	C				1.36E+09		1	0.1	Glutaraldehyde	111-30-8					2.3E+04	9.9E+04	3.4E+05	1.8E+04
				4.00E-04	I	1.00E-03	X	V		1.06E+05	1.36E+09	8.43E+04	1		Glycidaldehyde	765-34-4					9.4E+01		2.6E+02	6.9E+01
				1.00E-01	I						1.36E+09		1	0.1	Glyphosate	1071-83-6					2.3E+04	9.9E+04		1.9E+04
				1.00E-02	X			V			1.36E+09	1.45E+05	1		Guanidine	113-00-8					2.3E+03			2.3E+03
				2.00E-02	P						1.36E+09		1	0.1	Guanidine Chloride	50-01-1					4.7E+03	2.0E+04		3.8E+03
				3.00E-02	X						1.36E+09		1	0.1	Guanidine Nitrate	506-93-4					7.0E+03	3.0E+04		5.7E+03
				5.00E-01	I						1.36E+09		1	0.1	Haloxyfop, Methyl	69806-40-2					1.2E+01	4.9E+01		9.5E+00
4.50E+00	I	1.30E-03	I	1.00E-04	A			V			1.36E+09	4.79E+05	1		Heptachlor	76-44-8	1.5E+01		1.0E+02	1.3E+01	2.3E+01			2.3E+01
9.10E+00	I	2.60E-03	I	1.30E-05	I			V			1.36E+09	8.43E+05	1		Heptachlor Epoxide	1024-57-3	7.6E+00		9.1E+01	7.0E+00	3.1E+00			3.1E+00
						3.00E-03	X	V		2.09E+02	1.36E+09	7.80E+03	1		Heptanal, n-	111-71-7							7.3E+01	7.3E+01
				3.00E-04	X	4.00E-01	P	V		5.79E+01	1.36E+09	8.95E+02	1		Heptane, N-	142-82-5					7.0E+01		1.1E+03	6.6E+01
				2.00E-03	I			V			1.36E+09	3.80E+05	1		Hexabromobenzene	87-82-1					4.7E+02			4.7E+02
				2.00E-04	I						1.36E+09		1	0.1	Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					4.7E+01	2.0E+02		3.8E+01
1.60E+00	I	4.60E-04	I	1.00E-05	P			V			1.36E+09	6.80E+04	1		Hexachlorobenzene	118-74-1	4.3E+01		4.1E+01	2.1E+01	2.3E+00			2.3E+00
7.80E-02	I	2.20E-05	I	1.00E-03	P			V		1.68E+01	1.36E+09	1.08E+04	1		Hexachlorobutadiene	87-68-3	8.9E+02		1.4E+02	1.2E+02	2.3E+02			2.3E+02
6.30E+00	I	1.80E-03	I	9.00E-04	A						1.36E+09		1	0.1	Hexachlorocyclohexane, Alpha-	319-84-6	1.1E+01	3.9E+01	2.1E+05	8.6E+00	2.1E+02	8.9E+02		1.7E+02
1.80E+00	I	5.30E-04	I								1.36E+09		1	0.1	Hexachlorocyclohexane, Beta-	319-85-7	3.9E+01	1.4E+02	7.2E+05	3.0E+01				
1.10E+00	C	3.10E-04	C	3.00E-04	I						1.36E+09		1	0.04	Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	6.3E+01	5.6E+02	1.2E+06	5.7E+01	7.0E+01	7.4E+02		6.4E+01
1.80E+00	I	5.10E-04	I								1.36E+09		1	0.1	Hexachlorocyclohexane, Technical	608-73-1	3.9E+01	1.4E+02	7.5E+05	3.0E+01				
				6.00E-03	I	2.00E-04	I	V		1.57E+01	1.36E+09	8.51E+03	1		Hexachlorocyclopentadiene	77-47-4					1.4E+03		5.3E+00	5.3E+00
4.00E-02	I	1.10E-05	C	7.00E-04	I	3.00E-02	I	V			1.36E+09	8.01E+03	1		Hexachloroethane	67-72-1	1.7E+03		2.0E+02	1.8E+02	1.6E+02		7.5E+02	1.3E+02
				3.00E-04	I						1.36E+09		1	0.1	Hexachlorophene	70-30-4					7.0E+01	3.0E+02		5.7E+01
8.00E-02	I			4.00E-03	I						1.36E+09		1	0.015	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	8.7E+02	2.1E+04		8.3E+02	9.4E+02	2.6E+04		9.1E+02
						1.00E-05	I	V		3.39E+03	1.36E+09	3.00E+05	1		Hexamethylene Diisocyanate, 1,6-	822-06-0							9.4E+00	9.4E+00
						4.00E-04	C				1.36E+09		1	0.1	Hexamethylene diisocyanate biuret	4035-89-6							1.7E+06	1.7E+06
						4.00E-04	C				1.36E+09		1	0.1	Hexamethylene diisocyanate isocyanurate	3779-63-3							1.7E+06	1.7E+06
				4.00E-04	P						1.36E+09		1	0.1	Hexamethylphosphoramide	680-31-9					9.4E+01	4.0E+02		7.6E+01
		2.00E-07	X								6.00E-01	P	V	1.41E+02	1.36E+09	8.29E+02	1		Hexane, Commercial	E5241997			1.2E+03	1.2E+03			1.6E+03	1.6E+03
						7.00E-01	I	V		1.41E+02	1.36E+09	8.29E+02	1		Hexane, N-	110-54-3							1.8E+03	1.8E+03
				2.00E+00	P						1.36E+09		1	0.1	Hexanedioic Acid	124-04-9					4.7E+05	2.0E+06		3.8E+05
9.50E-03	P			7.00E-02	P	4.00E-04	P	V		2.74E+02	1.36E+09	3.62E+04	1		Hexanol, 1-,2-ethyl- (2-Ethyl-1-hexanol)	104-76-7	7.3E+03			7.3E+03	1.6E+04		4.5E+01	4.5E+01
				5.00E-03	I	3.00E-02	I	V		3.28E+03	1.36E+09	1.33E+04	1		Hexanone, 2-	591-78-6					1.2E+03		1.2E+03	6.0E+02
				3.30E-02	I						1.36E+09		1	0.1	Hexazinone	51235-04-2					7.7E+03	3.3E+04		6.3E+03
				2.50E-02	I						1.36E+09		1	0.1	Hexythiazox	78587-05-0					5.9E+03	2.5E+04		4.7E+03
				1.70E-02	O						1.36E+09		1	0.1	Hydramethylnon	67485-29-4					4.0E+03	1.7E+04		3.2E+03
3.00E+00	I	4.90E-03	I			3.00E-05	P	V		1.12E+05	1.36E+09	6.52E+04	1		Hydrazine	302-01-2	2.3E+01		3.7E+00	3.2E+00			6.1E+00	6.1E+00
3.00E+00	I	4.90E-03	I								1.36E+09		1		Hydrazine Sulfate	10034-93-2	2.3E+01		7.8E+04	2.3E+01				
						2.00E-02	I	V			1.36E+09		1		Hydrogen Chloride	7647-01-0							8.5E+07	8.5E+07
				4.00E-02	C	1.40E-02	C	V			1.36E+09		1		Hydrogen Fluoride	7664-39-3					9.4E+03		6.0E+07	9.4E+03
						2.00E-03	I	V			1.36E+09		1		Hydrogen Sulfide	7783-06-4							8.5E+06	8.5E+06
6.00E-02	P			4.00E-02	P						1.36E+09		1	0.1	Hydroquinone	123-31-9	1.2E+03	4.1E+03		9.0E+02	9.4E+03	4.0E+04		7.6E+03
6.11E-02	O			1.08E-01	O						1.36E+09		1	0.1	Imazalil	35554-44-0	1.1E+03	4.0E+03		8.9E+02	2.5E+04	1.1E+05		2.0E+04
				2.50E-01	I						1.36E+09		1	0.1	Imazaquin	81335-37-7					5.9E+04	2.5E+05		4.7E+04
				2.50E+00	O						1.36E+09		1	0.1	Imazethapyr	81335-77-5					5.9E+05	2.5E+06		4.7E+05
				1.00E-02	A						1.36E+09		1		Iodine	7553-56-2					2.3E+03			2.3E+03
				4.00E-02	I						1.36E+09		1	0.1	Iprodione	36734-19-7					9.4E+03	4.0E+04		7.6E+03
				7.00E-01	P						1.36E+09		1		Iron	7439-89-6					1.6E+05			1.6E+05
				3.00E-01	I	4.00E-01	X	V		1.00E+04	1.36E+09	2.81E+04	1		Isobutyl Alcohol	78-83-1					7.0E+04		3.5E+04	2.3E+04
9.50E-04	I			2.00E-01	I	2.00E+00	C				1.36E+09		1	0.1	Isophorone	78-59-1	7.3E+04	2.6E+05		5.7E+04	4.7E+04	2.0E+05	8.5E+09	3.8E+04
				1.50E-02	I			V			1.36E+09	4.20E+05	1		Isopropalin	33820-53-0					3.5E+03			3.5E+03
				2.00E+00	P	2.00E-01	P	V		1.09E+05	1.36E+09	2.77E+04	1		Isopropanol	67-63-0					4.7E+05		1.7E+04	1.7E+04
				1.00E-01	I						1.36E+09		1	0.1	Isopropyl Methyl Phosphonic Acid	1832-54-8					2.3E+04	9.9E+04		1.9E+04
				5.00E-02	I						1.36E+09		1	0.1	Isoxaben	82558-50-7					1.2E+04	4.9E+04		9.5E+03
						3.00E-01	A	V			1.36E+09		1		Jet propulsion fuel 7 (JP-7)	E1737665							1.3E+09	1.3E+09
				8.00E-03	O						1.36E+09		1	0.1	Lactofen	77501-63-4					1.9E+03	7.9E+03		1.5E+03
				2.00E-04	X						1.36E+09		1	0.1	Lactonitrile	78-97-7					4.7E+01	2.0E+02		3.8E+01
				5.00E-05	P						1.36E+09		1		Lanthanum	7439-91-0					1.2E+01			1.2E+01
				2.08E-05	P						1.36E+09		1	0.1	Lanthanum Acetate Hydrate	100587-90-4					4.9E+00	2.1E+01		3.9E+00
				1.87E-05	P						1.36E+09		1		Lanthanum Chloride Heptahydrate	10025-84-0					4.4E+00			4.4E+00

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				2.83E-05	P						1.36E+09		1		Lanthanum Chloride, Anhydrous	10099-58-8					6.6E+00			6.6E+00
				1.60E-05	P						1.36E+09		1		Lanthanum Nitrate Hexahydrate	10277-43-7					3.8E+00			3.8E+00
															Lead Compounds									
8.50E-03	C	1.20E-05	C								1.36E+09		1		~Lead Phosphate	7446-27-7	8.2E+03		3.2E+07	8.2E+03				
2.10E-01	C	8.00E-05	C								1.36E+09		1	0.1	~Lead acetate	301-04-2	3.3E+02	1.2E+03	4.8E+06	2.6E+02				
											1.36E+09		1		~Lead and Compounds	7439-92-1								2.0E+02
											1.36E+09		1		~Lead and Compounds (with other sources of lead present, see Guidance)	7439-92-1								1.0E+02
3.80E-02	C	1.10E-05	C								1.36E+09		1	0.1	~Lead subacetate	1335-32-6	1.8E+03	6.5E+03	3.5E+07	1.4E+03				
				1.00E-07	I			V		2.43E+00	1.36E+09	1.91E+03	1		~Tetraethyl Lead	78-00-2					2.3E-02			2.3E-02
				5.00E-06	P			V		3.83E+02	1.36E+09	2.55E+04	1		Lewisite	541-25-3					1.2E+00			1.2E+00
				7.70E-03	O						1.36E+09		1	0.1	Linuron	330-55-2					1.8E+03	7.6E+03		1.5E+03
				2.00E-03	P						1.36E+09		1		Lithium	7439-93-2					4.7E+02			4.7E+02
				5.00E-04	I						1.36E+09		1	0.1	MCPA	94-74-6					1.2E+02	4.9E+02		9.5E+01
				4.40E-02	O						1.36E+09		1	0.1	MCPB	94-81-5					1.0E+04	4.4E+04		8.3E+03
				1.00E-03	I						1.36E+09		1	0.1	MCPP	93-65-2					2.3E+02	9.9E+02		1.9E+02
				2.00E-02	I						1.36E+09		1	0.1	Malathion	121-75-5					4.7E+03	2.0E+04		3.8E+03
				1.00E-01	I	7.00E-04	C				1.36E+09		1	0.1	Maleic Anhydride	108-31-6					2.3E+04	9.9E+04	3.0E+06	1.9E+04
				5.00E-01	I						1.36E+09		1	0.1	Maleic Hydrazide	123-33-1					1.2E+05	4.9E+05		9.5E+04
				1.00E-04	P						1.36E+09		1	0.1	Malononitrile	109-77-3					2.3E+01	9.9E+01		1.9E+01
				3.00E-02	H						1.36E+09		1	0.1	Mancozeb	8018-01-7					7.0E+03	3.0E+04		5.7E+03
				5.00E-03	I						1.36E+09		1	0.1	Maneb	12427-38-2					1.2E+03	4.9E+03		9.5E+02
				1.40E-01	I	5.00E-05	I						1		Manganese (Diet)	7439-96-5								
				2.40E-02	G	5.00E-05	I				1.36E+09		0.04		Manganese (Non-diet)	7439-96-5					5.6E+03		2.1E+05	5.5E+03
				9.00E-05	H						1.36E+09		1	0.1	Mephosfolan	950-10-7					2.1E+01	8.9E+01		1.7E+01
				3.00E-02	I						1.36E+09		1	0.1	Mepiquat Chloride	24307-26-4					7.0E+03	3.0E+04		5.7E+03
1.10E-02	P			4.00E-03	P						1.36E+09		1	0.1	Mercaptobenzothiazole, 2-	149-30-4	6.3E+03	2.2E+04		4.9E+03	9.4E+02	4.0E+03		7.6E+02
															Mercury Compounds									
				3.00E-04	I	3.00E-04	G				1.36E+09		0.07		~Mercuric Chloride (and other Mercury salts)	7487-94-7					7.0E+01		1.3E+06	7.0E+01
						3.00E-04	I	V		3.13E+00	1.36E+09	3.47E+04	1		~Mercury (elemental)	7439-97-6							3.3E+01	3.3E+01
				1.00E-04	I						1.36E+09		1		~Methyl Mercury	22967-92-6					2.3E+01			2.3E+01
				8.00E-05	I						1.36E+09		1	0.1	~Phenylmercuric Acetate	62-38-4					1.9E+01	7.9E+01		1.5E+01
				3.00E-05	I			V			1.36E+09	1.94E+06	1		Merphos	150-50-5					7.0E+00			7.0E+00
				6.00E-02	I						1.36E+09		1	0.1	Metalaxyl	57837-19-1					1.4E+04	5.9E+04		1.1E+04
				1.00E-04	I	3.00E-02	P	V		4.58E+03	1.36E+09	6.79E+03	1		Methacrylonitrile	126-98-7					2.3E+01		6.4E+02	2.3E+01
				5.00E-05	I						1.36E+09		1	0.1	Methamidophos	10265-92-6					1.2E+01	4.9E+01		9.5E+00
				2.00E+00	I	2.00E+01	I	V		1.06E+05	1.36E+09	2.90E+04	1		Methanol	67-56-1					4.7E+05		1.8E+06	3.7E+05
				1.50E-03	O						1.36E+09		1	0.1	Methidathion	950-37-8					3.5E+02	1.5E+03		2.8E+02
				2.50E-02	I						1.36E+09		1	0.1	Methomyl	16752-77-5					5.9E+03	2.5E+04		4.7E+03
4.90E-02	C										1.36E+09		1	0.1	Methoxy-5-nitroaniline, 2-	99-59-2	1.4E+03	5.0E+03		1.1E+03				
				5.00E-03	I						1.36E+09		1	0.1	Methoxychlor	72-43-5					1.2E+03	4.9E+03		9.5E+02
				8.00E-03	P	1.00E-03	P	V		1.15E+05	1.36E+09	1.24E+05	1		Methoxyethanol Acetate, 2-	110-49-6					1.9E+03		3.9E+02	3.2E+02
				5.00E-03	P	7.00E-03	P	V		1.06E+05	1.36E+09	1.01E+05	1		Methoxyethanol, 2-	109-86-4					1.2E+03		2.2E+03	7.7E+02
				1.00E+00	X			V		2.90E+04	1.36E+09	8.12E+03	1		Methyl Acetate	79-20-9					2.3E+05			2.3E+05
						2.00E-02	P	V		6.75E+03	1.36E+09	6.97E+03	1		Methyl Acrylate	96-33-3							4.4E+02	4.4E+02
				6.00E-01	I	5.00E+00	I	V		2.84E+04	1.36E+09	1.22E+04	1		Methyl Ethyl Ketone (2-Butanone)	78-93-3					1.4E+05		1.9E+05	8.1E+04
		1.00E-03	X	1.00E-03	P	2.00E-05	X	V		1.80E+05	1.36E+09	5.04E+04	1		Methyl Hydrazine	60-34-4			1.4E+01	1.4E+01	2.3E+02		3.2E+00	3.1E+00
						3.00E+00	I	V		3.36E+03	1.36E+09	1.06E+04	1		Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1							9.9E+04	9.9E+04
						1.00E-03	C	V		1.01E+04	1.36E+09	4.42E+03	1		Methyl Isocyanate	624-83-9							1.4E+01	1.4E+01
				1.40E+00	I	7.00E-01	I	V		2.36E+03	1.36E+09	6.33E+03	1		Methyl Methacrylate	80-62-6					3.3E+05		1.4E+04	1.3E+04
				2.50E-04	I						1.36E+09		1	0.1	Methyl Parathion	298-00-0					5.9E+01	2.5E+02		4.7E+01
				6.00E-02	X						1.36E+09		1	0.1	Methyl Phosphonic Acid	993-13-5					1.4E+04	5.9E+04		1.1E+04
				6.00E-03	H	4.00E-02	H	V		3.93E+02	1.36E+09	2.43E+04	1		Methyl Styrene (Mixed Isomers)	25013-15-4					1.4E+03		3.0E+03	9.6E+02
9.90E-02	C	2.80E-05	C								1.36E+09		1	0.1	Methyl methanesulfonate	66-27-3	7.0E+02	2.5E+03	1.4E+07	5.5E+02				
1.80E-03	C	2.60E-07	C			3.00E+00	I	V		8.87E+03	1.36E+09	4.90E+03	1		Methyl tert-Butyl Ether (MTBE)	1634-04-4	3.9E+04		5.3E+03	4.7E+03			4.6E+04	4.6E+04
				3.00E-04	X						1.36E+09		1	0.1	Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					7.0E+01	3.0E+02		5.7E+01
						3.00E+00	X	V		2.45E+03	1.36E+09	1.72E+04	1		Methyl-2-Pentanol, 4-	108-11-2							1.6E+05	1.6E+05
9.00E-03	P			2.00E-02	X						1.36E+09		1	0.1	Methyl-5-Nitroaniline, 2-	99-55-8	7.7E+03	2.7E+04		6.0E+03	4.7E+03	2.0E+04		3.8E+03
8.30E+00	C	2.40E-03	C								1.36E+09		1	0.1	Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	8.4E+00	3.0E+01	1.6E+05	6.5E+00				
1.30E-01	C	3.70E-05	C								1.36E+09		1	0.1	Methylaniline Hydrochloride, 2-	636-21-5	5.3E+02	1.9E+03	1.0E+07	4.2E+02				
				1.00E-02	A						1.36E+09		1	0.1	Methylarsonic acid	124-58-3					2.3E+03	9.9E+03		1.9E+03
				2.00E-04	X						1.36E+09		1	0.1	Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					4.7E+01	2.0E+02		3.8E+01
1.00E-01	X			3.00E-04	X						1.36E+09		1	0.1	Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	7.0E+02	2.5E+03		5.4E+02	7.0E+01	3.0E+02		5.7E+01
2.20E+01	C	6.30E-03	C						M		1.36E+09		1	0.1	Methylcholanthrene, 3-	56-49-5	7.0E-01	2.7E+00	2.2E+04	5.5E-01				
						9.50E-02	X	V		6.76E+01	1.36E+09	9.90E+02	1		Methylcyclohexane	108-87-2						2.9E+02		2.9E+02
2.00E-03	I	1.00E-08	I	6.00E-03	I	6.00E-01	I	V	M	3.32E+03	1.36E+09	2.19E+03	1		Methylene Chloride	75-09-2	7.7E+03		2.2E+04	5.7E+03	1.4E+03		4.1E+03	1.0E+03
1.00E-01	P	4.30E-04	C	2.00E-03	P				M		1.36E+09		1	0.1	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.5E+02	6.0E+02	3.2E+05	1.2E+02	4.7E+02	2.0E+03		3.8E+02
4.60E-02	I	1.30E-05	C								1.36E+09		1	0.1	Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.5E+03	5.4E+03	2.9E+07	1.2E+03				
1.60E+00	C	4.60E-04	C			2.00E-02	C				1.36E+09		1	0.1	Methylenebisbenzenamine, 4,4'-	101-77-9	4.3E+01	1.5E+02	8.3E+05	3.4E+01			8.5E+07	8.5E+07
						6.00E-04	I				1.36E+09		1	0.1	Methylenediphenyl Diisocyanate	101-68-8							2.6E+06	2.6E+06
				7.00E-02	H			V		5.00E+02	1.36E+09	1.28E+04	1		Methylstyrene, Alpha-	98-83-9					1.6E+04			1.6E+04
				1.50E-01	I						1.36E+09		1	0.1	Metolachlor	51218-45-2					3.5E+04	1.5E+05		2.8E+04
				2.50E-02	I						1.36E+09		1	0.1	Metribuzin	21087-64-9					5.9E+03	2.5E+04		4.7E+03
				2.50E-01	I						1.36E+09		1	0.1	Metsulfuron-methyl	74223-64-6					5.9E+04	2.5E+05		4.7E+04
		4.50E-06	X	1.00E-02	X	1.00E-01	P	V		6.86E+00	1.36E+09	1.04E+03	1		Midrange Aliphatic Hydrocarbon Streams	E1790669			6.5E+01	6.5E+01	2.3E+03		3.3E+02	2.9E+02
				3.00E+00	P			V		3.42E-01	1.36E+09	1.38E+03	1		Mineral oils	8012-95-1					7.0E+05			7.0E+05
1.80E+01	C	5.10E-03	C	2.00E-04	I			V			1.36E+09	8.58E+05	1		Mirex	2385-85-5	3.9E+00		4.7E+01	3.6E+00	4.7E+01			4.7E+01
				2.00E-03	I						1.36E+09		1	0.1	Molinate	2212-67-1					4.7E+02	2.0E+03		3.8E+02
				5.00E-03	I	2.00E-03	A				1.36E+09		1		Molybdenum	7439-98-7					1.2E+03		8.5E+06	1.2E+03
				1.00E-01	I						1.36E+09		1		Monochloramine	10599-90-3					2.3E+04			2.3E+04
				2.00E-03	P						1.36E+09		1	0.1	Monomethylaniline	100-61-8					4.7E+02	2.0E+03		3.8E+02
				2.50E-02	I						1.36E+09		1	0.1	Myclobutanil	88671-89-0					5.9E+03	2.5E+04		4.7E+03
				3.00E-04	X						1.36E+09		1	0.1	N,N'-Diphenyl-1,4-benzenediamine	74-31-7					7.0E+01	3.0E+02		5.7E+01
				2.00E-03	I			V			1.36E+09	5.70E+04	1		Naled	300-76-5					4.7E+02			4.7E+02

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				3.00E-02	X	1.00E-01	P	V			1.36E+09		1		Naphtha, High Flash Aromatic (HFAN)	64742-95-6					7.0E+03		4.3E+08	7.0E+03
1.80E+00	C	0.00E+00	C								1.36E+09		1	0.1	Naphthylamine, 2-	91-59-8	3.9E+01	1.4E+02		3.0E+01				
				1.20E-01	O						1.36E+09		1	0.1	Napropamide	15299-99-7					2.8E+04	1.2E+05		2.3E+04
		2.60E-04	C	1.10E-02	C	1.40E-05	C				1.36E+09		1	0.1	Nickel Acetate	373-02-4			1.5E+06	1.5E+06	2.6E+03	1.1E+04	6.0E+04	2.0E+03
		2.60E-04	C	1.10E-02	C	1.40E-05	C				1.36E+09		1	0.1	Nickel Carbonate	3333-67-3			1.5E+06	1.5E+06	2.6E+03	1.1E+04	6.0E+04	2.0E+03
		2.60E-04	C	1.10E-02	C	1.40E-05	C	V			1.36E+09		1		Nickel Carbonyl	13463-39-3			1.5E+06	1.5E+06	2.6E+03		6.0E+04	2.5E+03
		2.60E-04	C	1.10E-02	C	1.40E-05	C				1.36E+09		0.04		Nickel Hydroxide	12054-48-7			1.5E+06	1.5E+06	2.6E+03		6.0E+04	2.5E+03
		2.60E-04	C	1.10E-02	C	2.00E-05	C				1.36E+09		0.04		Nickel Oxide	1313-99-1			1.5E+06	1.5E+06	2.6E+03		8.5E+04	2.5E+03
		2.40E-04	I	1.10E-02	C	1.40E-05	C				1.36E+09		0.04		Nickel Refinery Dust	E715532			1.6E+06	1.6E+06	2.6E+03		6.0E+04	2.5E+03
		2.60E-04	C	2.00E-02	I	1.00E-05	T				1.36E+09		0.04		Nickel Soluble Salts	7440-02-0			1.5E+06	1.5E+06	4.7E+03		4.3E+04	4.2E+03
1.70E+00	C	4.80E-04	I	1.10E-02	C	1.40E-05	C				1.36E+09		0.04		Nickel Subsulfide	12035-72-2	4.1E+01		8.0E+05	4.1E+01	2.6E+03		6.0E+04	2.5E+03
9.10E-01	C	2.60E-04	C	1.10E-02	C	1.40E-05	C				1.36E+09		1	0.1	Nickelocene	1271-28-9	7.6E+01	2.7E+02	1.5E+06	6.0E+01	2.6E+03	1.1E+04	6.0E+04	2.0E+03
				1.60E+00	I						1.36E+09		1		Nitrate (measured as nitrogen)	14797-55-8					3.8E+05			3.8E+05
											1.36E+09		1		Nitrate + Nitrite (measured as nitrogen)	E701177								
				1.00E-01	I						1.36E+09		1		Nitrite (measured as nitrogen)	14797-65-0					2.3E+04			2.3E+04
				1.00E-02	X	5.00E-05	X				1.36E+09		1	0.1	Nitroaniline, 2-	88-74-4					2.3E+03	9.9E+03	2.1E+05	1.9E+03
2.00E-02	P			4.00E-03	P	6.00E-03	P				1.36E+09		1	0.1	Nitroaniline, 4-	100-01-6	3.5E+03	1.2E+04		2.7E+03	9.4E+02	4.0E+03	2.6E+07	7.6E+02
		4.00E-05	I	2.00E-03	I	9.00E-03	I	V		3.05E+03	1.36E+09	7.32E+04	1		Nitrobenzene	98-95-3			5.1E+02	5.1E+02	4.7E+02		2.1E+03	3.8E+02
				3.00E+03	P						1.36E+09		1	0.1	Nitrocellulose	9004-70-0					7.0E+08	3.0E+09		5.7E+08
				7.00E-02	H						1.36E+09		1	0.1	Nitrofurantoin	67-20-9					1.6E+04	6.9E+04		1.3E+04
1.30E+00	C	3.70E-04	C								1.36E+09		1	0.1	Nitrofurazone	59-87-0	5.3E+01	1.9E+02	1.0E+06	4.2E+01				
1.70E-02	P			1.00E-04	P						1.36E+09		1	0.1	Nitroglycerin	55-63-0	4.1E+03	1.5E+04		3.2E+03	2.3E+01	9.9E+01		1.9E+01
				1.00E-01	I						1.36E+09		1	0.1	Nitroguanidine	556-88-7					2.3E+04	9.9E+04		1.9E+04
		8.80E-06	P			5.00E-03	P	V		1.80E+04	1.36E+09	1.69E+04	1		Nitromethane	75-52-5			5.4E+02	5.4E+02			2.6E+02	2.6E+02
		5.80E-04	X			2.00E-02	I	V		4.86E+03	1.36E+09	1.31E+04	1		Nitropropane, 2-	79-46-9			6.4E+00	6.4E+00			8.2E+02	8.2E+02
2.70E+01	C	7.70E-03	C						M		1.36E+09		1	0.1	Nitroso-N-ethylurea, N-	759-73-9	5.7E-01	2.2E+00	1.8E+04	4.5E-01				
1.20E+02	C	3.40E-02	C						M		1.36E+09		1	0.1	Nitroso-N-methylurea, N-	684-93-5	1.3E-01	5.0E-01	4.1E+03	1.0E-01				
5.40E+00	I	1.60E-03	I					V			1.36E+09	2.43E+05	1		Nitrosodibutylamine, N-	924-16-3	1.3E+01		4.3E+01	9.9E+00				
2.80E+00	I	8.00E-04	C								1.36E+09		1	0.1	Nitrosodiethanolamine, N-	1116-54-7	2.5E+01	8.8E+01	4.8E+05	1.9E+01				
1.50E+02	I	4.30E-02	I						M		1.36E+09		1	0.1	Nitrosodiethylamine, N-	55-18-5	1.0E-01	4.0E-01	3.2E+03	8.1E-02				
5.10E+01	I	1.40E-02	I	8.00E-06	P	4.00E-05	X	V	M	2.37E+05	1.36E+09	8.23E+04	1		Nitrosodimethylamine, N-	62-75-9	3.0E-01		6.0E-01	2.0E-01	1.9E+00		1.0E+01	1.6E+00
4.90E-03	I	2.60E-06	C								1.36E+09		1	0.1	Nitrosodiphenylamine, N-	86-30-6	1.4E+04	5.0E+04	1.5E+08	1.1E+04				
7.00E+00	I	2.00E-03	C								1.36E+09		1	0.1	Nitrosodipropylamine, N-	621-64-7	9.9E+00	3.5E+01	1.9E+05	7.8E+00				
2.20E+01	I	6.30E-03	C					V		1.08E+05	1.36E+09	1.21E+05	1		Nitrosomethylethylamine, N-	10595-95-6	3.2E+00		5.4E+00	2.0E+00				
6.70E+00	C	1.90E-03	C								1.36E+09		1	0.1	Nitrosomorpholine [N-]	59-89-2	1.0E+01	3.7E+01	2.0E+05	8.1E+00				
9.40E+00	C	2.70E-03	C								1.36E+09		1	0.1	Nitrosopiperidine [N-]	100-75-4	7.4E+00	2.6E+01	1.4E+05	5.8E+00				
2.10E+00	I	6.10E-04	I								1.36E+09		1	0.1	Nitrosopyrrolidine, N-	930-55-2	3.3E+01	1.2E+02	6.3E+05	2.6E+01				
				1.00E-04	X						1.36E+09		1	0.1	Nitrotoluene, m-	99-08-1					2.3E+01	9.9E+01		1.9E+01
2.20E-01	P			9.00E-04	P			V		1.51E+03	1.36E+09	1.37E+05	1		Nitrotoluene, o-	88-72-2	3.2E+02			3.2E+02	2.1E+02			2.1E+02
1.60E-02	P			4.00E-03	P						1.36E+09		1	0.1	Nitrotoluene, p-	99-99-0	4.3E+03	1.5E+04		3.4E+03	9.4E+02	4.0E+03		7.6E+02
		3.00E-04	X	2.00E-02	P	V				6.86E+00	1.36E+09	1.04E+03	1		Nonane, n-	111-84-2					7.0E+01		6.5E+01	3.4E+01
		1.50E-03	O								1.36E+09		1	0.1	Norflurazon	27314-13-2					3.5E+02	1.5E+03		2.8E+02
		3.00E-03	I								1.36E+09		1	0.1	Octabromodiphenyl Ether	32536-52-0					7.0E+02	3.0E+03		5.7E+02
		5.00E-02	I								1.36E+09		1	0.006	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0					1.2E+04	8.2E+05		1.2E+04
		2.00E-03	H								1.36E+09		1	0.1	Octamethylpyrophosphoramide	152-16-9					4.7E+02	2.0E+03		3.8E+02
7.79E-03	O			1.90E-01	O						1.36E+09		1	0.1	Oryzalin	19044-88-3	8.9E+03	3.2E+04		7.0E+03	4.5E+04	1.9E+05		3.6E+04
				5.00E-03	I						1.36E+09		1	0.1	Oxadiazon	19666-30-9					1.2E+03	4.9E+03		9.5E+02
				2.50E-02	I						1.36E+09		1	0.1	Oxamyl	23135-22-0					5.9E+03	2.5E+04		4.7E+03
7.32E-02	O			4.00E-02	O						1.36E+09		1	0.1	Oxyfluorfen	42874-03-3	9.5E+02	3.4E+03		7.4E+02	9.4E+03	4.0E+04		7.6E+03
				1.30E-02	I						1.36E+09		1	0.1	Paclobutrazol	76738-62-0					3.1E+03	1.3E+04		2.5E+03
				4.50E-03	I						1.36E+09		1	0.1	Paraquat Dichloride	1910-42-5					1.1E+03	4.4E+03		8.5E+02
				6.00E-03	H						1.36E+09		1	0.1	Parathion	56-38-2					1.4E+03	5.9E+03		1.1E+03
				5.00E-02	H			V			1.36E+09	4.49E+04	1		Pebulate	1114-71-2					1.2E+04			1.2E+04
				3.00E-01	O						1.36E+09		1	0.1	Pendimethalin	40487-42-1					7.0E+04	3.0E+05		5.7E+04
				2.00E-03	I			V		3.12E-01	1.36E+09	5.13E+05	1		Pentabromodiphenyl Ether	32534-81-9					4.7E+02			4.7E+02
				1.00E-04	I						1.36E+09		1	0.1	Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					2.3E+01	9.9E+01		1.9E+01
				8.00E-04	I			V			1.36E+09	8.12E+04	1		Pentachlorobenzene	608-93-5					1.9E+02			1.9E+02
9.00E-02	P							V		4.57E+02	1.36E+09	9.65E+03	1		Pentachloroethane	76-01-7	7.7E+02			7.7E+02				
2.60E-01	H			3.00E-03	I			V			1.36E+09	4.32E+05	1		Pentachloronitrobenzene	82-68-8	2.7E+02			2.7E+02	7.0E+02			7.0E+02
4.00E-01	I	5.10E-06	C	5.00E-03	I						1.36E+09		1	0.25	Pentachlorophenol	87-86-5	1.7E+02	2.5E+02	7.5E+07	1.0E+02	1.2E+03	2.0E+03		7.4E+02
4.30E-03	X			9.00E-03	P						1.36E+09		1	0.1	Pentaerythritol tetranitrate (PETN)	78-11-5	1.6E+04	5.7E+04		1.3E+04	2.1E+03	8.9E+03		1.7E+03
				1.00E-04	X						1.36E+09		1	0.1	Pentamethylphosphoramide (PMPA)	10159-46-3					2.3E+01	9.9E+01		1.9E+01
						1.00E+00	P	V		3.88E+02	1.36E+09	7.79E+02	1		Pentane, n-	109-66-0							2.4E+03	2.4E+03
															Per- and Polyfluoroalkyl Substances (PFAS)									
				3.00E-06	D						1.36E+09		1	0.1	~Ammonium perfluoro-2-methyl-3-oxahexanoate	62037-80-3					7.0E-01	3.0E+00		5.7E-01
				1.00E-03	I			V		2.68E+02	1.36E+09	5.98E+04	1		~Ammonium perfluorobutanoate	10495-86-0					2.3E+02			2.3E+02
		5.00E-04	I								1.36E+09		1	0.1	~Ammonium perfluorohexanoate	21615-47-4					1.2E+02	4.9E+02		9.5E+01
2.93E+04	D			3.00E-08	D						1.36E+09		1	0.1	~Ammonium perfluorooctanoate	3825-26-1	2.4E-03	8.4E-03		1.9E-03	7.0E-03	3.0E-02		5.7E-03
				3.00E-04	R			V			1.36E+09	5.53E+04	1		~Bis(trifluoromethylsulfonyl)amine (TFSI)	82113-65-3					7.0E+01			7.0E+01
		3.00E-06	D					V		1.92E+06	1.36E+09	4.97E+04	1		~Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6					7.0E-01			7.0E-01
		3.00E-04	R					V			1.36E+09	5.41E+04	1		~Lithium bis[(trifluoromethyl)sulfonyl]azanide	90076-65-6					7.0E+01			7.0E+01
		3.00E-04	P								1.36E+09		1	0.1	~Perfluorobutanesulfonate	45187-15-3					7.0E+01	3.0E+02		5.7E+01
		3.00E-04	P								1.36E+09		1	0.1	~Perfluorobutanesulfonic acid (PFBS)	375-73-5					7.0E+01	3.0E+02		5.7E+01
		1.00E-03	I					V		2.56E+03	1.36E+09	5.85E+04	1		~Perfluorobutanoate	45048-62-2					2.3E+02			2.3E+02
		1.00E-03	I					V		2.57E+03	1.36E+09	3.06E+04	1		~Perfluorobutanoic acid (PFBA)	375-22-4					2.3E+02			2.3E+02
		5.00E-05	N								1.36E+09		1	0.1	~Perfluorododecanoic acid (PFDoDA)	307-55-1					1.2E+01	4.9E+01		9.5E+00
		2.00E-05	A								1.36E+09		1	0.1	~Perfluorohexanesulfonate	108427-53-8					4.7E+00	2.0E+01		3.8E+00
		2.00E-05	A								1.36E+09		1	0.1	~Perfluorohexanesulfonic acid (PFHxS)	355-46-4					4.7E+00	2.0E+01		3.8E+00
		5.00E-04	I								1.36E+09		1	0.1	~Perfluorohexanoate	92612-52-7					1.2E+02	4.9E+02		9.5E+01
		5.00E-04	I								1.36E+09		1	0.1	~Perfluorohexanoic acid (PFHxA)	307-24-4					1.2E+02	4.9E+02		9.5E+01
		3.00E-06	A								1.36E+09		1	0.1	~Perfluorononanoate	72007-68-2					7.0E-01	3.0E+00		5.7E-01
		3.00E-06	A								1.36E+09		1	0.1	~Perfluorononanoic acid (PFNA)	375-95-1					7.0E-01	3.0E+00		5.7E-01
		4.00E-02	N								1.36E+09		1	0.1	~Perfluorooctadecanoic acid (PFODA)	16517-11-6					9.4E+03	4.0E+04		7.6E+03

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
3.95E+01	D			1.00E-07	D						1.36E+09		1	0.1	~Perfluorooctanesulfonate	45298-90-6	1.8E+00	6.3E+00		1.4E+00	2.3E-02	9.9E-02		1.9E-02
3.95E+01	D			1.00E-07	D						1.36E+09		1	0.1	~Perfluorooctanesulfonic acid (PFOS)	1763-23-1	1.8E+00	6.3E+00		1.4E+00	2.3E-02	9.9E-02		1.9E-02
2.93E+04	D			3.00E-08	D						1.36E+09		1	0.1	~Perfluorooctanoate	45285-51-6	2.4E-03	8.4E-03		1.9E-03	7.0E-03	3.0E-02		5.7E-03
2.93E+04	D			3.00E-08	D						1.36E+09		1	0.1	~Perfluorooctanoic acid (PFOA)	335-67-1	2.4E-03	8.4E-03		1.9E-03	7.0E-03	3.0E-02		5.7E-03
				5.00E-04	R			V		1.36E+04	1.36E+09	2.65E+04	1		~Perfluoropropanoic acid (PFPrA)	422-64-0					1.2E+02			1.2E+02
				1.00E-03	N						1.36E+09		1	0.1	~Perfluorotetradecanoic acid (PFTetDA)	376-06-7					2.3E+02	9.9E+02		1.9E+02
				3.00E-04	N						1.36E+09		1	0.1	~Perfluoroundecanoic acid (PFUDA)	2058-94-8					7.0E+01	3.0E+02		5.7E+01
				2.00E-03	I			V		9.61E+04	1.36E+09	6.13E+04	1		~Potassium heptafluorobutanoate	2966-54-3					4.7E+02			4.7E+02
				3.00E-04	P						1.36E+09		1	0.1	~Potassium perfluorobutanesulfonate	29420-49-3					7.0E+01	3.0E+02		5.7E+01
3.95E+01	D			1.00E-07	D						1.36E+09		1	0.1	~Potassium perfluorooctanesulfonate	2795-39-3	1.8E+00	6.3E+00		1.4E+00	2.3E-02	9.9E-02		1.9E-02
				1.00E-03	I			V		8.99E+04	1.36E+09	6.02E+04	1		~Sodium perfluorobutanoate	2218-54-4					2.3E+02			2.3E+02
				5.00E-04	I						1.36E+09		1	0.1	~Sodium perfluorohexanoate	2923-26-4					1.2E+02	4.9E+02		9.5E+01
															Perchlorates									
				7.00E-04	I						1.36E+09		1		~Ammonium Perchlorate	7790-98-9					1.6E+02			1.6E+02
				7.00E-04	I						1.36E+09		1		~Lithium Perchlorate	7791-03-9					1.6E+02			1.6E+02
				7.00E-04	I						1.36E+09		1		~Perchlorate and Perchlorate Salts	14797-73-0					1.6E+02			1.6E+02
				7.00E-04	I						1.36E+09		1		~Potassium Perchlorate	7778-74-7					1.6E+02			1.6E+02
				7.00E-04	I						1.36E+09		1		~Sodium Perchlorate	7601-89-0					1.6E+02			1.6E+02
				5.00E-02	I						1.36E+09		1	0.1	Permethrin	52645-53-1					1.2E+04	4.9E+04		9.5E+03
2.20E-03	C	6.30E-07	C								1.36E+09		1	0.1	Phenacetin	62-44-2	3.2E+04	1.1E+05	6.1E+08	2.5E+04				
				2.40E-01	O						1.36E+09		1	0.1	Phenmedipham	13684-63-4					5.6E+04	2.4E+05		4.6E+04
				3.00E-01	I	2.00E-01	C				1.36E+09		1	0.1	Phenol	108-95-2					7.0E+04	3.0E+05	8.5E+08	5.7E+04
				4.00E-03	I						1.36E+09		1	0.1	Phenol, 2-(1-methylethoxy)-, methylcarbamate	114-26-1					9.4E+02	4.0E+03		7.6E+02
				5.00E-04	X						1.36E+09		1	0.1	Phenothiazine	92-84-2					1.2E+02	4.9E+02		9.5E+01
				2.00E-04	X			V		1.29E+02	1.36E+09	7.06E+03	1		Phenyl Isothiocyanate	103-72-0					4.7E+01			4.7E+01
				6.00E-03	I						1.36E+09		1	0.1	Phenylenediamine, m-	108-45-2					1.4E+03	5.9E+03		1.1E+03
1.20E-01	P			4.00E-03	P						1.36E+09		1	0.1	Phenylenediamine, o-	95-54-5	5.8E+02	2.1E+03		4.5E+02	9.4E+02	4.0E+03		7.6E+02
				1.00E-03	X						1.36E+09		1	0.1	Phenylenediamine, p-	106-50-3					2.3E+02	9.9E+02		1.9E+02
1.94E-03	H										1.36E+09		1	0.1	Phenylphenol, 2-	90-43-7	3.6E+04	1.3E+05		2.8E+04				
				2.00E-04	H						1.36E+09		1	0.1	Phorate	298-02-2					4.7E+01	2.0E+02		3.8E+01
						3.00E-04	I	V		1.61E+03	1.36E+09	9.81E+02	1		Phosgene	75-44-5							9.2E-01	9.2E-01
				2.00E-02	I						1.36E+09		1	0.1	Phosmet	732-11-6					4.7E+03	2.0E+04		3.8E+03
															Phosphates, Inorganic									
				2.93E+00	X						1.36E+09		1		~Aluminum metaphosphate	13776-88-0					6.9E+05			6.9E+05
				3.00E-01	X						1.36E+09		1		~Aluminum salts of inorganic phosphates	E524680405					7.0E+04			7.0E+04
				1.00E+00	P						1.36E+09		1		~Dipotassium phosphate	7758-11-4					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Disodium phosphate	7558-79-4					2.3E+05			2.3E+05
				3.54E+00	X						1.36E+09		1		~Monoaluminum phosphate	13530-50-2					8.3E+05			8.3E+05
				1.00E+00	P						1.36E+09		1		~Monopotassium phosphate	7778-77-0					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Monosodium phosphate	7558-80-7					2.3E+05			2.3E+05
				1.36E+00	X						1.36E+09		1	0.1	~Phosphoric acid, aluminum salt (1:1) [aluminum phosphate]	7784-30-7					3.2E+05	1.3E+06		2.6E+05
				4.26E+00	X						1.36E+09		1		~Phosphoric acid, aluminum sodium salt (1:X:X) [sodium aluminum phosphate acidic (acidic SALP)]	7785-88-8					1.0E+06			1.0E+06
				1.00E+00	P						1.36E+09		1		~Polyphosphoric acid	8017-16-1					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Potassium salts of inorganic phosphates	E524680403					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Potassium tripolyphosphate	13845-36-8					2.3E+05			2.3E+05
				4.99E+00	X						1.36E+09		1		~Sodium aluminum phosphate (anhydrous)	10279-59-1					1.2E+06			1.2E+06
				3.52E+00	X						1.36E+09		1		~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					8.3E+05			8.3E+05
				1.00E+00	P						1.36E+09		1		~Sodium hexametaphosphate	10124-56-8					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Sodium polyphosphate	68915-31-1					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Sodium pyrophosphate	7758-16-9					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Sodium salts of inorganic phosphates	E524680404					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Sodium trimetaphosphate	7785-84-4					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Sodium tripolyphosphate	7758-29-4					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Tetrapotassium phosphate	7320-34-5					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Tetrasodium pyrophosphate	7722-88-5					2.3E+05			2.3E+05
				3.25E+00	X						1.36E+09		1		~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					7.6E+05			7.6E+05
				3.13E+00	X						1.36E+09		1	0.1	~Triphosphoric acid, aluminum salt (1:1) [aluminum triphosphate]	13939-25-8					7.3E+05	3.1E+06		5.9E+05
				1.00E+00	P						1.36E+09		1		~Tripotassium phosphate	7778-53-2					2.3E+05			2.3E+05
				1.00E+00	P						1.36E+09		1		~Trisodium phosphate	7601-54-9					2.3E+05			2.3E+05
				3.00E-04	I	3.00E-04	I	V			1.36E+09		1		Phosphine	7803-51-2					7.0E+01		1.3E+06	7.0E+01
				1.00E+00	P	1.00E-02	I				1.36E+09		1		Phosphoric Acid	7664-38-2					2.3E+05		4.3E+07	2.3E+05
				2.00E-05	I			V			1.36E+09	6.92E+03	1		Phosphorus, White	7723-14-0					4.7E+00			4.7E+00
															Phthalates									
1.40E-02	I	2.40E-06	C	2.00E-02	I						1.36E+09		1	0.1	~Bis(2-ethylhexyl)phthalate	117-81-7	5.0E+03	1.8E+04	1.6E+08	3.9E+03	4.7E+03	2.0E+04		3.8E+03
1.90E-03	P			2.00E-01	I						1.36E+09		1	0.1	~Butyl Benzyl Phthalate	85-68-7	3.7E+04	1.3E+05		2.9E+04	4.7E+04	2.0E+05		3.8E+04
				1.00E+00	I						1.36E+09		1	0.1	~Butylphthalyl Butylglycolate	85-70-1					2.3E+05	9.9E+05		1.9E+05
				1.00E-01	I						1.36E+09		1	0.1	~Dibutyl Phthalate	84-74-2					2.3E+04	9.9E+04		1.9E+04
				8.00E-01	I						1.36E+09		1	0.1	~Diethyl Phthalate	84-66-2					1.9E+05	7.9E+05		1.5E+05
				1.00E-01	I			V			1.36E+09	2.13E+04	1		~Dimethylterephthalate	120-61-6					2.3E+04			2.3E+04
				1.00E-02	P						1.36E+09		1	0.1	~Octyl Phthalate, di-N-	117-84-0					2.3E+03	9.9E+03		1.9E+03
				5.00E-01	X						1.36E+09		1	0.1	~Phthalic Acid, p-	100-21-0					1.2E+05	4.9E+05		9.5E+04
				2.00E+00	I	2.00E-02	C				1.36E+09		1	0.1	~Phthalic Anhydride	85-44-9					4.7E+05	2.0E+06	8.5E+07	3.8E+05
				7.00E-02	I						1.36E+09		1	0.1	Picloram	1918-02-1					1.6E+04	6.9E+04		1.3E+04
				1.00E-04	X						1.36E+09		1	0.1	Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					2.3E+01	9.9E+01		1.9E+01
				2.00E-03	X						1.36E+09		1	0.1	Picric Acid (2,4,6-Trinitrophenol)	88-89-1					4.7E+02	2.0E+03		3.8E+02
				7.30E-04	O						1.36E+09		1	0.1	Pirimiphos, Methyl	29232-93-7					1.7E+02	7.2E+02		1.4E+02
3.00E+01	C	8.60E-03	C	7.00E-06	H						1.36E+09		1	0.1	Polybrominated Biphenyls	36355-01-8	2.3E+00	8.2E+00	4.4E+04	1.8E+00	1.6E+00	6.9E+00		1.3E+00
															Polychlorinated Biphenyls (PCBs)									
7.00E-02	G	2.00E-05	G	7.00E-05	I			V			1.36E+09	5.86E+05	1	0.14	~Aroclor 1016	12674-11-2	9.9E+02	2.5E+03	8.2E+03	6.6E+02	1.6E+01	4.9E+01		1.2E+01
2.00E+00	G	5.71E-04	G					V			1.36E+09	2.04E+05	1	0.14	~Aroclor 1221	11104-28-2	3.5E+01	8.8E+01	1.0E+02	2.0E+01				
2.00E+00	G	5.71E-04	G					V			1.36E+09	1.12E+05	1	0.14	~Aroclor 1232	11141-16-5	3.5E+01	8.8E+01	5.5E+01	1.7E+01				
2.00E+00	G	5.71E-04	G					V			1.36E+09	5.91E+05	1	0.14	~Aroclor 1242	53469-21-9	3.5E+01	8.8E+01	2.9E+02	2.3E+01				
2.00E+00	G	5.71E-04	G					V			1.36E+09	5.14E+05	1	0.14	~Aroclor 1248	12672-29-6	3.5E+01	8.8E+01	2.5E+02	2.3E+01				

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information																Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
2.00E+00	G	5.71E-04	G	2.00E-05	I			V			1.36E+09	8.43E+05	1	0.14	~Aroclor 1254	11097-69-1	3.5E+01	8.8E+01	4.1E+02	2.4E+01	4.7E+00	1.4E+01		3.5E+00
2.00E+00	G	5.71E-04	G					V			1.36E+09	1.31E+06	1	0.14	~Aroclor 1260	11096-82-5	3.5E+01	8.8E+01	6.5E+02	2.4E+01				
				6.00E-04	X			V			1.36E+09	1.15E+06	1	0.14	~Aroclor 5460	11126-42-4					1.4E+02	4.2E+02		1.1E+02
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	2.43E+06	1	0.14	~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.8E+01	4.5E+01	6.0E+02	1.3E+01	5.5E+00	1.6E+01	1.0E+04	4.1E+00
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	1.58E+06	1	0.14	~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.8E+01	4.5E+01	3.9E+02	1.2E+01	5.5E+00	1.6E+01	6.6E+03	4.1E+00
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	1.04E+06	1	0.14	~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.8E+01	4.5E+01	2.6E+02	1.2E+01	5.5E+00	1.6E+01	4.3E+03	4.1E+00
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	1.11E+06	1	0.14	~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.8E+01	4.5E+01	2.7E+02	1.2E+01	5.5E+00	1.6E+01	4.6E+03	4.1E+00
3.90E+03	W	1.14E+00	W	2.33E-08	W	1.33E-06	W	V			1.36E+09	1.58E+06	1	0.14	~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.8E-02	4.5E-02	3.9E-01	1.2E-02	5.5E-03	1.6E-02	6.6E+00	4.1E-03
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	7.33E+05	1	0.14	~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.8E+01	4.5E+01	1.8E+02	1.2E+01	5.5E+00	1.6E+01	3.1E+03	4.1E+00
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	5.90E+05	1	0.14	~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.8E+01	4.5E+01	1.5E+02	1.2E+01	5.5E+00	1.6E+01	2.5E+03	4.1E+00
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	6.01E+05	1	0.14	~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.8E+01	4.5E+01	1.5E+02	1.2E+01	5.5E+00	1.6E+01	2.5E+03	4.1E+00
3.90E+00	W	1.14E-03	W	2.33E-05	W	1.33E-03	W	V			1.36E+09	1.05E+06	1	0.14	~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.8E+01	4.5E+01	2.6E+02	1.2E+01	5.5E+00	1.6E+01	4.4E+03	4.1E+00
1.30E+04	W	3.80E+00	W	7.00E-09	W	4.00E-07	W	V			1.36E+09	7.26E+05	1	0.14	~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	5.3E-03	1.4E-02	5.4E-02	3.6E-03	1.6E-03	4.9E-03	9.1E-01	1.2E-03
2.00E+00	I	5.71E-04	I					V			1.36E+09	5.32E+05	1	0.14	~Polychlorinated Biphenyls (high risk)	1336-36-3	3.5E+01	8.8E+01	2.6E+02	2.3E+01				
4.00E-01	I	1.00E-04	I					V					1	0.14	~Polychlorinated Biphenyls (low risk)	1336-36-3								
7.00E-02	I	2.00E-05	I					V					1	0.14	~Polychlorinated Biphenyls (lowest risk)	1336-36-3								
1.30E+01	W	3.80E-03	W	7.00E-06	W	4.00E-04	W				1.36E+09		1	0.14	~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	5.3E+00	1.4E+01	1.0E+05	3.8E+00	1.6E+00	4.9E+00	1.7E+06	1.2E+00
3.90E+01	W	1.14E-02	W	2.33E-06	W	1.33E-04	W	V			1.36E+09	5.09E+05	1	0.14	~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.8E+00	4.5E+00	1.3E+01	1.2E+00	5.5E-01	1.6E+00	2.1E+02	4.1E-01
						6.00E-04	I				1.36E+09		1	0.1	Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9							2.6E+06	2.6E+06
															Polynuclear Aromatic Hydrocarbons (PAHs)									
				6.00E-02	I			V			1.36E+09	1.41E+05	1	0.13	~Acenaphthene	83-32-9					1.4E+04	4.6E+04		1.1E+04
				3.00E-01	I			V			1.36E+09	5.23E+05	1	0.13	~Anthracene	120-12-7					7.0E+04	2.3E+05		5.4E+04
1.00E-01	E	6.00E-05	E					V	M		1.36E+09	4.41E+06	1	0.13	~Benz[a]anthracene	56-55-3	1.5E+02	4.6E+02	7.4E+03	1.1E+02				
1.00E+00	I	6.00E-04	I	3.00E-04	I	2.00E-06	I		M		1.36E+09		1	0.13	~Benzo[a]pyrene	50-32-8	1.5E+01	4.6E+01	2.3E+05	1.1E+01	7.0E+01	2.3E+02	8.5E+03	5.3E+01
1.00E-01	E	6.00E-05	E						M		1.36E+09		1	0.13	~Benzo[b]fluoranthene	205-99-2	1.5E+02	4.6E+02	2.3E+06	1.1E+02				
				9.00E-05	X	2.00E-06	X				1.36E+09		1	0.1	~Benzo[e]pyrene	192-97-2					2.1E+01	8.9E+01	8.5E+03	1.7E+01
1.20E+00	C	1.10E-04	C								1.36E+09		1	0.13	~Benzo[i]fluoranthene	205-82-3	5.8E+01	1.6E+02	3.5E+06	4.2E+01				
1.00E-02	E	6.00E-06	E						M		1.36E+09		1	0.13	~Benzo[k]fluoranthene	207-08-9	1.5E+03	4.6E+03	2.3E+07	1.1E+03				
				8.00E-02	I			V			1.36E+09	7.99E+04	1	0.13	~Chloronaphthalene, Beta-	91-58-7					1.9E+04	6.1E+04		1.4E+04
1.00E-03	E	6.00E-07	E						M		1.36E+09		1	0.13	~Chrysene	218-01-9	1.5E+04	4.6E+04	2.3E+08	1.1E+04				
1.00E+00	E	6.00E-04	E						M		1.36E+09		1	0.13	~Dibenz[a,h]anthracene	53-70-3	1.5E+01	4.6E+01	2.3E+05	1.1E+01				
1.20E+01	C	1.10E-03	C								1.36E+09		1	0.13	~Dibenzo[a,e]pyrene	192-65-4	5.8E+00	1.6E+01	3.5E+05	4.2E+00				
2.50E+02	C	7.10E-02	C						M		1.36E+09		1	0.13	~Dimethylbenz[a]anthracene, 7,12-	57-97-6	6.1E-02	1.8E-01	1.9E+03	4.6E-02				
				4.00E-02	I						1.36E+09		1	0.13	~Fluoranthene	206-44-0					9.4E+03	3.0E+04		7.2E+03
				4.00E-02	I			V			1.36E+09	2.81E+05	1	0.13	~Fluorene	86-73-7					9.4E+03	3.0E+04		7.2E+03
1.00E-01	E	6.00E-05	E						M		1.36E+09		1	0.13	~Indeno[1,2,3-cd]pyrene	193-39-5	1.5E+02	4.6E+02	2.3E+06	1.1E+02				
5.10E-02	X			7.00E-02	A	3.00E-06	P	V		3.94E+02	1.36E+09	5.86E+04	1	0.13	~Methylnaphthalene, 1-	90-12-0	1.4E+03	3.7E+03		1.0E+03	1.6E+04	5.3E+04	5.5E-01	5.5E-01
				4.00E-03	I			V			1.36E+09	5.80E+04	1	0.13	~Methylnaphthalene, 2-	91-57-6					9.4E+02	3.0E+03		7.2E+02
1.20E-01	C	3.40E-05	C	2.00E-02	I	3.00E-03	I	V			1.36E+09	4.63E+04	1	0.13	~Naphthalene	91-20-3	5.8E+02	1.6E+03	3.8E+02	2.0E+02	4.7E+03	1.5E+04	4.3E+02	3.9E+02
1.20E+00	C	1.10E-04	C								1.36E+09		1	0.13	~Nitropyrene, 4-	57835-92-4	5.8E+01	1.6E+02	3.5E+06	4.2E+01				
				9.00E-05	X	2.00E-06	X				1.36E+09		1	0.13	~Perylene	198-55-0					2.1E+01	6.8E+01	8.5E+03	1.6E+01
				3.00E-02	I			V			1.36E+09	2.38E+06	1	0.13	~Pyrene	129-00-0					7.0E+03	2.3E+04		5.4E+03
1.50E-01	I			9.00E-03	I						1.36E+09		1	0.1	Prochloraz	67747-09-5	4.6E+02	1.6E+03		3.6E+02	2.1E+03	8.9E+03		1.7E+03
				6.00E-03	H			V			1.36E+09	4.20E+05	1		Profluralin	26399-36-0					1.4E+03			1.4E+03
				1.50E-02	I						1.36E+09		1	0.1	Prometon	1610-18-0					3.5E+03	1.5E+04		2.8E+03
				4.00E-02	O						1.36E+09		1	0.1	Prometryn	7287-19-6					9.4E+03	4.0E+04		7.6E+03
				7.50E-02	I						1.36E+09		1	0.1	Pronamide	23950-58-5					1.8E+04	7.4E+04		1.4E+04
				1.30E-02	I						1.36E+09		1	0.1	Propachlor	1918-16-7					3.1E+03	1.3E+04		2.5E+03
				5.00E-03	I						1.36E+09		1	0.1	Propanil	709-98-8					1.2E+03	4.9E+03		9.5E+02
1.92E-01	O			4.00E-02	O						1.36E+09		1	0.1	Propargite	2312-35-8	3.6E+02	1.3E+03		2.8E+02	9.4E+03	4.0E+04		7.6E+03
				2.00E-03	I			V		1.11E+05	1.36E+09	6.27E+04	1		Proparqyl Alcohol	107-19-7					4.7E+02			4.7E+02
				2.00E-02	I						1.36E+09		1	0.1	Propazine	139-40-2					4.7E+03	2.0E+04		3.8E+03
				2.00E-02	I						1.36E+09		1	0.1	Propham	122-42-9					4.7E+03	2.0E+04		3.8E+03
				1.00E-01	O						1.36E+09		1	0.1	Propiconazole	60207-90-1					2.3E+04	9.9E+04		1.9E+04
						8.00E-03	I	V		3.26E+04	1.36E+09	8.94E+03	1		Propionaldehyde	123-38-6							2.2E+02	2.2E+02
				1.00E-01	X	1.00E+00	X	V		2.64E+02	1.36E+09	6.99E+03	1		Propyl benzene	103-65-1					2.3E+04		2.2E+04	1.1E+04
						3.00E+00	C	V		3.49E+02	1.36E+09	7.04E+02	1		Propylene	115-07-1							6.6E+03	6.6E+03
				2.00E+01	P						1.36E+09		1	0.1	Propylene Glycol	57-55-6					4.7E+06	2.0E+07		3.8E+06
						2.72E-04	A				1.36E+09		1	0.1	Propylene Glycol Dinitrate	6423-43-4							1.2E+06	1.2E+06
				7.00E-01	H	2.00E+00	I	V		1.06E+05	1.36E+09	7.83E+04	1		Propylene Glycol Monomethyl Ether	107-98-2					1.6E+05		4.9E+05	1.2E+05
2.40E-01	I	3.70E-06	I			3.00E-02	I	V		7.77E+04	1.36E+09	1.03E+04	1		Propylene Oxide	75-56-9	2.9E+02		7.8E+02	2.1E+02			9.7E+02	9.7E+02
				1.00E-03	I			V		5.30E+05	1.36E+09	5.54E+04	1		Pyridine	110-86-1					2.3E+02			2.3E+02
				5.00E-04	I						1.36E+09		1	0.1	Quinalphos	13593-03-8					1.2E+02	4.9E+02		9.5E+01
3.00E+00	I										1.36E+09		1	0.1	Quinoline	91-22-5	2.3E+01	8.2E+01		1.8E+01				
				9.00E-03	I						1.36E+09		1	0.1	Quizalofop-ethyl	76578-14-8					2.1E+03	8.9E+03		1.7E+03
						3.00E+04	A						1		Refractory Ceramic Fibers (units in fibers)	E715557								
				3.00E-02	I						1.36E+09		1	0.1	Resmethrin	10453-86-8					7.0E+03	3.0E+04		5.7E+03
				5.00E-02	H			V			1.36E+09	4.65E+05	1		Ronnel	299-84-3					1.2E+04			1.2E+04
				4.00E-03	I						1.36E+09		1	0.1	Rotenone	83-79-4					9.4E+02	4.0E+03		7.6E+02
2.20E-01	C	6.30E-05	C						M		1.36E+09		1	0.1	Safrole	94-59-7	7.0E+01	2.7E+02	2.2E+06	5.5E+01				
				5.00E-03	I						1.36E+09		1		Selenious Acid	7783-00-8					1.2E+03			1.2E+03
				5.00E-03	I	2.00E-02	C				1.36E+09		1		Selenium	7782-49-2					1.2E+03		8.5E+07	1.2E+03
				5.00E-03	C	2.00E-02	C				1.36E+09		1		Selenium Sulfide	7446-34-6					1.2E+03		8.5E+07	1.2E+03
				1.40E-01	O						1.36E+09		1	0.1	Sethoxydim	74051-80-2					3.3E+04	1.4E+05		2.7E+04
						3.00E-03	C				1.36E+09		1		Silica (crystalline, respirable)	7631-86-9							1.3E+07	1.3E+07
				5.00E-03	I						1.36E+09		0.04		Silver	7440-22-4					1.2E+03			1.2E+03
1.20E-01	H			5.00E-03	I						1.36E+09		1	0.1	Simazine	122-34-9	5.8E+02	2.1E+03		4.5E+02	1.2E+03	4.9E+03		9.5E+02
				1.30E-02	I						1.36E+09		1	0.1	Sodium Acifluorfen	62476-59-9					3.1E+03	1.3E+04		2.5E+03
				4.00E-03	I						1.36E+09		1		Sodium Azide	26628-22-8					9.4E+02			9.4E+02
2.70E-01	H			3.00E-02	I						1.36E+09		1	0.1	Sodium Diethyldithiocarbamate	148-18-5	2.6E+02	9.2E+02		2.0E+02	7.0E+03	3.0E+04		5.7E+03
				5.00E-02	A	1.40E-02	C				1.36E+09		1		Sodium Fluoride	7681-49-4					1.2E+04		6.0E+07	1.2E+04
				2.00E-05	I						1.36E+09		1	0.1	Sodium Fluoroacetate	62-74-8					4.7E+00	2.0E+01		3.8E+00
				1.00E-03	H						1.36E+09		1		Sodium Metavanadate	13718-26-8					2.3E+02			2.3E+02

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				8.00E-04	P						1.36E+09		1		Sodium Tungstate	13472-45-2					1.9E+02			1.9E+02
				8.00E-04	P						1.36E+09		1		Sodium Tungstate Dihydrate	10213-10-2					1.9E+02			1.9E+02
2.40E-02	H			3.00E-02	I						1.36E+09		1	0.1	Stirofos (Tetrachlorovinphos)	961-11-5	2.9E+03	1.0E+04		2.3E+03	7.0E+03	3.0E+04		5.7E+03
				6.00E-01	I						1.36E+09		1		Strontium, Stable	7440-24-6					1.4E+05			1.4E+05
				3.00E-04	I						1.36E+09		1	0.1	Strychnine	57-24-9					7.0E+01	3.0E+02		5.7E+01
				2.00E-01	I	1.00E+00	I	V		8.67E+02	1.36E+09	9.35E+03	1		Styrene	100-42-5					4.7E+04		2.9E+04	1.8E+04
				3.00E-03	P						1.36E+09		1	0.1	Styrene-Acrylonitrile (SAN) Trimer (THNA isomer)	57964-39-3					7.0E+02	3.0E+03		5.7E+02
				3.00E-03	P						1.36E+09		1	0.1	Styrene-Acrylonitrile (SAN) Trimer (THNP isomer)	57964-40-6					7.0E+02	3.0E+03		5.7E+02
				1.00E-03	P	2.00E-03	X				1.36E+09		1	0.1	Sulfolane	126-33-0					2.3E+02	9.9E+02	8.5E+06	1.9E+02
				8.00E-04	P						1.36E+09		1	0.1	Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					1.9E+02	7.9E+02		1.5E+02
						1.00E-03	C	V			1.36E+09		1		Sulfur Trioxide	7446-11-9							4.3E+06	4.3E+06
						1.00E-03	C				1.36E+09		1		Sulfuric Acid	7664-93-9							4.3E+06	4.3E+06
2.50E-02	I	7.10E-06	I	5.00E-02	H						1.36E+09		1	0.1	Sulfurous acid, 2-chloroethyl 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester	140-57-8	2.8E+03	9.9E+03	5.4E+07	2.2E+03	1.2E+04	4.9E+04		9.5E+03
				7.00E-02	I						1.36E+09		1	0.1	Tebuthiuron	34014-18-1					1.6E+04	6.9E+04		1.3E+04
				2.00E-02	H						1.36E+09		1	0.1	Temephos	3383-96-8					4.7E+03	2.0E+04		3.8E+03
				1.30E-02	I						1.36E+09		1	0.1	Terbacil	5902-51-2					3.1E+03	1.3E+04		2.5E+03
				2.50E-05	H			V		3.09E+01	1.36E+09	2.64E+05	1		Terbufos	13071-79-9					5.9E+00			5.9E+00
				1.00E-03	I						1.36E+09		1	0.1	Terbutryn	886-50-0					2.3E+02	9.9E+02		1.9E+02
5.00E-03	C	1.30E-06	C					V			1.36E+09	3.99E+03	1		Tert-Butyl Acetate	540-88-5	1.4E+04		8.6E+02	8.1E+02				
				1.00E-04	I						1.36E+09		1	0.1	Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					2.3E+01	9.9E+01		1.9E+01
				3.00E-05	P			V			1.36E+09	5.07E+04	1		Tetrachlorobenzene, 1,2,4,5-	95-94-3					7.0E+00			7.0E+00
2.60E-02	I	7.40E-06	I	3.00E-02	I			V		6.80E+02	1.36E+09	5.68E+03	1		Tetrachloroethane, 1,1,1,2-	630-20-6	2.7E+03		2.2E+02	2.0E+02	7.0E+03			7.0E+03
2.00E-01	I	5.80E-05	C	2.00E-02	I			V		1.90E+03	1.36E+09	1.51E+04	1		Tetrachloroethane, 1,1,2,2-	79-34-5	3.5E+02		7.3E+01	6.0E+01	4.7E+03			4.7E+03
2.10E-03	I	2.60E-07	I	6.00E-03	I	4.00E-02	I	V		1.66E+02	1.36E+09	2.35E+03	1		Tetrachloroethylene	127-18-4	3.3E+04		2.5E+03	2.4E+03	1.4E+03		2.9E+02	2.4E+02
				3.00E-02	I						1.36E+09		1	0.1	Tetrachlorophenol, 2,3,4,6-	58-90-2					7.0E+03	3.0E+04		5.7E+03
1.60E+01	X			6.00E-05	X			V			1.36E+09	1.05E+05	1		Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	4.3E+00			4.3E+00	1.4E+01			1.4E+01
				5.00E-04	I						1.36E+09		1	0.1	Tetraethyl Dithiopyrophosphate	3689-24-5					1.2E+02	4.9E+02		9.5E+01
						8.00E+01	I	V		2.05E+03	1.36E+09	1.22E+03	1		Tetrafluoroethane, 1,1,1,2-	811-97-2							3.1E+05	3.1E+05
				1.00E-04	X						1.36E+09		1	0.1	Tetramethylphosphoramide, -N,N,N',N" (TMPA)	16853-36-4					2.3E+01	9.9E+01		1.9E+01
				2.00E-03	P						1.36E+09		1	0.00065	Tetryl (Trinitrophenylmethylnitramine)	479-45-8					4.7E+02	3.0E+05		4.7E+02
				2.00E-05	G						1.36E+09		1		Thallic Oxide	1314-32-5					4.7E+00			4.7E+00
				1.00E-05	X						1.36E+09		1		Thallium (I) Nitrate	10102-45-1					2.3E+00			2.3E+00
				1.00E-05	X						1.36E+09		1		Thallium (Soluble Salts)	7440-28-0					2.3E+00			2.3E+00
				1.00E-05	X			V			1.36E+09	1.40E+05	1		Thallium Acetate	563-68-8					2.3E+00			2.3E+00
				2.00E-05	X						1.36E+09		1	0.1	Thallium Carbonate	6533-73-9					4.7E+00	2.0E+01		3.8E+00
				1.00E-05	X						1.36E+09		1		Thallium Chloride	7791-12-0					2.3E+00			2.3E+00
				1.00E-05	G						1.36E+09		1		Thallium Selenite	12039-52-0					2.3E+00			2.3E+00
				2.00E-05	X						1.36E+09		1		Thallium Sulfate	7446-18-6					4.7E+00			4.7E+00
				4.30E-02	O						1.36E+09		1	0.1	Thifensulfuron-methyl	79277-27-3					1.0E+04	4.3E+04		8.2E+03
				1.00E-02	I						1.36E+09		1	0.1	Thiobencarb	28249-77-6					2.3E+03	9.9E+03		1.9E+03
				3.00E-02	H						1.36E+09		1	0.1	Thiocyanic acid, (2-benzothiazolylthio)methyl ester (TCMTB)	21564-17-0					7.0E+03	3.0E+04		5.7E+03
				7.00E-02	X						1.36E+09		1	0.0075	Thiodiglycol	111-48-8					1.6E+04	9.2E+05		1.6E+04
				3.00E-04	H						1.36E+09		1	0.1	Thiofanox	39196-18-4					7.0E+01	3.0E+02		5.7E+01
1.16E-02	O			1.60E-01	O						1.36E+09		1	0.1	Thiophanate, Methyl	23564-05-8	6.0E+03	2.1E+04		4.7E+03	3.8E+04	1.6E+05		3.0E+04
				1.50E-02	O						1.36E+09		1	0.1	Thiram	137-26-8					3.5E+03	1.5E+04		2.8E+03
				6.00E-01	H						1.36E+09		1		Tin	7440-31-5					1.4E+05			1.4E+05
						1.00E-04	A	V			1.36E+09		1		Titanium Tetrachloride	7550-45-0							4.3E+05	4.3E+05
				8.00E-02	I	5.00E+00	I	V		8.18E+02	1.36E+09	4.29E+03	1		Toluene	108-88-3					1.9E+04		6.7E+04	1.5E+04
3.90E-02	C	1.10E-05	C			8.00E-06	C	V			1.36E+09	7.62E+05	1		Toluene-2,4-diisocyanate	584-84-9	1.8E+03		1.9E+04	1.6E+03			1.9E+01	1.9E+01
3.90E-02	C	1.10E-05	C			8.00E-06	C	V		1.71E+03	1.36E+09	6.32E+05	1		Toluene-2,6-diisocyanate	91-08-7	1.8E+03		1.6E+04	1.6E+03			1.6E+01	1.6E+01
				1.00E-04	X						1.36E+09		1	0.1	Toluenediamine, 2,3-	2687-25-4					2.3E+01	9.9E+01		1.9E+01
1.80E-01	X			2.00E-04	X						1.36E+09		1	0.1	Toluenediamine, 2,5-	95-70-5	3.9E+02	1.4E+03		3.0E+02	4.7E+01	2.0E+02		3.8E+01
				1.00E-04	X						1.36E+09		1	0.1	Toluenediamine, 3,4-	496-72-0					2.3E+01	9.9E+01		1.9E+01
				5.00E-03	P						1.36E+09		1	0.1	Toluic Acid, p-	99-94-5					1.2E+03	4.9E+03		9.5E+02
1.60E-02	P	5.10E-05	C								1.36E+09		1	0.1	Toluidine, o- (Methylaniline, 2-)	95-53-4	4.3E+03	1.5E+04	7.5E+06	3.4E+03				
3.00E-02	P			4.00E-03	X						1.36E+09		1	0.1	Toluidine, p-	106-49-0	2.3E+03	8.2E+03		1.8E+03	9.4E+02	4.0E+03		7.6E+02
				3.00E+00	P			V		3.42E-01	1.36E+09	1.38E+03	1		Total Petroleum Hydrocarbons (Aliphatic High)	E1790670					7.0E+05			7.0E+05
				5.00E-03	P	4.00E-01	P	V		1.12E+02	1.36E+09	1.65E+03	1		Total Petroleum Hydrocarbons (Aliphatic Low)	E1790666					1.2E+03		2.1E+03	7.5E+02
				1.00E-02	X	1.00E-01	P	V		6.86E+00	1.36E+09	1.04E+03	1		Total Petroleum Hydrocarbons (Aliphatic Medium)	E1790668					2.3E+03		3.3E+02	2.9E+02
				3.00E-04	P	2.00E-06	P		M		1.36E+09		1	0.13	Total Petroleum Hydrocarbons (Aromatic High)	E1790676					7.0E+01	2.3E+02	8.5E+03	5.3E+01
				1.00E-02	P	6.00E-02	P	V		2.31E+02	1.36E+09	7.75E+03	1		Total Petroleum Hydrocarbons (Aromatic Medium)	E1790674					2.3E+03		1.5E+03	9.0E+02
1.10E+00	I	3.20E-04	I	9.00E-05	P						1.36E+09		1	0.1	Toxaphene	8001-35-2	6.3E+01	2.2E+02	1.2E+06	4.9E+01	2.1E+01	8.9E+01		1.7E+01
				3.00E-05	X						1.36E+09		1	0.1	Toxaphene, Weathered	E1841606					7.0E+00	3.0E+01		5.7E+00
				7.50E-03	I						1.36E+09		1	0.1	Tralomethrin	66841-25-6					1.8E+03	7.4E+03		1.4E+03
				3.00E-04	A			V			1.36E+09	3.36E+03	1		Tri-n-butyltin	688-73-3					7.0E+01			7.0E+01
				8.00E+01	X						1.36E+09		1	0.1	Triacetin	102-76-1					1.9E+07	7.9E+07		1.5E+07
				3.40E-02	O						1.36E+09		1	0.1	Triadimefon	43121-43-3					8.0E+03	3.4E+04		6.4E+03
7.17E-02	O			2.50E-02	O			V			1.36E+09	3.62E+05	1		Triallate	2303-17-5	9.7E+02			9.7E+02	5.9E+03			5.9E+03
				1.00E-02	I						1.36E+09		1	0.1	Triasulfuron	82097-50-5					2.3E+03	9.9E+03		1.9E+03
				8.00E-03	I						1.36E+09		1	0.1	Tribenuron-methyl	101200-48-0					1.9E+03	7.9E+03		1.5E+03
				5.00E-03	I			V			1.36E+09	4.83E+04	1		Tribromobenzene, 1,2,4-	615-54-3					1.2E+03			1.2E+03
				9.00E-03	X						1.36E+09		1	0.1	Tribromophenol, 2,4,6-	118-79-6					2.1E+03	8.9E+03		1.7E+03
				2.00E-04	O						1.36E+09		1	0.1	Tribufos	78-48-8					4.7E+01	2.0E+02		3.8E+01
9.00E-03	P			1.00E-02	P						1.36E+09		1	0.1	Tributyl Phosphate	126-73-8	7.7E+03	2.7E+04		6.0E+03	2.3E+03	9.9E+03		1.9E+03
				3.00E-04	P						1.36E+09		1	0.1	Tributyltin Compounds	E1790679					7.0E+01	3.0E+02		5.7E+01
				3.00E-04	I						1.36E+09		1	0.1	Tributyltin Oxide	56-35-9					7.0E+01	3.0E+02		5.7E+01
											1.36E+09		1	0.1	Trichloramine	10025-85-1								
				3.00E+01	I	5.00E+00	P	V		9.10E+02	1.36E+09	1.29E+03	1		Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					7.0E+06		2.0E+04	2.0E+04
7.00E-02	I			2.00E-02	I						1.36E+09		1	0.1	Trichloroacetic Acid	76-03-9	9.9E+02	3.5E+03		7.8E+02	4.7E+03	2.0E+04		3.8E+03
2.90E-02	H										1.36E+09		1	0.1	Trichloroaniline HCl, 2,4,6-	33663-50-2	2.4E+03	8.5E+03		1.9E+03				
7.00E-03	X			3.00E-05	X						1.36E+09		1	0.1	Trichloroaniline, 2,4,6-	634-93-5	9.9E+03	3.5E+04		7.8E+03	7.0E+00	3.0E+01		5.7E+00
				8.00E-04	X			V			1.36E+09	3.22E+04	1		Trichlorobenzene, 1,2,3-	87-61-6					1.9E+02			1.9E+02
2.90E-02	P			1.00E-02	I	2.00E-03	P	V		4.04E+02	1.36E+09	2.99E+04	1		Trichlorobenzene, 1,2,4-	120-82-1	2.4E+03			2.4E+03	2.3E+03		1.9E+02	1.7E+02

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-04				Noncancer Child Hazard Index (HI) = 3			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-04 (mg/kg)	Dermal SL TR=1E-04 (mg/kg)	Inhalation SL TR=1E-04 (mg/kg)	Carcinogenic SL TR=1E-04 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)
				2.00E+00	I	5.00E+00	I	V		6.40E+02	1.36E+09	1.65E+03	1		Trichloroethane, 1,1,1-	71-55-6					4.7E+05		2.6E+04	2.4E+04
5.70E-02	I	1.60E-05	I	4.00E-03	I	2.00E-04	X	V		2.16E+03	1.36E+09	7.22E+03	1		Trichloroethane, 1,1,2-	79-00-5	1.2E+03		1.3E+02	1.1E+02	9.4E+02		4.5E+00	4.5E+00
4.60E-02	I	4.10E-06	I	5.00E-04	I	2.00E-03	I	V	M	6.92E+02	1.36E+09	2.21E+03	1		Trichloroethylene	79-01-6	8.8E+02		1.1E+02	9.4E+01	1.2E+02		1.4E+01	1.2E+01
				3.00E-01	I			V		1.23E+03	1.36E+09	1.04E+03	1		Trichlorofluoromethane	75-69-4					7.0E+04			7.0E+04
				1.00E-01	I						1.36E+09		1	0.1	Trichlorophenol, 2,4,5-	95-95-4					2.3E+04	9.9E+04		1.9E+04
1.10E-02	I	3.10E-06	I	1.00E-03	P						1.36E+09		1	0.1	Trichlorophenol, 2,4,6-	88-06-2	6.3E+03	2.2E+04	1.2E+08	4.9E+03	2.3E+02	9.9E+02		1.9E+02
				1.00E-02	I						1.36E+09		1	0.1	Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					2.3E+03	9.9E+03		1.9E+03
				8.00E-03	I						1.36E+09		1	0.1	Trichlorophenoxypropionic acid, -2,4,5	93-72-1					1.9E+03	7.9E+03		1.5E+03
				5.00E-03	I			V		1.28E+03	1.36E+09	1.50E+04	1		Trichloropropane, 1,1,2-	598-77-6					1.2E+03			1.2E+03
3.00E+01	I			4.00E-03	I	3.00E-04	I	V	M	1.40E+03	1.36E+09	1.57E+04	1		Trichloropropane, 1,2,3-	96-18-4	5.1E-01			5.1E-01	9.4E+02		1.5E+01	1.5E+01
				3.00E-03	X	3.00E-04	P	V		3.11E+02	1.36E+09	2.34E+03	1		Trichloropropene, 1,2,3-	96-19-5					7.0E+02		2.2E+00	2.2E+00
				2.00E-02	A						1.36E+09		1	0.1	Tricresyl Phosphate (TCP)	1330-78-5					4.7E+03	2.0E+04		3.8E+03
				3.00E-03	I						1.36E+09		1	0.1	Tridiphane	58138-08-2					7.0E+02	3.0E+03		5.7E+02
						7.00E-03	I	V		2.79E+04	1.36E+09	1.58E+04	1		Triethylamine	121-44-8							3.5E+02	3.5E+02
				2.00E+00	P						1.36E+09		1	0.1	Triethylene Glycol	112-27-6					4.7E+05	2.0E+06		3.8E+05
						2.00E+01	P	V		4.81E+03	1.36E+09	7.12E+02	1		Trifluoroethane, 1,1,1-	420-46-2							4.5E+04	4.5E+04
7.70E-03	I			7.50E-03	I			V			1.36E+09	5.13E+05	1		Trifluralin	1582-09-8	9.0E+03			9.0E+03	1.8E+03			1.8E+03
2.00E-02	P			1.00E-02	P						1.36E+09		1	0.1	Trimethyl Phosphate	512-56-1	3.5E+03	1.2E+04		2.7E+03	2.3E+03	9.9E+03		1.9E+03
				1.00E-02	I	6.00E-02	I	V		2.93E+02	1.36E+09	9.44E+03	1		Trimethylbenzene, 1,2,3-	526-73-8					2.3E+03		1.8E+03	1.0E+03
				1.00E-02	I	6.00E-02	I	V		2.19E+02	1.36E+09	7.91E+03	1		Trimethylbenzene, 1,2,4-	95-63-6					2.3E+03		1.5E+03	9.1E+02
				1.00E-02	I	6.00E-02	I	V		1.82E+02	1.36E+09	6.61E+03	1		Trimethylbenzene, 1,3,5-	108-67-8					2.3E+03		1.2E+03	8.1E+02
				1.00E-02	X			V		2.96E+01	1.36E+09	1.00E+03	1		Trimethylpentene, 2,4,4-	25167-70-8					2.3E+03			2.3E+03
				3.00E-02	I						1.36E+09		1	0.019	Trinitrobenzene, 1,3,5-	99-35-4					7.0E+03	1.6E+05		6.7E+03
3.00E-02	I			5.00E-04	I						1.36E+09		1	0.032	Trinitrotoluene, 2,4,6-	118-96-7	2.3E+03	2.6E+04		2.1E+03	1.2E+02	1.5E+03		1.1E+02
				2.00E-02	P						1.36E+09		1	0.1	Triphenylphosphine Oxide	791-28-6					4.7E+03	2.0E+04		3.8E+03
				2.00E-02	A						1.36E+09		1	0.1	Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					4.7E+03	2.0E+04		3.8E+03
				1.00E-02	X						1.36E+09		1	0.1	Tris(1-chloro-2-propyl)phosphate	13674-84-5					2.3E+03	9.9E+03		1.9E+03
2.30E+00	C	6.60E-04	C					V		4.67E+02	1.36E+09	9.03E+05	1		Tris(2,3-dibromopropyl)phosphate	126-72-7	3.0E+01		3.8E+02	2.8E+01				
2.00E-02	P			7.00E-03	P						1.36E+09		1	0.1	Tris(2-chloroethyl)phosphate	115-96-8	3.5E+03	1.2E+04		2.7E+03	1.6E+03	6.9E+03		1.3E+03
3.20E-03	P			1.00E-01	P						1.36E+09		1	0.1	Tris(2-ethylhexyl)phosphate	78-42-2	2.2E+04	7.7E+04		1.7E+04	2.3E+04	9.9E+04		1.9E+04
				8.00E-04	P						1.36E+09		1		Tungsten	7440-33-7					1.9E+02			1.9E+02
				2.00E-04	A	4.00E-05	A				1.36E+09		1		Uranium	7440-61-1					4.7E+01		1.7E+05	4.7E+01
1.00E+00	C	2.90E-04	C						M		1.36E+09		1	0.1	Urethane	51-79-6	1.5E+01	6.0E+01	4.8E+05	1.2E+01				
		8.30E-03	P	9.00E-03	I	7.00E-06	P				1.36E+09		0.026		Vanadium Pentoxide	1314-62-1			4.6E+04	4.6E+04	2.1E+03		3.0E+04	2.0E+03
				5.04E-03	G	1.00E-04	A				1.36E+09		0.026		Vanadium and Compounds	7440-62-2					1.2E+03		4.3E+05	1.2E+03
				1.00E-03	I			V			1.36E+09	1.23E+05	1		Vernolate	1929-77-7					2.3E+02			2.3E+02
				1.20E-03	O						1.36E+09		1	0.1	Vinclozolin	50471-44-8					2.8E+02	1.2E+03		2.3E+02
				1.00E+00	H	2.00E-01	I	V		2.75E+03	1.36E+09	4.40E+03	1		Vinyl Acetate	108-05-4					2.3E+05		2.8E+03	2.7E+03
		1.50E-05	P			3.00E-03	I	V		2.47E+03	1.36E+09	1.37E+03	1		Vinyl Bromide	593-60-2			2.6E+01	2.6E+01			1.3E+01	1.3E+01
7.20E-01	I	4.40E-06	I	3.00E-03	I	1.00E-01	I	V	M	3.92E+03	1.36E+09	9.56E+02	1		Vinyl Chloride	75-01-4	9.4E+00		1.6E+01	5.9E+00	7.0E+02		3.0E+02	2.1E+02
				3.00E-04	I						1.36E+09		1	0.1	Warfarin	81-81-2					7.0E+01	3.0E+02		5.7E+01
				2.00E-01	G	1.00E-01	G	V		3.88E+02	1.36E+09	5.47E+03	1		Xylene, m-	108-38-3					4.7E+04		1.7E+03	1.6E+03
				2.00E-01	G	1.00E-01	G	V		4.34E+02	1.36E+09	6.45E+03	1		Xylene, o-	95-47-6					4.7E+04		2.0E+03	1.9E+03
				2.00E-01	G	1.00E-01	G	V		3.90E+02	1.36E+09	5.58E+03	1		Xylene, p-	106-42-3					4.7E+04		1.7E+03	1.7E+03
				2.00E-01	I	1.00E-01	I	V		2.60E+02	1.36E+09	5.74E+03	1		Xylenes	1330-20-7					4.7E+04		1.8E+03	1.7E+03
				3.00E-04	I						1.36E+09		1		Zinc Phosphide	1314-84-7					7.0E+01			7.0E+01
				3.00E-01	I						1.36E+09		1		Zinc and Compounds	7440-66-6					7.0E+04			7.0E+04
				5.00E-02	I						1.36E+09		1	0.1	Zineb	12122-67-7					1.2E+04	4.9E+04		9.5E+03
				8.00E-05	X						1.36E+09		1		Zirconium	7440-67-7					1.9E+01			1.9E+01

RMLs
TR=1E-04
THQ=3.0

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information																Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				3.0E-04	O						1.36E+09		1	0.1	Acephate	30560-19-1					2.3E+00	9.9E+00		1.9E+00
		2.2E-06	I			9.0E-03	I	V		1.07E+05	1.36E+09	8.72E+03	1		Acetaldehyde	75-07-0			1.1E+01	1.1E+01			8.2E+00	8.2E+00
				2.0E-02	I						1.36E+09		1	0.1	Acetochlor	34256-82-1					1.6E+02	6.6E+02		1.3E+02
				9.0E-01	I			V		1.14E+05	1.36E+09	1.37E+04	1		Acetone	67-64-1					7.0E+03			7.0E+03
						2.0E-03	X				1.36E+09		1	0.1	Acetone Cyanohydrin	75-86-5							2.8E+05	2.8E+05
						6.0E-02	I	V		1.28E+05	1.36E+09	1.30E+04	1		Acetonitrile	75-05-8							8.1E+01	8.1E+01
				1.0E-01	I			V		2.52E+03	1.36E+09	5.97E+04	1		Acetophenone	98-86-2					7.8E+02			7.8E+02
3.8E+00	C	1.3E-03	C								1.36E+09		1	0.1	Acetylaminofluorene, 2-	53-96-3	1.8E-01	6.5E-01	2.9E+03	1.4E-01				
				5.0E-04	I	2.0E-05	I	V		2.27E+04	1.36E+09	6.91E+03	1		Acrolein	107-02-8					3.9E+00		1.4E-02	1.4E-02
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M		1.36E+09		1	0.1	Acrylamide	79-06-1	3.1E-01	1.2E+00	1.4E+04	2.4E-01	1.6E+01	6.6E+01	8.5E+05	1.3E+01
				5.0E-01	I	2.0E-04	P	V		1.09E+05	1.36E+09	9.53E+04	1		Acrylic Acid	79-10-7					3.9E+03		2.0E+00	2.0E+00
5.4E-01	I	6.8E-05	I	1.0E-03	H	2.0E-03	I	V		1.13E+04	1.36E+09	7.69E+03	1		Acrylonitrile	107-13-1	1.3E+00		3.2E-01	2.5E-01	7.8E+00		1.6E+00	1.3E+00
						6.0E-03	P				1.36E+09		1	0.1	Adiponitrile	111-69-3							8.5E+05	8.5E+05
5.6E-02	C			1.0E-02	I						1.36E+09		1	0.1	Alachlor	15972-60-8	1.2E+01	4.4E+01		9.7E+00	7.8E+01	3.3E+02		6.3E+01
				1.0E-03	I						1.36E+09		1	0.1	Aldicarb	116-06-3					7.8E+00	3.3E+01		6.3E+00
				1.0E-03	I						1.36E+09		1	0.1	Aldicarb Sulfone	1646-88-4					7.8E+00	3.3E+01		6.3E+00
											1.36E+09		1	0.1	Aldicarb sulfoxide	1646-87-3								
1.7E+01	I	4.9E-03	I	3.0E-05	I			V			1.36E+09	1.72E+06	1		Aldrin	309-00-2	4.1E-02		9.8E-01	3.9E-02	2.3E-01			2.3E-01
				4.0E-03	P	1.0E-04	X	V		1.11E+05	1.36E+09	3.42E+04	1		Allyl Alcohol	107-18-6					3.1E+01		3.6E-01	3.5E-01
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1.42E+03	1.36E+09	1.58E+03	1		Allyl Chloride	107-05-1	3.3E+01		7.4E-01	7.2E-01			1.7E-01	1.7E-01
				1.0E+00	P	5.0E-03	P				1.36E+09		1		Aluminum	7429-90-5					7.8E+03		7.1E+05	7.7E+03
				4.0E-04	I						1.36E+09		1		Aluminum Phosphide	20859-73-8					3.1E+00			3.1E+00
				9.0E-03	I						1.36E+09		1	0.1	Ametryn	834-12-8					7.0E+01	3.0E+02		5.7E+01
2.1E+01	C	6.0E-03	C								1.36E+09		1	0.1	Aminobiphenyl, 4-	92-67-1	3.3E-02	1.2E-01	6.4E+02	2.6E-02				
				8.0E-02	P						1.36E+09		1	0.1	Aminophenol, m-	591-27-5					6.3E+02	2.6E+03		5.1E+02
				4.0E-03	X						1.36E+09		1	0.1	Aminophenol, o-	95-55-6					3.1E+01	1.3E+02		2.5E+01
				2.0E-02	P						1.36E+09		1	0.1	Aminophenol, p-	123-30-8					1.6E+02	6.6E+02		1.3E+02
				2.5E-03	I						1.36E+09		1	0.1	Amitraz	33089-61-1					2.0E+01	8.2E+01		1.6E+01
						5.0E-01	I	V					1		Ammonia	7664-41-7								
				2.0E-03	X						1.36E+09		1	0.1	Ammonium Picrate	131-74-8					1.6E+01	6.6E+01		1.3E+01
				2.0E-01	I						1.36E+09		1		Ammonium Sulfamate	7773-06-0					1.6E+03			1.6E+03
						3.0E-03	X	V		1.37E+04	1.36E+09	2.62E+04	1		Amyl Alcohol, tert-	75-85-4							8.2E+00	8.2E+00
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I				1.36E+09		1	0.1	Aniline	62-53-3	1.2E+02	4.3E+02	2.4E+06	9.5E+01	5.5E+01	2.3E+02	1.4E+05	4.4E+01
4.0E-02	P			2.0E-03	X						1.36E+09		1	0.1	Anthraquinone, 9,10-	84-65-1	1.7E+01	6.2E+01		1.4E+01	1.6E+01	6.6E+01		1.3E+01
				4.0E-04	I	3.0E-04	A				1.36E+09		0.15		Antimony (metallic)	7440-36-0					3.1E+00		4.3E+04	3.1E+00
				5.0E-04	H						1.36E+09		0.15		Antimony Pentoxide	1314-60-9					3.9E+00			3.9E+00
				4.0E-04	H						1.36E+09		0.15		Antimony Tetroxide	1332-81-6					3.1E+00			3.1E+00
						2.0E-04	I				1.36E+09		0.15		Antimony Trioxide	1309-64-4							2.8E+04	2.8E+04
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C				1.36E+09		1	0.03	Arsenic, Inorganic	7440-38-2	7.7E-01	5.5E+00	8.9E+02	6.8E-01	3.9E+00	3.3E+01	2.1E+03	3.5E+00
				3.5E-06	C	5.0E-05	I				1.36E+09		1		Arsine	7784-42-1					2.7E-02		7.1E+03	2.7E-02
													1		Asbestos (units in fibers)	1332-21-4								
				3.6E-01	O						1.36E+09		1	0.1	Asulam	3337-71-1					2.8E+03	1.2E+04		2.3E+03
2.3E-01	C			3.0E-03	A						1.36E+09		1	0.1	Atrazine	1912-24-9	3.0E+00	1.1E+01		2.4E+00	2.3E+01	9.9E+01		1.9E+01
8.8E-01	C	2.5E-04	C								1.36E+09		1	0.1	Auramine	492-80-8	7.9E-01	2.8E+00	1.5E+04	6.2E-01				
				4.0E-04	I						1.36E+09		1	0.1	Avermectin B1	65195-55-3					3.1E+00	1.3E+01		2.5E+00
				3.0E-03	A	1.0E-02	A				1.36E+09		1	0.1	Azinphos-methyl	86-50-0					2.3E+01	9.9E+01	1.4E+06	1.9E+01
1.1E-01	I	3.1E-05	I					V			1.36E+09	5.23E+05	1		Azobenzene	103-33-3	6.3E+00		4.7E+01	5.6E+00				
				1.0E+00	P	7.0E-06	P				1.36E+09		1	0.1	Azodicarbonamide	123-77-3					7.8E+03	3.3E+04	9.9E+02	8.6E+02
				2.0E-01	I	5.0E-04	H				1.36E+09		0.07		Barium	7440-39-3					1.6E+03		7.1E+04	1.5E+03
				5.0E-03	O			V			1.36E+09	3.07E+05	1		Benfluralin	1861-40-1					3.9E+01			3.9E+01
				5.0E-02	I						1.36E+09		1	0.1	Benomyl	17804-35-2					3.9E+02	1.6E+03		3.2E+02
				2.0E-01	I						1.36E+09		1	0.1	Bensulfuron-methyl	83055-99-6					1.6E+03	6.6E+03		1.3E+03
				3.0E-02	I						1.36E+09		1	0.1	Bentazon	25057-89-0					2.3E+02	9.9E+02		1.9E+02
4.0E-03	P			1.0E-01	I			V		1.16E+03	1.36E+09	2.25E+04	1		Benzaldehyde	100-52-7	1.7E+02			1.7E+02	7.8E+02			7.8E+02
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		1.82E+03	1.36E+09	3.54E+03	1		Benzene	71-43-2	1.3E+01		1.3E+00	1.2E+00	3.1E+01		1.1E+01	8.2E+00
1.0E-01	X			3.0E-04	X						1.36E+09		1	0.1	Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	7.0E+00	2.5E+01		5.4E+00	2.3E+00	9.9E+00		1.9E+00
				1.0E-03	P			V		1.26E+03	1.36E+09	1.94E+04	1		Benzenethiol	108-98-5					7.8E+00			7.8E+00
2.3E+02	I	6.7E-02	I	3.0E-03	I				M		1.36E+09		1	0.1	Benzidine	92-87-5	6.7E-04	2.6E-03	2.1E+01	5.3E-04	2.3E+01	9.9E+01		1.9E+01
				4.0E+00	I						1.36E+09		1	0.1	Benzoic Acid	65-85-0					3.1E+04	1.3E+05		2.5E+04
1.3E+01	I							V		3.24E+02	1.36E+09	6.76E+04	1		Benzotrichloride	98-07-7	5.3E-02			5.3E-02				
				1.0E-01	P						1.36E+09		1	0.1	Benzyl Alcohol	100-51-6					7.8E+02	3.3E+03		6.3E+02
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		1.46E+03	1.36E+09	2.55E+04	1		Benzyl Chloride	100-44-7	4.1E+00		1.5E+00	1.1E+00	1.6E+01		2.7E+00	2.3E+00
		2.4E-03	I	2.0E-03	I	2.0E-05	I				1.36E+09		0.007		Beryllium and compounds	7440-41-7			1.6E+03	1.6E+03	1.6E+01		2.8E+03	1.6E+01
				9.0E-03	P						1.36E+09		1	0.1	Bifenox	42576-02-3					7.0E+01	3.0E+02		5.7E+01
				1.5E-02	I						1.36E+09		1	0.1	Biphenthrin	82657-04-3					1.2E+02	4.9E+02		9.5E+01
8.0E-03	I			5.0E-01	I	4.0E-04	X	V			1.36E+09	1.14E+05	1		Biphenyl, 1,1'-	92-52-4	8.7E+01			8.7E+01	3.9E+03		4.8E+00	4.7E+00
				4.0E-02	I			V		1.02E+03	1.36E+09	3.50E+04	1		Bis(2-chloro-1-methylethyl) ether	108-60-1					3.1E+02			3.1E+02
				3.0E-03	P						1.36E+09		1	0.1	Bis(2-chloroethoxy)methane	111-91-1					2.3E+01	9.9E+01		1.9E+01
1.1E+00	I	3.3E-04	I					V		5.05E+03	1.36E+09	4.25E+04	1		Bis(2-chloroethyl)ether	111-44-4	6.3E-01		3.6E-01	2.3E-01				
2.2E+02	I	6.2E-02	I					V		4.22E+03	1.36E+09	1.88E+03	1		Bis(chloromethyl)ether	542-88-1	3.2E-03		8.5E-05	8.3E-05				
				5.0E-02	I						1.36E+09		1	0.1	Bisphenol A	80-05-7					3.9E+02	1.6E+03		3.2E+02
				2.0E-01	I	2.0E-02	H				1.36E+09		1		Boron And Borates Only	7440-42-8					1.6E+03		2.8E+06	1.6E+03
				2.0E+00	P	2.0E-02	P	V			1.36E+09		1		Boron Trichloride	10294-34-5					1.6E+04		2.8E+06	1.6E+04
				4.0E-02	C	1.3E-02	C	V			1.36E+09		1		Boron Trifluoride	7637-07-2					3.1E+02		1.8E+06	3.1E+02
7.0E-01	I	1.4E-04	C	4.0E-03	I						1.36E+09		1		Bromate	15541-45-4	9.9E-01		2.7E+04	9.9E-01	3.1E+01			3.1E+01
				1.0E-04	X	6.0E-05	X	V		2.38E+03	1.36E+09	5.92E+03	1		Bromo-2-chloroethane, 1-	107-04-0					7.8E-01		3.7E-02	3.5E-02
				3.0E-04	X			V		8.96E+02	1.36E+09	1.12E+04	1		Bromo-3-fluorobenzene, 1-	1073-06-9					2.3E+00			2.3E+00
				3.0E-04	X			V		3.23E+02	1.36E+09	1.14E+04	1		Bromo-4-fluorobenzene, 1-	460-00-4					2.3E+00			2.3E+00
				1.7E-03	C						1.36E+09		1	0.1	Bromoacetic acid	79-08-3					1.3E+01	5.6E+01		1.1E+01
				8.0E-03	I	6.0E-02	I	V		6.79E+02	1.36E+09	8.37E+03	1		Bromobenzene	108-86-1					6.3E+01		5.2E+01	2.9E+01
						4.0E-02	X	V		4.04E+03	1.36E+09	3.58E+03	1		Bromochloromethane	74-97-5							1.5E+01	1.5E+01
6.2E-02	I	3.7E-05	C	8.0E-03	P			V		9.32E+02	1.36E+09	3.97E+03	1		Bromodichloromethane	75-27-4	1.1E+01		3.0E-01	2.9E-01	6.3E+01			6.3E+01
7.9E-03	I	1.1E-06	I	2.0E-02	I			V		9.15E+02	1.36E+09	9.70E+03	1		Bromoform	75-25-2	8.8E+01		2.5E+01	1.9E+01	1.6E+02			1.6E+02

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				1.4E-03	I	5.0E-03	I	V		3.59E+03	1.36E+09	1.40E+03	1		Bromomethane	74-83-9					1.1E+01		7.3E-01	6.8E-01
				5.0E-03	H			V			1.36E+09	1.24E+05	1		Bromophos	2104-96-3					3.9E+01			3.9E+01
		3.7E-06	C			1.0E-01	A	V		9.66E+02	1.36E+09	2.14E+03	1		Bromopropane, 1-	106-94-5			1.6E+00	1.6E+00			2.2E+01	2.2E+01
1.0E-01	O			1.5E-02	O						1.36E+09		1	0.1	Bromoxynil	1689-84-5	6.7E+00	2.4E+01		5.3E+00	1.2E+02	4.9E+02		9.5E+01
1.0E-01	O			1.5E-02	O			V			1.36E+09	4.74E+05	1		Bromoxynil Octanoate	1689-99-2	6.7E+00			6.7E+00	1.2E+02			1.2E+02
6.0E-01	C	3.0E-05	I			2.0E-03	I	V		6.67E+02	1.36E+09	8.66E+02	1		Butadiene, 1,3-	106-99-0	1.2E+00		8.1E-02	7.6E-02			1.8E-01	1.8E-01
				1.0E-01	I			V		7.64E+03	1.36E+09	3.00E+04	1		Butanol, N-	71-36-3					7.8E+02			7.8E+02
5.0E-04	I			4.0E-01	I	5.0E+00	I	V			1.36E+09	2.87E+04	1		Butyl Alcohol, t-	75-65-0	1.4E+03			1.4E+03	3.1E+03		1.5E+04	2.6E+03
				2.0E+00	P	3.0E+01	P	V		2.13E+04	1.36E+09	2.92E+04	1		Butyl alcohol, sec-	78-92-2					1.6E+04		9.1E+04	1.3E+04
				5.0E-02	I			V			1.36E+09	8.63E+04	1		Butylate	2008-41-5					3.9E+02			3.9E+02
2.0E-04	C	5.7E-08	C								1.36E+09		1	0.1	Butylated hydroxyanisole	25013-16-5	3.5E+03	1.2E+04	6.7E+07	2.7E+03				
3.6E-03	P			3.0E-01	P						1.36E+09		1	0.1	Butylated hydroxytoluene	128-37-0	1.9E+02	6.9E+02		1.5E+02	2.3E+03	9.9E+03		1.9E+03
				5.0E-02	P			V		1.08E+02	1.36E+09	8.14E+03	1		Butylbenzene, n-	104-51-8					3.9E+02			3.9E+02
				1.0E-01	X			V		1.45E+02	1.36E+09	7.35E+03	1		Butylbenzene, sec-	135-98-8					7.8E+02			7.8E+02
				1.0E-01	X			V		1.83E+02	1.36E+09	7.36E+03	1		Butylbenzene, tert-	98-06-6					7.8E+02			7.8E+02
				2.0E-02	A						1.36E+09		1	0.1	Cacodylic Acid	75-60-5					1.6E+02	6.6E+02		1.3E+02
		1.8E-03	I	1.0E-04	A	1.0E-05	A				1.36E+09		0.025	0.001	Cadmium (Diet)	7440-43-9			2.1E+03	2.1E+03	7.8E-01	8.2E+00	1.4E+03	7.1E-01
		1.8E-03	I	1.0E-04	A	1.0E-05	A						0.05	0.001	Cadmium (Water)	7440-43-9								
				5.0E-01	I	2.2E-03	C				1.36E+09		1	0.1	Caprolactam	105-60-2					3.9E+03	1.6E+04	3.1E+05	3.1E+03
1.5E-01	C	4.3E-05	C	2.0E-03	I						1.36E+09		1	0.1	Captafol	2425-06-1	4.6E+00	1.6E+01	8.9E+04	3.6E+00	1.6E+01	6.6E+01		1.3E+01
2.3E-03	C	6.6E-07	C	1.3E-01	I						1.36E+09		1	0.1	Captan	133-06-2	3.0E+02	1.1E+03	5.8E+06	2.4E+02	1.0E+03	4.3E+03		8.2E+02
				1.0E-01	I						1.36E+09		1	0.1	Carbaryl	63-25-2					7.8E+02	3.3E+03		6.3E+02
				5.0E-03	I						1.36E+09		1	0.1	Carbofuran	1563-66-2					3.9E+01	1.6E+02		3.2E+01
				1.0E-01	I	7.0E-01	I	V		7.38E+02	1.36E+09	1.17E+03	1		Carbon Disulfide	75-15-0					7.8E+02		8.5E+01	7.7E+01
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		4.58E+02	1.36E+09	1.49E+03	1		Carbon Tetrachloride	56-23-5	9.9E+00		7.0E-01	6.5E-01	3.1E+01		1.6E+01	1.0E+01
						1.0E-01	P	V		5.89E+03	1.36E+09	6.46E+02	1		Carbonyl Sulfide	463-58-1							6.7E+00	6.7E+00
				1.0E-02	I						1.36E+09		1	0.1	Carbosulfan	55285-14-8					7.8E+01	3.3E+02		6.3E+01
				1.0E-01	I						1.36E+09		1	0.1	Carboxin	5234-68-4					7.8E+02	3.3E+03		6.3E+02
						9.0E-04	I				1.36E+09		1		Ceric oxide	1306-38-3							1.3E+05	1.3E+05
				1.0E-01	I			V			1.36E+09	1.45E+05	1		Chloral Hydrate	302-17-0					7.8E+02			7.8E+02
				1.5E-02	I						1.36E+09		1	0.1	Chloramben	133-90-4					1.2E+02	4.9E+02		9.5E+01
											1.36E+09		1	0.1	Chloramines, Organic	E701235								
4.0E-01	H										1.36E+09		1	0.1	Chloranil	118-75-2	1.7E+00	6.1E+00		1.3E+00				
				5.0E-04	G			V			1.36E+09	1.49E+06	1	0.04	Chlordane (alpha)	5103-71-9					3.9E+00	4.1E+01		3.6E+00
				5.0E-04	G			V			1.36E+09	1.49E+06	1	0.04	Chlordane (gamma)	5103-74-2					3.9E+00	4.1E+01		3.6E+00
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I	V			1.36E+09	1.53E+06	1	0.04	Chlordane (technical mixture)	12789-03-6	2.0E+00	1.8E+01	4.3E+01	1.7E+00	3.9E+00	4.1E+01	1.1E+02	3.5E+00
1.0E+01	I	4.6E-03	C	3.0E-04	I						1.36E+09		1	0.1	Chlordecone (Kepone)	143-50-0	7.0E-02	2.5E-01	8.3E+02	5.4E-02	2.3E+00	9.9E+00		1.9E+00
				7.0E-04	A						1.36E+09		1	0.1	Chlorfenvinphos	470-90-6					5.5E+00	2.3E+01		4.4E+00
				9.0E-02	O						1.36E+09		1	0.1	Chlorimuron, Ethyl-	90982-32-4					7.0E+02	3.0E+03		5.7E+02
				1.0E-01	I	1.5E-04	A	V		2.78E+03	1.36E+09	1.22E+03	1		Chlorine	7782-50-5					7.8E+02		1.8E-02	1.8E-02
				3.0E-02	I	2.0E-04	I	V			1.36E+09		1		Chlorine Dioxide	10049-04-4					2.3E+02		2.8E+04	2.3E+02
				3.0E-02	I						1.36E+09		1		Chlorite (Sodium Salt)	7758-19-2					2.3E+02			2.3E+02
						5.0E+01	I	V		1.15E+03	1.36E+09	1.03E+03	1		Chloro-1,1-difluoroethane, 1-	75-68-3							5.4E+03	5.4E+03
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		7.86E+02	1.36E+09	1.08E+03	1		Chloro-1,3-butadiene, 2- (Chloroprene)	126-99-8			1.0E-02	1.0E-02	1.6E+02		2.2E+00	2.2E+00
4.6E-01	H										1.36E+09		1	0.1	Chloro-2-methylaniline HCl, 4-	3165-93-3	1.5E+00	5.4E+00		1.2E+00				
1.0E-01	P	7.7E-05	C	3.0E-03	X						1.36E+09		1	0.1	Chloro-2-methylaniline, 4-	95-69-2	7.0E+00	2.5E+01	5.0E+04	5.4E+00	2.3E+01	9.9E+01		1.9E+01
2.7E-01	X							V		1.18E+04	1.36E+09	1.62E+04	1		Chloroacetaldehyde, 2-	107-20-0	2.6E+00			2.6E+00				
				3.5E-03	C						1.36E+09		1	0.1	Chloroacetic Acid	79-11-8					2.7E+01	1.2E+02		2.2E+01
						3.0E-05	I				1.36E+09		1	0.1	Chloroacetophenone, 2-	532-27-4							4.3E+03	4.3E+03
2.0E-01	P			5.0E-04	P						1.36E+09		1	0.1	Chloroaniline, p-	106-47-8	3.5E+00	1.2E+01		2.7E+00	3.9E+00	1.6E+01		3.2E+00
				2.0E-02	I	5.0E-02	P	V		7.61E+02	1.36E+09	6.45E+03	1		Chlorobenzene	108-90-7					1.6E+02		3.4E+01	2.8E+01
				1.0E-01	X						1.36E+09		1	0.1	Chlorobenzene sulfonic acid, p-	98-66-8					7.8E+02	3.3E+03		6.3E+02
1.1E-01	C	3.1E-05	C	2.0E-02	I						1.36E+09		1	0.1	Chlorobenzilate	510-15-6	6.3E+00	2.2E+01	1.2E+05	4.9E+00	1.6E+02	6.6E+02		1.3E+02
				3.0E-02	X						1.36E+09		1	0.1	Chlorobenzoic Acid, p-	74-11-3					2.3E+02	9.9E+02		1.9E+02
		8.6E-06	C	3.0E-03	P	3.0E-01	P	V		2.90E+02	1.36E+09	6.76E+03	1		Chlorobenzotrifluoride, 4-	98-56-6			2.2E+00	2.2E+00	2.3E+01		2.1E+02	2.1E+01
				4.0E-02	P			V		7.28E+02	1.36E+09	1.76E+03	1		Chlorobutane, 1-	109-69-3					3.1E+02			3.1E+02
						5.0E+01	I	V		1.68E+03	1.36E+09	9.38E+02	1		Chlorodifluoromethane	75-45-6							4.9E+03	4.9E+03
				2.0E-02	P			V		1.11E+05	1.36E+09	7.81E+04	1		Chloroethanol, 2-	107-07-3					1.6E+02			1.6E+02
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		2.54E+03	1.36E+09	2.63E+03	1		Chloroform	67-66-3	2.2E+01		3.2E-01	3.2E-01	7.8E+01		2.7E+01	2.0E+01
						9.0E-02	I	V		1.32E+03	1.36E+09	1.18E+03	1		Chloromethane	74-87-3							1.1E+01	1.1E+01
2.4E+00	C	6.9E-04	C					V		9.32E+03	1.36E+09	5.33E+03	1		Chloromethyl Methyl Ether	107-30-2	2.9E-01		2.2E-02	2.0E-02				
3.0E-01	P			3.0E-03	P	1.0E-05	X				1.36E+09		1	0.1	Chloronitrobenzene, o-	88-73-3	2.3E+00	8.2E+00		1.8E+00	2.3E+01	9.9E+01	1.4E+03	1.9E+01
6.0E-02	P			7.0E-04	P	2.0E-03	P				1.36E+09		1	0.1	Chloronitrobenzene, p-	100-00-5	1.2E+01	4.1E+01		9.0E+00	5.5E+00	2.3E+01	2.8E+05	4.4E+00
				5.0E-03	I			V		2.74E+04	1.36E+09	1.39E+05	1		Chlorophenol, 2-	95-57-8					3.9E+01			3.9E+01
						4.0E-04	C	V		6.17E+02	1.36E+09	4.68E+03	1		Chloropicrin	76-06-2							2.0E-01	2.0E-01
1.7E-02	C			1.5E-02	I						1.36E+09		1	0.1	Chlorothalonil	1897-45-6	4.1E+01	1.5E+02		3.2E+01	1.2E+02	4.9E+02		9.5E+01
				2.0E-02	I			V		9.07E+02	1.36E+09	8.12E+03	1		Chlorotoluene, o-	95-49-8					1.6E+02			1.6E+02
				2.0E-02	X			V		2.53E+02	1.36E+09	7.29E+03	1		Chlorotoluene, p-	106-43-4					1.6E+02			1.6E+02
2.4E+02	C	6.9E-02	C								1.36E+09		1	0.1	Chlorozotocin	54749-90-5	2.9E-03	1.0E-02	5.5E+01	2.3E-03				
				5.0E-03	O						1.36E+09		1	0.1	Chlorpropham	101-21-3					3.9E+01	1.6E+02		3.2E+01
				1.0E-03	A						1.36E+09		1	0.1	Chlorpyrifos	2921-88-2					7.8E+00	3.3E+01		6.3E+00
				1.0E-02	H						1.36E+09		1	0.1	Chlorpyrifos Methyl	5598-13-0					7.8E+01	3.3E+02		6.3E+01
				5.0E-02	O						1.36E+09		1	0.1	Chlorsulfuron	64902-72-3					3.9E+02	1.6E+03		3.2E+02
				1.0E-02	I						1.36E+09		1	0.1	Chlorthal-dimethyl	1861-32-1					7.8E+01	3.3E+02		6.3E+01
				8.0E-04	H						1.36E+09		1	0.1	Chlorthiophos	60238-56-4					6.3E+00	2.6E+01		5.1E+00
						6.0E-05	C				1.36E+09		1		Chromium(III) (Soluble Compounds)	16065-83-1							8.5E+03	8.5E+03
				1.5E+00	I						1.36E+09		0.013		Chromium(III), Insoluble Salts	16065-83-1					1.2E+04			1.2E+04
5.0E-01	C	8.4E-02	G	3.0E-03	I	1.0E-04	I		M		1.36E+09		0.025		Chromium(VI)	18540-29-9	3.1E-01		1.6E+01	3.0E-01	2.3E+01		1.4E+04	2.3E+01
											1.36E+09		0.013		Chromium, Total	7440-47-3								
				1.3E-02	I						1.36E+09		1	0.1	Clofentezine	74115-24-5					1.0E+02	4.3E+02		8.2E+01
		9.0E-03	P	3.0E-04	P	6.0E-06	P				1.36E+09		1		Cobalt	7440-48-4			4.2E+02	4.2E+02	2.3E+00		8.5E+02	2.3E+00
		6.2E-04	I					V	M				1		Coke Oven Emissions	E649830								
				4.0E-02	H						1.36E+09		1		Copper	7440-50-8					3.1E+02			3.1E+02

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				5.0E-02	I	6.0E-01	C				1.36E+09		1	0.1	Cresol, m-	108-39-4					3.9E+02	1.6E+03	8.5E+07	3.2E+02
				5.0E-02	I	6.0E-01	C				1.36E+09		1	0.1	Cresol, o-	95-48-7					3.9E+02	1.6E+03	8.5E+07	3.2E+02
				2.0E-02	P	6.0E-01	C				1.36E+09		1	0.1	Cresol, p-	106-44-5					1.6E+02	6.6E+02	8.5E+07	1.3E+02
				1.0E-01	A						1.36E+09		1	0.1	Cresol, p-chloro-m-	59-50-7					7.8E+02	3.3E+03		6.3E+02
				1.0E-01	A	6.0E-01	C				1.36E+09		1	0.1	Cresols	1319-77-3					7.8E+02	3.3E+03	8.5E+07	6.3E+02
1.9E+00	H			1.0E-03	P			V		1.66E+04	1.36E+09	1.89E+04	1		Crotonaldehyde, trans-	123-73-9	3.7E-01			3.7E-01	7.8E+00			7.8E+00
				1.0E-01	I	4.0E-01	I	V		2.68E+02	1.36E+09	6.21E+03	1		Cumene	98-82-8					7.8E+02		2.6E+02	1.9E+02
2.2E-01	C	6.3E-05	C								1.36E+09		1	0.1	Cupferron	135-20-6	3.2E+00	1.1E+01	6.1E+04	2.5E+00				
8.4E-01	H			2.0E-03	H						1.36E+09		1	0.1	Cyanazine	21725-46-2	8.3E-01	2.9E+00		6.5E-01	1.6E+01	6.6E+01		1.3E+01
															Cyanides									
				1.0E-03	I	9.0E-03	C				1.36E+09		1		~Calcium Cyanide	592-01-8					7.8E+00		1.3E+06	7.8E+00
				5.0E-03	I						1.36E+09		1		~Copper Cyanide	544-92-3					3.9E+01			3.9E+01
				6.0E-04	I	8.0E-04	G	V		9.54E+05	1.36E+09	5.33E+04	1		~Cyanide (CN-)	57-12-5					4.7E+00		4.4E+00	2.3E+00
				1.0E-03	I			V			1.36E+09		1		~Cyanogen	460-19-5					7.8E+00			7.8E+00
				9.0E-02	I			V			1.36E+09		1		~Cyanogen Bromide	506-68-3					7.0E+02			7.0E+02
				5.0E-02	I			V			1.36E+09		1		~Cyanogen Chloride	506-77-4					3.9E+02			3.9E+02
				6.0E-04	I	8.0E-04	I	V		1.00E+07	1.36E+09	5.22E+04	1		~Hydrogen Cyanide	74-90-8					4.7E+00		4.4E+00	2.3E+00
				2.0E-03	I	9.0E-03	C				1.36E+09		1		~Potassium Cyanide	151-50-8					1.6E+01		1.3E+06	1.6E+01
				5.0E-03	I						1.36E+09		0.04		~Potassium Silver Cyanide	506-61-6					3.9E+01			3.9E+01
				1.0E-01	I						1.36E+09		0.04		~Silver Cyanide	506-64-9					7.8E+02			7.8E+02
				1.0E-03	I	9.0E-03	C				1.36E+09		1		~Sodium Cyanide	143-33-9					7.8E+00		1.3E+06	7.8E+00
				2.0E-04	P						1.36E+09		1		~Thiocyanates	E1790665					1.6E+00			1.6E+00
				2.0E-04	X			V			1.36E+09		1		~Thiocyanic Acid	463-56-9					1.6E+00			1.6E+00
				5.0E-02	I						1.36E+09		1		~Zinc Cyanide	557-21-1					3.9E+02			3.9E+02
						6.0E+00	I	V		1.17E+02	1.36E+09	1.04E+03	1		Cyclohexane	110-82-7							6.5E+02	6.5E+02
2.0E-02	X			2.0E-02	X						1.36E+09		1		Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	3.5E+01	1.2E+02		2.7E+01	1.6E+02	6.6E+02		1.3E+02
				5.0E+00	I	7.0E-01	P	V		5.11E+03	1.36E+09	4.17E+04	1		Cyclohexanone	108-94-1					3.9E+04		3.0E+03	2.8E+03
				5.0E-03	P	1.0E+00	X	V		2.83E+02	1.36E+09	1.46E+03	1		Cyclohexene	110-83-8					3.9E+01		1.5E+02	3.1E+01
				2.0E-01	I			V		2.93E+05	1.36E+09	7.46E+04	1		Cyclohexylamine	108-91-8					1.6E+03			1.6E+03
				2.5E-02	I						1.36E+09		1	0.1	Cyfluthrin	68359-37-5					2.0E+02	8.2E+02		1.6E+02
				5.0E-01	O						1.36E+09		1	0.1	Cyromazine	66215-27-8					3.9E+03	1.6E+04		3.2E+03
				3.0E-02	I						1.36E+09		1	0.1	Dalapon	75-99-0					2.3E+02	9.9E+02		1.9E+02
1.8E-02	C	5.1E-06	C	1.5E-01	I						1.36E+09		1	0.1	Daminozide	1596-84-5	3.9E+01	1.4E+02	7.5E+05	3.0E+01	1.2E+03	4.9E+03		9.5E+02
7.0E-04	I			7.0E-03	I						1.36E+09		1	0.1	Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	9.9E+02	3.5E+03		7.8E+02	5.5E+01	2.3E+02		4.4E+01
				4.0E-05	I						1.36E+09		1	0.1	Demeton	8065-48-3					3.1E-01	1.3E+00		2.5E-01
1.2E-03	I			6.0E-01	I						1.36E+09		1	0.1	Di(2-ethylhexyl)adipate	103-23-1	5.8E+02	2.1E+03		4.5E+02	4.7E+03	2.0E+04		3.8E+03
6.1E-02	H										1.36E+09		1	0.1	Diallate	2303-16-4	1.1E+01	4.1E+01		8.9E+00				
				7.0E-04	A						1.36E+09		1	0.1	Diazinon	333-41-5					5.5E+00	2.3E+01		4.4E+00
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	9.79E+02	1.36E+09	3.20E+04	1		Dibromo-3-chloropropane, 1,2-	96-12-8	1.9E-01		5.4E-03	5.3E-03	1.6E+00		6.7E-01	4.7E-01
2.5E-01	C			3.0E-04	C						1.36E+09		1	0.1	Dibromoacetic acid	631-64-1	2.8E+00	9.9E+00		2.2E+00	2.3E+00	9.9E+00		1.9E+00
				4.0E-04	X			V		1.59E+02	1.36E+09	1.93E+04	1		Dibromobenzene, 1,3-	108-36-1					3.1E+00			3.1E+00
				1.0E-02	I			V			1.36E+09	2.20E+04	1		Dibromobenzene, 1,4-	106-37-6					7.8E+01			7.8E+01
8.4E-02	I			2.0E-02	I			V		8.02E+02	1.36E+09	7.95E+03	1		Dibromochloromethane	124-48-1	8.3E+00			8.3E+00	1.6E+02			1.6E+02
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1.34E+03	1.36E+09	8.64E+03	1		Dibromoethane, 1,2-	106-93-4	3.5E-01		4.0E-02	3.6E-02	7.0E+01		8.1E+00	7.3E+00
						4.0E-03	X	V		2.82E+03	1.36E+09	5.64E+03	1		Dibromomethane (Methylene Bromide)	74-95-3							2.4E+00	2.4E+00
				3.0E-04	P						1.36E+09		1	0.1	Dibutyltin Compounds	E1790661					2.3E+00	9.9E+00		1.9E+00
				3.0E-02	I						1.36E+09		1	0.1	Dicamba	1918-00-9					2.3E+02	9.9E+02		1.9E+02
											1.36E+09		1	0.1	Dichloramine	3400-09-7								
		4.2E-03	P					V		5.54E+02	1.36E+09	3.21E+03	1		Dichloro-2-butene, 1,4-	764-41-0			2.1E-03	2.1E-03				
		4.2E-03	P					V		5.19E+02	1.36E+09	1.11E+04	1		Dichloro-2-butene, cis-1,4-	1476-11-5			7.4E-03	7.4E-03				
		4.2E-03	P					V		7.60E+02	1.36E+09	1.11E+04	1		Dichloro-2-butene, trans-1,4-	110-57-6			7.4E-03	7.4E-03				
5.0E-02	I			4.0E-03	I						1.36E+09		1	0.1	Dichloroacetic Acid	79-43-6	1.4E+01	4.9E+01		1.1E+01	3.1E+01	1.3E+02		2.5E+01
				9.0E-02	I	2.0E-01	H	V		3.76E+02	1.36E+09	1.17E+04	1		Dichlorobenzene, 1,2-	95-50-1					7.0E+02		2.4E+02	1.8E+02
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V			1.36E+09	1.04E+04	1		Dichlorobenzene, 1,4-	106-46-7	1.3E+02		2.7E+00	2.6E+00	5.5E+02		8.7E+02	3.4E+02
4.5E-01	I	3.4E-04	C								1.36E+09		1	0.1	Dichlorobenzidine, 3,3'-	91-94-1	1.5E+00	5.5E+00	1.1E+04	1.2E+00				
				9.0E-03	X						1.36E+09		1	0.1	Dichlorobenzophenone, 4,4'-	90-98-2					7.0E+01	3.0E+02		5.7E+01
				2.0E-01	I	1.0E-01	X	V		8.45E+02	1.36E+09	8.41E+02	1		Dichlorodifluoromethane	75-71-8					1.6E+03		8.8E+00	8.7E+00
2.4E-01	I	6.9E-05	C	5.0E-04	A						1.36E+09		1	0.1	Dichlorodiphenyldichloroethane, p,p`- (DDD)	72-54-8	2.9E+00	1.0E+01	5.5E+04	2.3E+00	3.9E+00	1.6E+01		3.2E+00
3.4E-01	I	9.7E-05	C	5.0E-04	A			V			1.36E+09	2.10E+06	1		Dichlorodiphenyldichloroethylene, p,p`- (DDE)	72-55-9	2.0E+00		6.1E+01	2.0E+00	3.9E+00			3.9E+00
3.4E-01	I	9.7E-05	I	5.0E-04	I						1.36E+09		1	0.03	Dichlorodiphenyltrichloroethane, p,p`- (DDT)	50-29-3	2.0E+00	2.4E+01	3.9E+04	1.9E+00	3.9E+00	5.5E+01		3.7E+00
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1.69E+03	1.36E+09	2.08E+03	1		Dichloroethane, 1,1-	75-34-3	1.2E+02		3.7E+00	3.6E+00	1.6E+03			1.6E+03
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		2.98E+03	1.36E+09	4.57E+03	1		Dichloroethane, 1,2-	107-06-2	7.6E+00		4.9E-01	4.6E-01	4.7E+01		3.3E+00	3.1E+00
				5.0E-02	I	2.0E-01	I	V		1.19E+03	1.36E+09	1.16E+03	1		Dichloroethylene, 1,1-	75-35-4					3.9E+02		2.4E+01	2.3E+01
				2.0E-03	I	4.0E-02	X	V		2.37E+03	1.36E+09	2.50E+03	1		Dichloroethylene, cis-1,2-	156-59-2					1.6E+01		1.0E+01	6.3E+00
				2.0E-02	I	4.0E-02	X	V		1.85E+03	1.36E+09	1.75E+03	1		Dichloroethylene, trans-1,2-	156-60-5					1.6E+02		7.3E+00	7.0E+00
				3.0E-03	I						1.36E+09		1	0.1	Dichlorophenol, 2,4-	120-83-2					2.3E+01	9.9E+01		1.9E+01
				1.0E-02	I						1.36E+09		1	0.05	Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					7.8E+01	6.6E+02		7.0E+01
3.7E-02	P	3.7E-06	P	4.0E-02	P	4.0E-03	I	V		1.36E+03	1.36E+09	3.79E+03	1		Dichloropropane, 1,2-	78-87-5	1.9E+01		2.9E+00	2.5E+00	3.1E+02		1.6E+00	1.6E+00
				2.0E-02	P			V		1.49E+03	1.36E+09	6.76E+03	1		Dichloropropane, 1,3-	142-28-9					1.6E+02			1.6E+02
				3.0E-03	I						1.36E+09		1	0.1	Dichloropropanol, 2,3-	616-23-9					2.3E+01	9.9E+01		1.9E+01
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		1.57E+03	1.36E+09	3.55E+03	1		Dichloropropene, 1,3-	542-75-6	7.0E+00		2.5E+00	1.8E+00	2.3E+02		7.4E+00	7.2E+00
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I				1.36E+09		1	0.1	Dichlorvos	62-73-7	2.4E+00	8.5E+00	4.6E+04	1.9E+00	3.9E+00	1.6E+01	7.1E+04	3.2E+00
				3.0E-05	O						1.36E+09		1	0.1	Dicrotophos	141-66-2					2.3E-01	9.9E-01		1.9E-01
				8.0E-02	P	3.0E-04	X	V		2.56E+02	1.36E+09	4.11E+03	1		Dicyclopentadiene	77-73-6					6.3E+02		1.3E-01	1.3E-01
1.6E+01	I	4.6E-03	I	5.0E-05	I						1.36E+09		1	0.1	Dieldrin	60-57-1	4.3E-02	1.5E-01	8.3E+02	3.4E-02	3.9E-01	1.6E+00		3.2E-01
		3.0E-04	C			5.0E-03	I						1	0.1	Diesel Engine Exhaust	E17136615								
				2.0E-03	P	2.0E-04	P				1.36E+09		1	0.1	Diethanolamine	111-42-2					1.6E+01	6.6E+01	2.8E+04	1.3E+01
				3.0E-02	P	1.0E-04	P				1.36E+09		1	0.1	Diethylene Glycol Monobutyl Ether	112-34-5					2.3E+02	9.9E+02	1.4E+04	1.9E+02
				6.0E-02	P	3.0E-04	P				1.36E+09		1	0.1	Diethylene Glycol Monoethyl Ether	111-90-0					4.7E+02	2.0E+03	4.3E+04	3.8E+02
				1.0E-03	P			V		1.12E+05	1.36E+09	1.39E+05	1		Diethylformamide	617-84-5					7.8E+00			7.8E+00
3.5E+02	C	1.0E-01	C								1.36E+09		1	0.1	Diethylstilbestrol	56-53-1	2.0E-03	7.1E-03	3.8E+01	1.6E-03				
				8.3E-02	O						1.36E+09		1	0.1	Difenzoquat	43222-48-6					6.5E+02	2.7E+03		5.2E+02
				2.0E-02	I						1.36E+09		1	0.1	Diflubenzuron	35367-38-5					1.6E+02	6.6E+02		1.3E+02

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
						4.0E+01	I	V		1.43E+03	1.36E+09	1.15E+03	1		Difluoroethane, 1,1-	75-37-6							4.8E+03	4.8E+03
						3.0E+01	X	V		6.91E+02	1.36E+09	7.58E+02	1		Difluoropropane, 2,2-	420-45-1							2.4E+03	2.4E+03
4.4E-02	C	1.3E-05	C					V			1.36E+09	1.23E+05	1		Dihydrosafrole	94-58-6	1.6E+01		2.7E+01	9.9E+00				
						7.0E-01	P	V		2.26E+03	1.36E+09	3.06E+03	1		Diisopropyl Ether	108-20-3							2.2E+02	2.2E+02
				8.0E-02	I			V		5.30E+02	1.36E+09	3.81E+04	1		Diisopropyl Methylphosphonate	1445-75-6					6.3E+02			6.3E+02
				2.2E-02	O						1.36E+09		1	0.1	Dimethipin	55290-64-7					1.7E+02	7.2E+02		1.4E+02
				2.2E-03	O						1.36E+09		1	0.1	Dimethoate	60-51-5					1.7E+01	7.3E+01		1.4E+01
1.6E+00	P	1.4E-01	C								1.36E+09		1	0.1	Dimethoxybenzidine, 3,3'-	119-90-4	4.3E-01	1.5E+00	2.7E+01	3.3E-01				
1.7E-03	P			6.0E-02	P						1.36E+09		1	0.1	Dimethyl methylphosphonate	756-79-6	4.1E+02	1.5E+03		3.2E+02	4.7E+02	2.0E+03		3.8E+02
4.6E+00	C	1.3E-03	C								1.36E+09		1	0.1	Dimethylamino azobenzene [p-]	60-11-7	1.5E-01	5.4E-01	2.9E+03	1.2E-01				
5.8E-01	H										1.36E+09		1	0.1	Dimethylaniline HCl, 2,4-	21436-96-4	1.2E+00	4.3E+00		9.4E-01				
2.0E-01	P			2.0E-03	X						1.36E+09		1	0.1	Dimethylaniline, 2,4-	95-68-1	3.5E+00	1.2E+01		2.7E+00	1.6E+01	6.6E+01		1.3E+01
2.7E-02	P			2.0E-03	I			V		8.30E+02	1.36E+09	3.13E+04	1		Dimethylaniline, N,N-	121-69-7	2.6E+01			2.6E+01	1.6E+01			1.6E+01
1.1E+01	P										1.36E+09		1	0.1	Dimethylbenzidine, 3,3'-	119-93-7	6.3E-02	2.2E-01		4.9E-02				
				1.0E-01	P	3.0E-02	I	V		1.06E+05	1.36E+09	1.28E+05	1		Dimethylformamide	68-12-2					7.8E+02		4.0E+02	2.6E+02
				1.0E-04	X	2.0E-06	X	V		1.72E+05	1.36E+09	2.77E+04	1		Dimethylhydrazine, 1,1-	57-14-7					7.8E-01		5.8E-03	5.7E-03
5.5E+02	C	1.6E-01	C					V		1.89E+05	1.36E+09	1.68E+05	1		Dimethylhydrazine, 1,2-	540-73-8	1.3E-03		2.9E-03	8.8E-04				
				2.0E-02	I						1.36E+09		1	0.1	Dimethylphenol, 2,4-	105-67-9					1.6E+02	6.6E+02		1.3E+02
				6.0E-04	I						1.36E+09		1	0.1	Dimethylphenol, 2,6-	576-26-1					4.7E+00	2.0E+01		3.8E+00
				1.0E-03	I						1.36E+09		1	0.1	Dimethylphenol, 3,4-	95-65-8					7.8E+00	3.3E+01		6.3E+00
4.5E-02	C	1.3E-05	C					V		4.73E+02	1.36E+09	5.48E+03	1		Dimethylvinylchloride	513-37-1	1.5E+01		1.2E+00	1.1E+00				
				8.0E-05	X						1.36E+09		1	0.1	Dinitro-o-cresol, 4,6-	534-52-1					6.3E-01	2.6E+00		5.1E-01
				2.0E-03	I						1.36E+09		1	0.1	Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					1.6E+01	6.6E+01		1.3E+01
				4.0E-04	X	2.0E-03	X				1.36E+09		1	0.1	Dinitroaniline, 3,5-	618-87-1					3.1E+00	1.3E+01	2.8E+05	2.5E+00
				1.0E-04	P						1.36E+09		1	0.1	Dinitrobenzene, 1,2-	528-29-0					7.8E-01	3.3E+00		6.3E-01
				1.0E-04	I						1.36E+09		1	0.1	Dinitrobenzene, 1,3-	99-65-0					7.8E-01	3.3E+00		6.3E-01
				1.0E-04	P						1.36E+09		1	0.1	Dinitrobenzene, 1,4-	100-25-4					7.8E-01	3.3E+00		6.3E-01
				2.0E-03	I						1.36E+09		1	0.1	Dinitrophenol, 2,4-	51-28-5					1.6E+01	6.6E+01		1.3E+01
6.8E-01	I										1.36E+09		1	0.1	Dinitrotoluene Mixture, 2,4/2,6-	E1615210	1.0E+00	3.6E+00		8.0E-01				
3.1E-01	C	8.9E-05	C	2.0E-03	I						1.36E+09		1	0.102	Dinitrotoluene, 2,4-	121-14-2	2.2E+00	7.8E+00	4.3E+04	1.7E+00	1.6E+01	6.5E+01		1.3E+01
1.5E+00	P			3.0E-04	X						1.36E+09		1	0.099	Dinitrotoluene, 2,6-	606-20-2	4.6E-01	1.7E+00		3.6E-01	2.3E+00	1.0E+01		1.9E+00
				1.0E-04	X						1.36E+09		1	0.006	Dinitrotoluene, 2-Amino-4,6-	35572-78-2					7.8E-01	5.5E+01		7.7E-01
				1.0E-04	X						1.36E+09		1	0.009	Dinitrotoluene, 4-Amino-2,6-	19406-51-0					7.8E-01	3.7E+01		7.7E-01
4.5E-01	X			9.0E-04	X						1.36E+09		1	0.1	Dinitrotoluene, Technical grade	25321-14-6	1.5E+00	5.5E+00		1.2E+00	7.0E+00	3.0E+01		5.7E+00
				1.0E-03	I						1.36E+09		1	0.1	Dinoseb	88-85-7					7.8E+00	3.3E+01		6.3E+00
1.0E-01	I	5.0E-06	I	3.0E-02	I	3.0E-02	I	V		1.16E+05	1.36E+09	3.96E+04	1		Dioxane, 1,4-	123-91-1	7.0E+00		2.2E+01	5.3E+00	2.3E+02		1.2E+02	8.1E+01
															Dioxins									
6.2E+03	I	1.3E+00	I								1.36E+09		1	0.03	~Hexachlorodibenzo-p-dioxin, Mixture	34465-46-8	1.1E-04	1.3E-03	2.9E+00	1.0E-04				
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C	V			1.36E+09	1.96E+06	1	0.03	~TCDD, 2,3,7,8-	1746-01-6	5.3E-06	6.3E-05	1.4E-04	4.8E-06	5.5E-06	7.7E-05	8.2E-03	5.1E-06
				3.0E-02	I						1.36E+09		1	0.1	Diphenamid	957-51-7					2.3E+02	9.9E+02		1.9E+02
						4.0E-04	X	V			1.36E+09	8.06E+04	1		Diphenyl Ether	101-84-8							3.4E+00	3.4E+00
				8.0E-04	X						1.36E+09		1	0.1	Diphenyl Sulfone	127-63-9					6.3E+00	2.6E+01		5.1E+00
				1.0E-01	O						1.36E+09		1	0.1	Diphenylamine	122-39-4					7.8E+02	3.3E+03		6.3E+02
8.0E-01	I	2.2E-04	I								1.36E+09		1	0.1	Diphenylhydrazine, 1,2-	122-66-7	8.7E-01	3.1E+00	1.7E+04	6.8E-01				
				2.2E-03	I						1.36E+09		1	0.1	Diquat	2764-72-9					1.7E+01	7.3E+01		1.4E+01
7.4E+00	C	2.1E-03	C								1.36E+09		1	0.1	Direct Black 38	1937-37-7	9.4E-02	3.3E-01	1.8E+03	7.3E-02				
7.4E+00	C	2.1E-03	C								1.36E+09		1	0.1	Direct Blue 6	2602-46-2	9.4E-02	3.3E-01	1.8E+03	7.3E-02				
6.7E+00	C	1.9E-03	C								1.36E+09		1	0.1	Direct Brown 95	16071-86-6	1.0E-01	3.7E-01	2.0E+03	8.1E-02				
				4.0E-05	I						1.36E+09		1	0.1	Disulfoton	298-04-4					3.1E-01	1.3E+00		2.5E-01
				1.0E-02	I			V			1.36E+09	4.54E+04	1		Dithiane, 1,4-	505-29-3					7.8E+01			7.8E+01
				2.0E-03	I						1.36E+09		1	0.1	Diuron	330-54-1					1.6E+01	6.6E+01		1.3E+01
				2.0E-02	O						1.36E+09		1	0.1	Dodine	2439-10-3					1.6E+02	6.6E+02		1.3E+02
				5.0E-02	O			V			1.36E+09	1.17E+05	1		EPTC	759-94-4					3.9E+02			3.9E+02
				6.0E-03	I			V			1.36E+09	4.10E+05	1		Endosulfan	115-29-7					4.7E+01			4.7E+01
				6.0E-03	P						1.36E+09		1	0.1	Endosulfan Sulfate	1031-07-8					4.7E+01	2.0E+02		3.8E+01
				2.0E-02	I						1.36E+09		1	0.1	Endothall	145-73-3					1.6E+02	6.6E+02		1.3E+02
				3.0E-04	I						1.36E+09		1	0.1	Endrin	72-20-8					2.3E+00	9.9E+00		1.9E+00
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		1.05E+04	1.36E+09	1.89E+04	1		Epichlorohydrin	106-89-8	7.0E+01		4.4E+01	2.7E+01	4.7E+01		2.0E+00	1.9E+00
						2.0E-02	I	V		1.53E+04	1.36E+09	7.66E+03	1		Epoxybutane, 1,2-	106-88-7							1.6E+01	1.6E+01
				4.0E-02	P						1.36E+09		1	0.1	Ethanol, 2-(2-methoxyethoxy)-	111-77-3					3.1E+02	1.3E+03		2.5E+02
				5.0E-03	I						1.36E+09		1	0.1	Ethephon	16672-87-0					3.9E+01	1.6E+02		3.2E+01
				5.0E-04	I						1.36E+09		1	0.1	Ethion	563-12-2					3.9E+00	1.6E+01		3.2E+00
				1.0E-01	P	6.0E-02	P	V		2.38E+04	1.36E+09	6.15E+04	1		Ethoxyethanol Acetate, 2-	111-15-9					7.8E+02		3.8E+02	2.6E+02
				9.0E-02	P	4.0E-02	P	V		1.06E+05	1.36E+09	9.84E+04	1		Ethoxyethanol, 2-	110-80-5					7.0E+02		4.1E+02	2.6E+02
				7.0E-01	P	7.0E-02	P	V		1.08E+04	1.36E+09	8.62E+03	1		Ethyl Acetate	141-78-6					5.5E+03		6.3E+01	6.2E+01
				5.0E-03	P	8.0E-03	P	V		2.50E+03	1.36E+09	6.34E+03	1		Ethyl Acrylate	140-88-5					3.9E+01		5.3E+00	4.7E+00
						4.0E+00	P	V		2.12E+03	1.36E+09	1.29E+03	1		Ethyl Chloride (Chloroethane)	75-00-3							5.4E+02	5.4E+02
				2.0E-01	I			V		1.01E+04	1.36E+09	3.12E+03	1		Ethyl Ether	60-29-7					1.6E+03			1.6E+03
						3.0E-01	P	V		1.10E+03	1.36E+09	5.77E+03	1		Ethyl Methacrylate	97-63-2							1.8E+02	1.8E+02
		8.0E-08	I	1.0E+00	I	4.0E+01	I	V		2.87E+03	1.36E+09	3.67E+03	1		Ethyl Tertiary Butyl Ether (ETBE)	637-92-3			1.3E+02	1.3E+02	7.8E+03		1.5E+04	5.2E+03
				1.0E-05	I						1.36E+09		1	0.1	Ethyl-p-nitrophenyl Phosphonate	2104-64-5					7.8E-02	3.3E-01		6.3E-02
1.1E-02	C	2.5E-06	C	5.0E-02	P	1.0E+00	I	V		4.80E+02	1.36E+09	5.67E+03	1		Ethylbenzene	100-41-4	6.3E+01		6.4E+00	5.8E+00	3.9E+02		5.9E+02	2.4E+02
				7.0E-02	P						1.36E+09		1	0.1	Ethylene Cyanohydrin	109-78-4					5.5E+02	2.3E+03		4.4E+02
				9.0E-02	P			V		1.89E+05	1.36E+09	1.80E+05	1		Ethylene Diamine	107-15-3					7.0E+02			7.0E+02
				8.0E-01	A	4.0E-01	C				1.36E+09		1	0.1	Ethylene Glycol	107-21-1					6.3E+03	2.6E+04	5.7E+07	5.1E+03
				1.0E-01	I	1.6E+00	I				1.36E+09		1	0.1	Ethylene Glycol Monobutyl Ether	111-76-2					7.8E+02	3.3E+03	2.3E+08	6.3E+02
3.1E-01	C	3.0E-03	I			3.0E-02	C	V	M	1.21E+05	1.36E+09	6.09E+03	1		Ethylene Oxide	75-21-8	4.9E-01		2.1E-03	2.0E-03			1.9E+01	1.9E+01
4.5E-02	C	1.3E-05	C	8.0E-05	I						1.36E+09		1	0.1	Ethylene Thiourea	96-45-7	1.5E+01	5.5E+01	2.9E+05	1.2E+01	6.3E-01	2.6E+00		5.1E-01
6.5E+01	C	1.9E-02	C					V		1.54E+05	1.36E+09	2.39E+04	1		Ethyleneimine	151-56-4	1.1E-02		3.5E-03	2.7E-03				
				3.0E+00	I						1.36E+09		1	0.1	Ethylphthalyl Ethyl Glycolate	84-72-0					2.3E+04	9.9E+04		1.9E+04
				2.5E-04	I						1.36E+09		1	0.1	Fenamiphos	22224-92-6					2.0E+00	8.2E+00		1.6E+00
				2.5E-02	I						1.36E+09		1	0.1	Fenpropathrin	39515-41-8					2.0E+02	8.2E+02		1.6E+02
				2.5E-02	I						1.36E+09		1	0.1	Fenvalerate	51630-58-1					2.0E+02	8.2E+02		1.6E+02

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information																Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				1.3E-02	I						1.36E+09		1	0.1	Fluometuron	2164-17-2					1.0E+02	4.3E+02		8.2E+01
				4.0E-02	C	1.3E-02	C				1.36E+09		1		Fluoride	16984-48-8					3.1E+02		1.8E+06	3.1E+02
				6.0E-02	I	1.3E-02	C				1.36E+09		1		Fluorine (Soluble Fluoride)	7782-41-4					4.7E+02		1.8E+06	4.7E+02
				8.0E-02	I						1.36E+09		1	0.1	Fluridone	59756-60-4					6.3E+02	2.6E+03		5.1E+02
				4.0E-02	O						1.36E+09		1	0.1	Flurprimidol	56425-91-3					3.1E+02	1.3E+03		2.5E+02
				2.0E-03	O						1.36E+09		1	0.1	Flusilazole	85509-19-9					1.6E+01	6.6E+01		1.3E+01
				5.0E-01	O						1.36E+09		1	0.1	Flutolanil	66332-96-5					3.9E+03	1.6E+04		3.2E+03
				1.0E-02	I						1.36E+09		1	0.1	Fluvalinate	69409-94-5					7.8E+01	3.3E+02		6.3E+01
				9.0E-02	O						1.36E+09		1	0.1	Folpet	133-07-3					7.0E+02	3.0E+03		5.7E+02
				1.0E-02	O						1.36E+09		1	0.1	Fomesafen	72178-02-0					7.8E+01	3.3E+02		6.3E+01
				2.0E-03	I						1.36E+09		1	0.1	Fonofos	944-22-9					1.6E+01	6.6E+01		1.3E+01
2.1E-02	C	1.3E-05	I	2.0E-01	I	9.8E-03	A	V		4.24E+04	1.36E+09	7.77E+04	1		Formaldehyde	50-00-0	3.3E+01		1.7E+01	1.1E+01	1.6E+03		8.0E+01	7.6E+01
				9.0E-01	P	3.0E-04	X	V		1.06E+05	1.36E+09	9.30E+04	1		Formic Acid	64-18-6					7.0E+03		2.9E+00	2.9E+00
				2.5E+00	O						1.36E+09		1	0.1	Fosetyl-AL	39148-24-8					2.0E+04	8.2E+04		1.6E+04
															Furans									
				1.0E-03	X			V			1.36E+09	1.56E+05	1		~Dibenzofuran	132-64-9					7.8E+00			7.8E+00
				1.0E-03	I			V		6.22E+03	1.36E+09	2.62E+03	1		~Furan	110-00-9					7.8E+00			7.8E+00
				9.0E-01	I	2.0E+00	I	V		1.65E+05	1.36E+09	1.20E+04	1		~Tetrahydrofuran	109-99-9					7.0E+03		2.5E+03	1.8E+03
3.8E+00	H										1.36E+09		1	0.1	Furazolidone	67-45-8	1.8E-01	6.5E-01		1.4E-01				
				3.0E-03	I	5.0E-02	H	V		1.01E+04	1.36E+09	4.86E+04	1		Furfural	98-01-1					2.3E+01		2.5E+02	2.1E+01
1.5E+00	C	4.3E-04	C								1.36E+09		1	0.1	Furium	531-82-8	4.6E-01	1.6E+00	8.9E+03	3.6E-01				
3.0E-02	I	8.6E-06	C								1.36E+09		1	0.1	Furmecyclox	60568-05-0	2.3E+01	8.2E+01	4.4E+05	1.8E+01				
				6.0E-03	O						1.36E+09		1	0.1	Glufosinate, Ammonium	77182-82-2					4.7E+01	2.0E+02		3.8E+01
				1.0E-01	A	8.0E-05	C				1.36E+09		1	0.1	Glutaraldehyde	111-30-8					7.8E+02	3.3E+03	1.1E+04	6.0E+02
				4.0E-04	I	1.0E-03	X	V		1.06E+05	1.36E+09	8.43E+04	1		Glycidaldehyde	765-34-4					3.1E+00		8.8E+00	2.3E+00
				1.0E-01	I						1.36E+09		1	0.1	Glyphosate	1071-83-6					7.8E+02	3.3E+03		6.3E+02
				1.0E-02	X			V			1.36E+09	1.45E+05	1		Guanidine	113-00-8					7.8E+01			7.8E+01
				2.0E-02	P						1.36E+09		1	0.1	Guanidine Chloride	50-01-1					1.6E+02	6.6E+02		1.3E+02
				3.0E-02	X						1.36E+09		1	0.1	Guanidine Nitrate	506-93-4					2.3E+02	9.9E+02		1.9E+02
				5.0E-05	I						1.36E+09		1	0.1	Haloxyfop, Methyl	69806-40-2					3.9E-01	1.6E+00		3.2E-01
4.5E+00	I	1.3E-03	I	1.0E-04	A			V			1.36E+09	4.79E+05	1		Heptachlor	76-44-8	1.5E-01		1.0E+00	1.3E-01	7.8E-01			7.8E-01
9.1E+00	I	2.6E-03	I	1.3E-05	I			V			1.36E+09	8.43E+05	1		Heptachlor Epoxide	1024-57-3	7.6E-02		9.1E-01	7.0E-02	1.0E-01			1.0E-01
						3.0E-03	X	V		2.09E+02	1.36E+09	7.80E+03	1		Heptanal, n-	111-71-7							2.4E+00	2.4E+00
				3.0E-04	X	4.0E-01	P	V		5.79E+01	1.36E+09	8.95E+02	1		Heptane, N-	142-82-5					2.3E+00		3.7E+01	2.2E+00
				2.0E-03	I			V			1.36E+09	3.80E+05	1		Hexabromobenzene	87-82-1					1.6E+01			1.6E+01
				2.0E-04	I						1.36E+09		1	0.1	Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					1.6E+00	6.6E+00		1.3E+00
1.6E+00	I	4.6E-04	I	1.0E-05	P			V			1.36E+09	6.80E+04	1		Hexachlorobenzene	118-74-1	4.3E-01		4.1E-01	2.1E-01	7.8E-02			7.8E-02
7.8E-02	I	2.2E-05	I	1.0E-03	P			V		1.68E+01	1.36E+09	1.08E+04	1		Hexachlorobutadiene	87-68-3	8.9E+00		1.4E+00	1.2E+00	7.8E+00			7.8E+00
6.3E+00	I	1.8E-03	I								1.36E+09		1	0.1	Hexachlorocyclohexane, Alpha-	319-84-6	1.1E-01	3.9E-01	2.1E+03	8.6E-02				
1.8E+00	I	5.3E-04	I								1.36E+09		1	0.1	Hexachlorocyclohexane, Beta-	319-85-7	3.9E-01	1.4E+00	7.2E+03	3.0E-01				
1.1E+00	C	3.1E-04	C	3.0E-04	I						1.36E+09		1	0.04	Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	6.3E-01	5.6E+00	1.2E+04	5.7E-01	2.3E+00	2.5E+01		2.1E+00
1.8E+00	I	5.1E-04	I								1.36E+09		1	0.1	Hexachlorocyclohexane, Technical	608-73-1	3.9E-01	1.4E+00	7.5E+03	3.0E-01				
				6.0E-03	I	2.0E-04	I	V		1.57E+01	1.36E+09	8.51E+03	1		Hexachlorocyclopentadiene	77-47-4					4.7E+01		1.8E-01	1.8E-01
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I	V			1.36E+09	8.01E+03	1		Hexachloroethane	67-72-1	1.7E+01		2.0E+00	1.8E+00	5.5E+00		2.5E+01	4.5E+00
				3.0E-04	I						1.36E+09		1	0.1	Hexachlorophene	70-30-4					2.3E+00	9.9E+00		1.9E+00
8.0E-02	I			4.0E-03	I						1.36E+09		1	0.015	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	8.7E+00	2.1E+02		8.3E+00	3.1E+01	8.8E+02		3.0E+01
						1.0E-05	I	V		3.39E+03	1.36E+09	3.00E+05	1		Hexamethylene Diisocyanate, 1,6-	822-06-0							3.1E-01	3.1E-01
						4.0E-04	C				1.36E+09		1	0.1	Hexamethylene diisocyanate biuret	4035-89-6							5.7E+04	5.7E+04
						4.0E-04	C				1.36E+09		1	0.1	Hexamethylene diisocyanate isocyanurate	3779-63-3							5.7E+04	5.7E+04
				4.0E-04	P						1.36E+09		1	0.1	Hexamethylphosphoramide	680-31-9					3.1E+00	1.3E+01		2.5E+00
		2.0E-07	X			6.0E-01	P	V		1.41E+02	1.36E+09	8.29E+02	1		Hexane, Commercial	E5241997			1.2E+01	1.2E+01			5.2E+01	5.2E+01
						7.0E-01	I	V		1.41E+02	1.36E+09	8.29E+02	1		Hexane, N-	110-54-3							6.1E+01	6.1E+01
				2.0E+00	P						1.36E+09		1	0.1	Hexanedioic Acid	124-04-9					1.6E+04	6.6E+04		1.3E+04
9.5E-03	P			7.0E-02	P	4.0E-04	P	V			2.74E+02	1.36E+09	3.62E+04	1	Hexanol, 1-2-ethyl- (2-Ethyl-1-hexanol)	104-76-7	7.3E+01			7.3E+01	5.5E+02		1.5E+00	1.5E+00
				5.0E-03	I	3.0E-02	I	V		3.28E+03	1.36E+09	1.33E+04	1		Hexanone, 2-	591-78-6					3.9E+01		4.2E+01	2.0E+01
				3.3E-02	I						1.36E+09		1	0.1	Hexazinone	51235-04-2					2.6E+02	1.1E+03		2.1E+02
				2.5E-02	I						1.36E+09		1	0.1	Hexythiazox	78587-05-0					2.0E+02	8.2E+02		1.6E+02
				1.7E-02	O						1.36E+09		1	0.1	Hydramethylnon	67485-29-4					1.3E+02	5.6E+02		1.1E+02
3.0E+00	I	4.9E-03	I			3.0E-05	P	V		1.12E+05	1.36E+09	6.52E+04	1		Hydrazine	302-01-2	2.3E-01		3.7E-02	3.2E-02			2.0E-01	2.0E-01
3.0E+00	I	4.9E-03	I								1.36E+09		1		Hydrazine Sulfate	10034-93-2	2.3E-01		7.8E+02	2.3E-01				
						2.0E-02	I	V			1.36E+09		1		Hydrogen Chloride	7647-01-0							2.8E+06	2.8E+06
				4.0E-02	C	1.4E-02	C	V			1.36E+09		1		Hydrogen Fluoride	7664-39-3					3.1E+02		2.0E+06	3.1E+02
						2.0E-03	I	V			1.36E+09		1		Hydrogen Sulfide	7783-06-4							2.8E+05	2.8E+05
6.0E-02	P			4.0E-02	P						1.36E+09		1	0.1	Hydroquinone	123-31-9	1.2E+01	4.1E+01		9.0E+00	3.1E+02	1.3E+03		2.5E+02
6.1E-02	O			1.1E-01	O						1.36E+09		1	0.1	Imazalil	35554-44-0	1.1E+01	4.0E+01		8.9E+00	8.4E+02	3.6E+03		6.8E+02
				2.5E-01	I						1.36E+09		1	0.1	Imazaquin	81335-37-7					2.0E+03	8.2E+03		1.6E+03
				2.5E+00	O						1.36E+09		1	0.1	Imazethapyr	81335-77-5					2.0E+04	8.2E+04		1.6E+04
				1.0E-02	A						1.36E+09		1		Iodine	7553-56-2					7.8E+01			7.8E+01
				4.0E-02	I						1.36E+09		1	0.1	Iprodione	36734-19-7					3.1E+02	1.3E+03		2.5E+02
				7.0E-01	P						1.36E+09		1		Iron	7439-89-6					5.5E+03			5.5E+03
				3.0E-01	I	4.0E-01	X	V		1.00E+04	1.36E+09	2.81E+04	1		Isobutyl Alcohol	78-83-1					2.3E+03		1.2E+03	7.8E+02
9.5E-04	I			2.0E-01	I	2.0E+00	C				1.36E+09		1	0.1	Isophorone	78-59-1	7.3E+02	2.6E+03		5.7E+02	1.6E+03	6.6E+03	2.8E+08	1.3E+03
				1.5E-02	I			V			1.36E+09	4.20E+05	1		Isopropalin	33820-53-0					1.2E+02			1.2E+02
				2.0E+00	P	2.0E-01	P	V		1.09E+05	1.36E+09	2.77E+04	1		Isopropanol	67-63-0					1.6E+04		5.8E+02	5.6E+02
				1.0E-01	I						1.36E+09		1	0.1	Isopropyl Methyl Phosphonic Acid	1832-54-8					7.8E+02	3.3E+03		6.3E+02
				5.0E-02	I						1.36E+09		1	0.1	Isoxaben	82558-50-7					3.9E+02	1.6E+03		3.2E+02
						3.0E-01	A	V			1.36E+09		1		Jet propulsion fuel 7 (JP-7)	E1737665							4.3E+07	4.3E+07
				8.0E-03	O						1.36E+09		1	0.1	Lactofen	77501-63-4					6.3E+01	2.6E+02		5.1E+01
				2.0E-04	X						1.36E+09		1	0.1	Lactonitrile	78-97-7					1.6E+00	6.6E+00		1.3E+00
				5.0E-05	P						1.36E+09		1		Lanthanum	7439-91-0					3.9E-01			3.9E-01
				2.1E-05	P						1.36E+09		1	0.1	Lanthanum Acetate Hydrate	100587-90-4					1.6E-01	6.9E-01		1.3E-01
				1.9E-05	P						1.36E+09		1		Lanthanum Chloride Heptahydrate	10025-84-0					1.5E-01			1.5E-01
				2.8E-05	P						1.36E+09		1		Lanthanum Chloride, Anhydrous	10099-58-8					2.2E-01			2.2E-01

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information																Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				1.6E-05	P						1.36E+09		1		Lanthanum Nitrate Hexahydrate	10277-43-7					1.3E-01			1.3E-01
															Lead Compounds										
8.5E-03	C	1.2E-05	C								1.36E+09		1		~Lead Phosphate	7446-27-7	8.2E+01		3.2E+05	8.2E+01				
2.1E-01	C	8.0E-05	C								1.36E+09		1	0.1	~Lead acetate	301-04-2	3.3E+00	1.2E+01	4.8E+04	2.6E+00				
											1.36E+09		1		~Lead and Compounds	7439-92-1								4.0E+02
3.8E-02	C	1.1E-05	C								1.36E+09		1	0.1	~Lead subacetate	1335-32-6	1.8E+01	6.5E+01	3.5E+05	1.4E+01				
				1.0E-07	I			V		2.43E+00	1.36E+09	1.91E+03	1		~Tetraethyl Lead	78-00-2					7.8E-04			7.8E-04
				5.0E-06	P			V		3.83E+02	1.36E+09	2.55E+04	1		Lewisite	541-25-3					3.9E-02			3.9E-02
				7.7E-03	O						1.36E+09		1	0.1	Linuron	330-55-2					6.0E+01	2.5E+02		4.9E+01
				2.0E-03	P						1.36E+09		1		Lithium	7439-93-2					1.6E+01			1.6E+01
				5.0E-04	I						1.36E+09		1	0.1	MCPA	94-74-6					3.9E+00	1.6E+01		3.2E+00
				4.4E-02	O						1.36E+09		1	0.1	MCPB	94-81-5					3.4E+02	1.5E+03		2.8E+02
				1.0E-03	I						1.36E+09		1	0.1	MCPP	93-65-2					7.8E+00	3.3E+01		6.3E+00
				2.0E-02	I						1.36E+09		1	0.1	Malathion	121-75-5					1.6E+02	6.6E+02		1.3E+02
				1.0E-01	I	7.0E-04	C				1.36E+09		1	0.1	Maleic Anhydride	108-31-6					7.8E+02	3.3E+03	9.9E+04	6.3E+02
				5.0E-01	I						1.36E+09		1	0.1	Maleic Hydrazide	123-33-1					3.9E+03	1.6E+04		3.2E+03
				1.0E-04	P						1.36E+09		1	0.1	Malononitrile	109-77-3					7.8E-01	3.3E+00		6.3E-01
				3.0E-02	H						1.36E+09		1	0.1	Mancozeb	8018-01-7					2.3E+02	9.9E+02		1.9E+02
				5.0E-03	I						1.36E+09		1	0.1	Maneb	12427-38-2					3.9E+01	1.6E+02		3.2E+01
				1.4E-01	I	5.0E-05	I						1		Manganese (Diet)	7439-96-5								
				2.4E-02	G	5.0E-05	I				1.36E+09		0.04		Manganese (Non-diet)	7439-96-5					1.9E+02		7.1E+03	1.8E+02
				9.0E-05	H						1.36E+09		1	0.1	Mephosfolan	950-10-7					7.0E-01	3.0E+00		5.7E-01
				3.0E-02	I						1.36E+09		1	0.1	Mepiquat Chloride	24307-26-4					2.3E+02	9.9E+02		1.9E+02
1.1E-02	P			4.0E-03	P						1.36E+09		1	0.1	Mercaptobenzothiazole, 2-	149-30-4	6.3E+01	2.2E+02		4.9E+01	3.1E+01	1.3E+02		2.5E+01
															Mercury Compounds									
				3.0E-04	I	3.0E-04	G				1.36E+09		0.07		~Mercuric Chloride (and other Mercury salts)	7487-94-7					2.3E+00		4.3E+04	2.3E+00
						3.0E-04	I	V		3.13E+00	1.36E+09	3.47E+04	1		~Mercury (elemental)	7439-97-6							1.1E+00	1.1E+00
				1.0E-04	I						1.36E+09		1		~Methyl Mercury	22967-92-6					7.8E-01			7.8E-01
				8.0E-05	I						1.36E+09		1	0.1	~Phenylmercuric Acetate	62-38-4					6.3E-01	2.6E+00		5.1E-01
				3.0E-05	I			V			1.36E+09	1.94E+06	1		Merphos	150-50-5					2.3E-01			2.3E-01
				6.0E-02	I						1.36E+09		1	0.1	Metalaxyl	57837-19-1					4.7E+02	2.0E+03		3.8E+02
				1.0E-04	I	3.0E-02	P	V		4.58E+03	1.36E+09	6.79E+03	1		Methacrylonitrile	126-98-7					7.8E-01		2.1E+01	7.5E-01
				5.0E-05	I						1.36E+09		1	0.1	Methamidophos	10265-92-6					3.9E-01	1.6E+00		3.2E-01
				2.0E+00	I	2.0E+01	I	V		1.06E+05	1.36E+09	2.90E+04	1		Methanol	67-56-1					1.6E+04		6.1E+04	1.2E+04
				1.5E-03	O						1.36E+09		1	0.1	Methidathion	950-37-8					1.2E+01	4.9E+01		9.5E+00
				2.5E-02	I						1.36E+09		1	0.1	Methomyl	16752-77-5					2.0E+02	8.2E+02		1.6E+02
4.9E-02	C										1.36E+09		1	0.1	Methoxy-5-nitroaniline, 2-	99-59-2	1.4E+01	5.0E+01		1.1E+01				
				5.0E-03	I						1.36E+09		1	0.1	Methoxychlor	72-43-5					3.9E+01	1.6E+02		3.2E+01
				8.0E-03	P	1.0E-03	P	V		1.15E+05	1.36E+09	1.24E+05	1		Methoxyethanol Acetate, 2-	110-49-6					6.3E+01		1.3E+01	1.1E+01
				5.0E-03	P	7.0E-03	P	V		1.06E+05	1.36E+09	1.01E+05	1		Methoxyethanol, 2-	109-86-4					3.9E+01		7.4E+01	2.6E+01
				1.0E+00	X			V		2.90E+04	1.36E+09	8.12E+03	1		Methyl Acetate	79-20-9					7.8E+03			7.8E+03
						2.0E-02	P	V		6.75E+03	1.36E+09	6.97E+03	1		Methyl Acrylate	96-33-3							1.5E+01	1.5E+01
				6.0E-01	I	5.0E+00	I	V		2.84E+04	1.36E+09	1.22E+04	1		Methyl Ethyl Ketone (2-Butanone)	78-93-3					4.7E+03		6.4E+03	2.7E+03
		1.0E-03	X	1.0E-03	P	2.0E-05	X	V		1.80E+05	1.36E+09	5.04E+04	1		Methyl Hydrazine	60-34-4			1.4E-01	1.4E-01	7.8E+00		1.1E-01	1.0E-01
						3.0E+00	I	V		3.36E+03	1.36E+09	1.06E+04	1		Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1							3.3E+03	3.3E+03
						1.0E-03	C	V		1.01E+04	1.36E+09	4.42E+03	1		Methyl Isocyanate	624-83-9							4.6E-01	4.6E-01
				1.4E+00	I	7.0E-01	I	V		2.36E+03	1.36E+09	6.33E+03	1		Methyl Methacrylate	80-62-6					1.1E+04		4.6E+02	4.4E+02
				2.5E-04	I						1.36E+09		1	0.1	Methyl Parathion	298-00-0					2.0E+00	8.2E+00		1.6E+00
				6.0E-02	X						1.36E+09		1	0.1	Methyl Phosphonic Acid	993-13-5					4.7E+02	2.0E+03		3.8E+02
				6.0E-03	H	4.0E-02	H	V		3.93E+02	1.36E+09	2.43E+04	1		Methyl Styrene (Mixed Isomers)	25013-15-4					4.7E+01		1.0E+02	3.2E+01
9.9E-02	C	2.8E-05	C								1.36E+09		1	0.1	Methyl methanesulfonate	66-27-3	7.0E+00	2.5E+01	1.4E+05	5.5E+00				
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		8.87E+03	1.36E+09	4.90E+03	1		Methyl tert-Butyl Ether (MTBE)	1634-04-4	3.9E+02		5.3E+01	4.7E+01			1.5E+03	1.5E+03
				3.0E-04	X						1.36E+09		1	0.1	Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					2.3E+00	9.9E+00		1.9E+00
						3.0E+00	X	V		2.45E+03	1.36E+09	1.72E+04	1		Methyl-2-Pentanol, 4-	108-11-2							5.4E+03	5.4E+03
9.0E-03	P			2.0E-02	X						1.36E+09		1	0.1	Methyl-5-Nitroaniline, 2-	99-55-8	7.7E+01	2.7E+02		6.0E+01	1.6E+02	6.6E+02		1.3E+02
8.3E+00	C	2.4E-03	C								1.36E+09		1	0.1	Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	8.4E-02	3.0E-01	1.6E+03	6.5E-02				
1.3E-01	C	3.7E-05	C								1.36E+09		1	0.1	Methylaniline Hydrochloride, 2-	636-21-5	5.3E+00	1.9E+01	1.0E+05	4.2E+00				
				1.0E-02	A						1.36E+09		1	0.1	Methylarsonic acid	124-58-3					7.8E+01	3.3E+02		6.3E+01
				2.0E-04	X						1.36E+09		1	0.1	Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					1.6E+00	6.6E+00		1.3E+00
1.0E-01	X			3.0E-04	X						1.36E+09		1	0.1	Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	7.0E+00	2.5E+01		5.4E+00	2.3E+00	9.9E+00		1.9E+00
2.2E+01	C	6.3E-03	C						M		1.36E+09		1	0.1	Methylcholanthrene, 3-	56-49-5	7.0E-03	2.7E-02	2.2E+02	5.5E-03				
						9.5E-02	X	V		6.76E+01	1.36E+09	9.90E+02	1		Methylcyclohexane	108-87-2							9.8E+00	9.8E+00
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	3.32E+03	1.36E+09	2.19E+03	1		Methylene Chloride	75-09-2	7.7E+01		2.2E+02	5.7E+01	4.7E+01		1.4E+02	3.5E+01
1.0E-01	P	4.3E-04	C	2.0E-03	P				M		1.36E+09		1	0.1	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.5E+00	6.0E+00	3.2E+03	1.2E+00	1.6E+01	6.6E+01		1.3E+01
4.6E-02	I	1.3E-05	C								1.36E+09		1	0.1	Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.5E+01	5.4E+01	2.9E+05	1.2E+01				
1.6E+00	C	4.6E-04	C			2.0E-02	C				1.36E+09		1	0.1	Methylenebisbenzenamine, 4,4'-	101-77-9	4.3E-01	1.5E+00	8.3E+03	3.4E-01			2.8E+06	2.8E+06
						6.0E-04	I				1.36E+09		1	0.1	Methylenediphenyl Diisocyanate	101-68-8							8.5E+04	8.5E+04
				7.0E-02	H			V		5.00E+02	1.36E+09	1.28E+04	1		Methylstyrene, Alpha-	98-83-9					5.5E+02			5.5E+02
				1.5E-01	I						1.36E+09		1	0.1	Metolachlor	51218-45-2					1.2E+03	4.9E+03		9.5E+02
				2.5E-02	I						1.36E+09		1	0.1	Metribuzin	21087-64-9					2.0E+02	8.2E+02		1.6E+02
				2.5E-01	I						1.36E+09		1	0.1	Metsulfuron-methyl	74223-64-6					2.0E+03	8.2E+03		1.6E+03
		4.5E-06	X	1.0E-02	X	1.0E-01	P	V		6.86E+00	1.36E+09	1.04E+03	1		Midrange Aliphatic Hydrocarbon Streams	E1790669			6.5E-01	6.5E-01	7.8E+01		1.1E+01	9.6E+00
				3.0E+00	P			V		3.42E-01	1.36E+09	1.38E+03	1		Mineral oils	8012-95-1					2.3E+04			2.3E+04
1.8E+01	C	5.1E-03	C	2.0E-04	I			V			1.36E+09	8.58E+05	1		Mirex	2385-85-5	3.9E-02		4.7E-01	3.6E-02	1.6E+00			1.6E+00
				2.0E-03	I						1.36E+09		1	0.1	Molinate	2212-67-1					1.6E+01	6.6E+01		1.3E+01
				5.0E-03	I	2.0E-03	A				1.36E+09		1		Molybdenum	7439-98-7					3.9E+01		2.8E+05	3.9E+01
				1.0E-01	I						1.36E+09		1		Monochloramine	10599-90-3					7.8E+02			7.8E+02
				2.0E-03	P						1.36E+09		1	0.1	Monomethylaniline	100-61-8					1.6E+01	6.6E+01		1.3E+01
				2.5E-02	I						1.36E+09		1	0.1	Myclobutanil	88671-89-0					2.0E+02	8.2E+02		1.6E+02
				3.0E-04	X						1.36E+09		1	0.1	N,N'-Diphenyl-1,4-benzenediamine	74-31-7					2.3E+00	9.9E+00		1.9E+00
				2.0E-03	I			V			1.36E+09	5.70E+04	1		Naled	300-76-5					1.6E+01			1.6E+01
				3.0E-02	X	1.0E-01	P	V			1.36E+09		1		Naphtha, High Flash Aromatic (HFAN)	64742-95-6					2.3E+02		1.4E+07	2.3E+02
1.8E+00	C	0.0E+00	C								1.36E+09		1	0.1	Naphthylamine, 2-	91-59-8	3.9E-01	1.4E+00		3.0E-01				

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				1.2E-01	O						1.36E+09		1	0.1	Napropamide	15299-99-7					9.4E+02	4.0E+03		7.6E+02
		2.6E-04	C	1.1E-02	C	1.4E-05	C				1.36E+09		1	0.1	Nickel Acetate	373-02-4			1.5E+04	1.5E+04	8.6E+01	3.6E+02	2.0E+03	6.7E+01
		2.6E-04	C	1.1E-02	C	1.4E-05	C				1.36E+09		1	0.1	Nickel Carbonate	3333-67-3			1.5E+04	1.5E+04	8.6E+01	3.6E+02	2.0E+03	6.7E+01
		2.6E-04	C	1.1E-02	C	1.4E-05	C	V			1.36E+09		1		Nickel Carbonyl	13463-39-3			1.5E+04	1.5E+04	8.6E+01		2.0E+03	8.2E+01
		2.6E-04	C	1.1E-02	C	1.4E-05	C				1.36E+09		0.04		Nickel Hydroxide	12054-48-7			1.5E+04	1.5E+04	8.6E+01		2.0E+03	8.2E+01
		2.6E-04	C	1.1E-02	C	2.0E-05	C				1.36E+09		0.04		Nickel Oxide	1313-99-1			1.5E+04	1.5E+04	8.6E+01		2.8E+03	8.4E+01
		2.4E-04	I	1.1E-02	C	1.4E-05	C				1.36E+09		0.04		Nickel Refinery Dust	E715532			1.6E+04	1.6E+04	8.6E+01		2.0E+03	8.2E+01
		2.6E-04	C	2.0E-02	I	1.4E-05	C				1.36E+09		0.04		Nickel Soluble Salts	7440-02-0			1.5E+04	1.5E+04	1.6E+02		2.0E+03	1.4E+02
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C				1.36E+09		0.04		Nickel Subsulfide	12035-72-2	4.1E-01		8.0E+03	4.1E-01	8.6E+01		2.0E+03	8.2E+01
9.1E-01	C	2.6E-04	C	1.1E-02	C	1.4E-05	C				1.36E+09		1	0.1	Nickelocene	1271-28-9	7.6E-01	2.7E+00	1.5E+04	6.0E-01	8.6E+01	3.6E+02	2.0E+03	6.7E+01
				1.6E+00	I						1.36E+09		1		Nitrate (measured as nitrogen)	14797-55-8					1.3E+04			1.3E+04
											1.36E+09		1		Nitrate + Nitrite (measured as nitrogen)	E701177								
				1.0E-01	I						1.36E+09		1		Nitrite (measured as nitrogen)	14797-65-0					7.8E+02			7.8E+02
				1.0E-02	X	5.0E-05	X				1.36E+09		1	0.1	Nitroaniline, 2-	88-74-4					7.8E+01	3.3E+02	7.1E+03	6.3E+01
2.0E-02	P			4.0E-03	P	6.0E-03	P				1.36E+09		1	0.1	Nitroaniline, 4-	100-01-6	3.5E+01	1.2E+02		2.7E+01	3.1E+01	1.3E+02	8.5E+05	2.5E+01
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		3.05E+03	1.36E+09	7.32E+04	1		Nitrobenzene	98-95-3			5.1E+00	5.1E+00	1.6E+01		6.9E+01	1.3E+01
				3.0E+03	P						1.36E+09		1	0.1	Nitrocellulose	9004-70-0					2.3E+07	9.9E+07		1.9E+07
				7.0E-02	H						1.36E+09		1	0.1	Nitrofurantoin	67-20-9					5.5E+02	2.3E+03		4.4E+02
1.3E+00	C	3.7E-04	C								1.36E+09		1	0.1	Nitrofurazone	59-87-0	5.3E-01	1.9E+00	1.0E+04	4.2E-01				
1.7E-02	P			1.0E-04	P						1.36E+09		1	0.1	Nitroglycerin	55-63-0	4.1E+01	1.5E+02		3.2E+01	7.8E-01	3.3E+00		6.3E-01
				1.0E-01	I						1.36E+09		1	0.1	Nitroguanidine	556-88-7					7.8E+02	3.3E+03		6.3E+02
		8.8E-06	P			5.0E-03	P	V		1.80E+04	1.36E+09	1.69E+04	1		Nitromethane	75-52-5			5.4E+00	5.4E+00			8.8E+00	8.8E+00
		5.8E-04	X			2.0E-02	I	V		4.86E+03	1.36E+09	1.31E+04	1		Nitropropane, 2-	79-46-9			6.4E-02	6.4E-02			2.7E+01	2.7E+01
2.7E+01	C	7.7E-03	C						M		1.36E+09		1	0.1	Nitroso-N-ethylurea, N-	759-73-9	5.7E-03	2.2E-02	1.8E+02	4.5E-03				
1.2E+02	C	3.4E-02	C						M		1.36E+09		1	0.1	Nitroso-N-methylurea, N-	684-93-5	1.3E-03	5.0E-03	4.1E+01	1.0E-03				
5.4E+00	I	1.6E-03	I					V			1.36E+09	2.43E+05	1		Nitroso-di-N-butylamine, N-	924-16-3	1.3E-01		4.3E-01	9.9E-02				
7.0E+00	I	2.0E-03	C								1.36E+09		1	0.1	Nitroso-di-N-propylamine, N-	621-64-7	9.9E-02	3.5E-01	1.9E+03	7.8E-02				
2.8E+00	I	8.0E-04	C								1.36E+09		1	0.1	Nitrosodiethanolamine, N-	1116-54-7	2.5E-01	8.8E-01	4.8E+03	1.9E-01				
1.5E+02	I	4.3E-02	I						M		1.36E+09		1	0.1	Nitrosodiethylamine, N-	55-18-5	1.0E-03	4.0E-03	3.2E+01	8.1E-04				
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X	V	M	2.37E+05	1.36E+09	8.23E+04	1		Nitrosodimethylamine, N-	62-75-9	3.0E-03		6.0E-03	2.0E-03	6.3E-02		3.4E-01	5.3E-02
4.9E-03	I	2.6E-06	C								1.36E+09		1	0.1	Nitrosodiphenylamine, N-	86-30-6	1.4E+02	5.0E+02	1.5E+06	1.1E+02				
2.2E+01	I	6.3E-03	C					V		1.08E+05	1.36E+09	1.21E+05	1		Nitrosomethylethylamine, N-	10595-95-6	3.2E-02		5.4E-02	2.0E-02				
6.7E+00	C	1.9E-03	C								1.36E+09		1	0.1	Nitrosomorpholine [N-]	59-89-2	1.0E-01	3.7E-01	2.0E+03	8.1E-02				
9.4E+00	C	2.7E-03	C								1.36E+09		1	0.1	Nitrosopiperidine [N-]	100-75-4	7.4E-02	2.6E-01	1.4E+03	5.8E-02				
2.1E+00	I	6.1E-04	I								1.36E+09		1	0.1	Nitrosopyrrolidine, N-	930-55-2	3.3E-01	1.2E+00	6.3E+03	2.6E-01				
				1.0E-04	X						1.36E+09		1	0.1	Nitrotoluene, m-	99-08-1					7.8E-01	3.3E+00		6.3E-01
2.2E-01	P			9.0E-04	P			V		1.51E+03	1.36E+09	1.37E+05	1		Nitrotoluene, o-	88-72-2	3.2E+00			3.2E+00	7.0E+00			7.0E+00
1.6E-02	P			4.0E-03	P						1.36E+09		1	0.1	Nitrotoluene, p-	99-99-0	4.3E+01	1.5E+02		3.4E+01	3.1E+01	1.3E+02		2.5E+01
				3.0E-04	X	2.0E-02	P	V		6.86E+00	1.36E+09	1.04E+03	1		Nonane, n-	111-84-2					2.3E+00		2.2E+00	1.1E+00
				1.5E-03	O						1.36E+09		1	0.1	Norflurazon	27314-13-2					1.2E+01	4.9E+01		9.5E+00
				3.0E-03	I						1.36E+09		1	0.1	Octabromodiphenyl Ether	32536-52-0					2.3E+01	9.9E+01		1.9E+01
				5.0E-02	I						1.36E+09		1	0.006	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0					3.9E+02	2.7E+04		3.9E+02
				2.0E-03	H						1.36E+09		1	0.1	Octamethylpyrophosphoramide	152-16-9					1.6E+01	6.6E+01		1.3E+01
7.8E-03	O			1.9E-01	O						1.36E+09		1	0.1	Oryzalin	19044-88-3	8.9E+01	3.2E+02		7.0E+01	1.5E+03	6.3E+03		1.2E+03
				5.0E-03	I						1.36E+09		1	0.1	Oxadiazon	19666-30-9					3.9E+01	1.6E+02		3.2E+01
				2.5E-02	I						1.36E+09		1	0.1	Oxamyl	23135-22-0					2.0E+02	8.2E+02		1.6E+02
7.3E-02	O			4.0E-02	O						1.36E+09		1	0.1	Oxyfluorfen	42874-03-3	9.5E+00	3.4E+01		7.4E+00	3.1E+02	1.3E+03		2.5E+02
				1.3E-02	I						1.36E+09		1	0.1	Paclobutrazol	76738-62-0					1.0E+02	4.3E+02		8.2E+01
				4.5E-03	I						1.36E+09		1	0.1	Paraquat Dichloride	1910-42-5					3.5E+01	1.5E+02		2.8E+01
				6.0E-03	H						1.36E+09		1	0.1	Parathion	56-38-2					4.7E+01	2.0E+02		3.8E+01
				5.0E-02	H			V			1.36E+09	4.49E+04	1		Pebulate	1114-71-2					3.9E+02			3.9E+02
				3.0E-01	O						1.36E+09		1	0.1	Pendimethalin	40487-42-1					2.3E+03	9.9E+03		1.9E+03
				2.0E-03	I			V		3.12E-01	1.36E+09	5.13E+05	1		Pentabromodiphenyl Ether	32534-81-9					1.6E+01			1.6E+01
				1.0E-04	I						1.36E+09		1	0.1	Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					7.8E-01	3.3E+00		6.3E-01
				8.0E-04	I			V			1.36E+09	8.12E+04	1		Pentachlorobenzene	608-93-5					6.3E+00			6.3E+00
9.0E-02	P							V		4.57E+02	1.36E+09	9.65E+03	1		Pentachloroethane	76-01-7	7.7E+00			7.7E+00				
2.6E-01	H			3.0E-03	I			V			1.36E+09	4.32E+05	1		Pentachloronitrobenzene	82-68-8	2.7E+00			2.7E+00	2.3E+01			2.3E+01
4.0E-01	I	5.1E-06	C	5.0E-03	I						1.36E+09		1	0.25	Pentachlorophenol	87-86-5	1.7E+00	2.5E+00	7.5E+05	1.0E+00	3.9E+01	6.6E+01		2.5E+01
4.3E-03	X			9.0E-03	P						1.36E+09		1	0.1	Pentaerythritol tetranitrate (PETN)	78-11-5	1.6E+02	5.7E+02		1.3E+02	7.0E+01	3.0E+02		5.7E+01
				1.0E-04	X						1.36E+09		1	0.1	Pentamethylphosphoramide (PMPA)	10159-46-3					7.8E-01	3.3E+00		6.3E-01
						1.0E+00	P	V		3.88E+02	1.36E+09	7.79E+02	1		Pentane, n-	109-66-0							8.1E+01	8.1E+01
															Per- and Polyfluoroalkyl Substances (PFAS)									
				3.0E-06	D						1.36E+09		1	0.1	~Ammonium perfluoro-2-methyl-3-oxahexanoate	62037-80-3					2.3E-02	9.9E-02		1.9E-02
				1.0E-03	I			V		2.68E+02	1.36E+09	5.98E+04	1		~Ammonium perfluorobutanoate	10495-86-0					7.8E+00			7.8E+00
				5.0E-04	I						1.36E+09		1	0.1	~Ammonium perfluorohexanoate	21615-47-4					3.9E+00	1.6E+01		3.2E+00
				3.0E-04	R			V			1.36E+09	5.53E+04	1		~Bis(trifluoromethylsulfonyl)amine (TFSI)	82113-65-3					2.3E+00			2.3E+00
				3.0E-06	D			V		1.92E+06	1.36E+09	4.97E+04	1		~Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6					2.3E-02			2.3E-02
				3.0E-04	R			V			1.36E+09	5.41E+04	1		~Lithium bis[(trifluoromethyl)sulfonyl]azanide	90076-65-6					2.3E+00			2.3E+00
				3.0E-04	P						1.36E+09		1	0.1	~Perfluorobutanesulfonate	45187-15-3					2.3E+00	9.9E+00		1.9E+00
				3.0E-04	P						1.36E+09		1	0.1	~Perfluorobutanesulfonic acid (PFBS)	375-73-5					2.3E+00	9.9E+00		1.9E+00
				1.0E-03	I			V		2.56E+03	1.36E+09	5.85E+04	1		~Perfluorobutanoate	45048-62-2					7.8E+00			7.8E+00
				1.0E-03	I			V		2.57E+03	1.36E+09	3.82E+04	1		~Perfluorobutanoic acid (PFBA)	375-22-4					7.8E+00			7.8E+00
				5.0E-05	N						1.36E+09		1	0.1	~Perfluorododecanoic acid (PFDoDA)	307-55-1					3.9E-01	1.6E+00		3.2E-01
				2.0E-05	A						1.36E+09		1	0.1	~Perfluorohexanesulfonate	108427-53-8					1.6E-01	6.6E-01		1.3E-01
				2.0E-05	A						1.36E+09		1	0.1	~Perfluorohexanesulfonic acid (PFHxS)	355-46-4					1.6E-01	6.6E-01		1.3E-01
				5.0E-04	I						1.36E+09		1	0.1	~Perfluorohexanoate	92612-52-7					3.9E+00	1.6E+01		3.2E+00
				5.0E-04	I						1.36E+09		1	0.1	~Perfluorohexanoic acid (PFHxA)	307-24-4					3.9E+00	1.6E+01		3.2E+00
				3.0E-06	A						1.36E+09		1	0.1	~Perfluorononanoate	72007-68-2					2.3E-02	9.9E-02		1.9E-02
				3.0E-06	A						1.36E+09		1	0.1	~Perfluorononanoic acid (PFNA)	375-95-1					2.3E-02	9.9E-02		1.9E-02
				4.0E-02	N						1.36E+09		1	0.1	~Perfluorooctadecanoic acid (PFODA)	16517-11-6					3.1E+02	1.3E+03		2.5E+02
				2.0E-06	A						1.36E+09		1	0.1	~Perfluorooctanesulfonate	45298-90-6					1.6E-02	6.6E-02		1.3E-02
				2.0E-06	A						1.36E+09		1	0.1	~Perfluorooctanesulfonic acid (PFOS)	1763-23-1					1.6E-02	6.6E-02		1.3E-02
7.0E-02	D			3.0E-06	A						1.36E+09		1	0.1	~Perfluorooctanoate	45285-51-6	9.9E+00	3.5E+01		7.8E+00	2.3E-02	9.9E-02		1.9E-02

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
7.0E-02	D			3.0E-06	A						1.36E+09		1	0.1	~Perfluorooctanoic acid (PFOA)	335-67-1	9.9E+00	3.5E+01		7.8E+00	2.3E-02	9.9E-02		1.9E-02
				5.0E-04	R			V		1.36E+04	1.36E+09	2.65E+04	1		~Perfluoropropanoic acid (PFPrA)	422-64-0					3.9E+00			3.9E+00
				1.0E-03	N						1.36E+09		1	0.1	~Perfluorotetradecanoic acid (PFTetA)	376-06-7					7.8E+00	3.3E+01		6.3E+00
				3.0E-04	N						1.36E+09		1	0.1	~Perfluoroundecanoic acid (PFUDA)	2058-94-8					2.3E+00	9.9E+00		1.9E+00
				2.0E-03	I			V		9.61E+04	1.36E+09	6.13E+04	1		~Potassium heptafluorobutanoate	2966-54-3					1.6E+01			1.6E+01
				3.0E-04	P						1.36E+09		1	0.1	~Potassium perfluorobutanesulfonate	29420-49-3					2.3E+00	9.9E+00		1.9E+00
				2.0E-06	A						1.36E+09		1	0.1	~Potassium perfluorooctanesulfonate	2795-39-3					1.6E-02	6.6E-02		1.3E-02
				1.0E-03	I			V		8.99E+04	1.36E+09	6.02E+04	1		~Sodium perfluorobutanoate	2218-54-4					7.8E+00			7.8E+00
				5.0E-04	I						1.36E+09		1	0.1	~Sodium perfluorohexanoate	2923-26-4					3.9E+00	1.6E+01		3.2E+00
															Perchlorates									
				7.0E-04	I						1.36E+09		1		~Ammonium Perchlorate	7790-98-9					5.5E+00			5.5E+00
				7.0E-04	I						1.36E+09		1		~Lithium Perchlorate	7791-03-9					5.5E+00			5.5E+00
				7.0E-04	I						1.36E+09		1		~Perchlorate and Perchlorate Salts	14797-73-0					5.5E+00			5.5E+00
				7.0E-04	I						1.36E+09		1		~Potassium Perchlorate	7778-74-7					5.5E+00			5.5E+00
				7.0E-04	I						1.36E+09		1		~Sodium Perchlorate	7601-89-0					5.5E+00			5.5E+00
				5.0E-02	I						1.36E+09		1	0.1	Permethrin	52645-53-1					3.9E+02	1.6E+03		3.2E+02
2.2E-03	C	6.3E-07	C								1.36E+09		1	0.1	Phenacetin	62-44-2	3.2E+02	1.1E+03	6.1E+06	2.5E+02				
				2.4E-01	O						1.36E+09		1	0.1	Phenmedipham	13684-63-4					1.9E+03	7.9E+03		1.5E+03
				3.0E-01	I	2.0E-01	C				1.36E+09		1	0.1	Phenol	108-95-2					2.3E+03	9.9E+03	2.8E+07	1.9E+03
				4.0E-03	I						1.36E+09		1	0.1	Phenol, 2-(1-methylethoxy)-, methylcarbamate	114-26-1					3.1E+01	1.3E+02		2.5E+01
				5.0E-04	X						1.36E+09		1	0.1	Phenothiazine	92-84-2					3.9E+00	1.6E+01		3.2E+00
				2.0E-04	X			V		1.29E+02	1.36E+09	7.06E+03	1		Phenyl Isothiocyanate	103-72-0					1.6E+00			1.6E+00
				6.0E-03	I						1.36E+09		1	0.1	Phenylenediamine, m-	108-45-2					4.7E+01	2.0E+02		3.8E+01
1.2E-01	P			4.0E-03	P						1.36E+09		1	0.1	Phenylenediamine, o-	95-54-5	5.8E+00	2.1E+01		4.5E+00	3.1E+01	1.3E+02		2.5E+01
				1.0E-03	X						1.36E+09		1	0.1	Phenylenediamine, p-	106-50-3					7.8E+00	3.3E+01		6.3E+00
1.9E-03	H										1.36E+09		1	0.1	Phenylphenol, 2-	90-43-7	3.6E+02	1.3E+03		2.8E+02				
				2.0E-04	H						1.36E+09		1	0.1	Phorate	298-02-2					1.6E+00	6.6E+00		1.3E+00
						3.0E-04	I	V		1.61E+03	1.36E+09	9.81E+02	1		Phosgene	75-44-5							3.1E-02	3.1E-02
				2.0E-02	I						1.36E+09		1	0.1	Phosmet	732-11-6					1.6E+02	6.6E+02		1.3E+02
															Phosphates, Inorganic									
				2.9E+00	X						1.36E+09		1		~Aluminum metaphosphate	13776-88-0					2.3E+04			2.3E+04
				3.0E-01	X						1.36E+09		1		~Aluminum salts of inorganic phosphates	E524680405					2.3E+03			2.3E+03
				1.0E+00	P						1.36E+09		1		~Dipotassium phosphate	7758-11-4					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Disodium phosphate	7558-79-4					7.8E+03			7.8E+03
				3.5E+00	X						1.36E+09		1		~Monoaluminum phosphate	13530-50-2					2.8E+04			2.8E+04
				1.0E+00	P						1.36E+09		1		~Monopotassium phosphate	7778-77-0					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Monosodium phosphate	7558-80-7					7.8E+03			7.8E+03
				1.4E+00	X						1.36E+09		1	0.1	~Phosphoric acid, aluminum salt (1:1) [aluminum phosphate]	7784-30-7					1.1E+04	4.5E+04		8.6E+03
				4.3E+00	X						1.36E+09		1		~Phosphoric acid, aluminum sodium salt (1-X:X) [sodium aluminum phosphate acidic (acidic SALP)]	7785-88-8					3.3E+04			3.3E+04
				1.0E+00	P						1.36E+09		1		~Polyphosphoric acid	8017-16-1					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Potassium salts of inorganic phosphates	E524680403					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Potassium tripolyphosphate	13845-36-8					7.8E+03			7.8E+03
				5.0E+00	X						1.36E+09		1		~Sodium aluminum phosphate (anhydrous)	10279-59-1					3.9E+04			3.9E+04
				3.5E+00	X						1.36E+09		1		~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					2.8E+04			2.8E+04
				1.0E+00	P						1.36E+09		1		~Sodium hexametaphosphate	10124-56-8					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Sodium polyphosphate	68915-31-1					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Sodium pyrophosphate	7758-16-9					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Sodium salts of inorganic phosphates	E524680404					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Sodium trimetaphosphate	7785-84-4					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Sodium tripolyphosphate	7758-29-4					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Tetrapotassium phosphate	7320-34-5					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Tetrasodium pyrophosphate	7722-88-5					7.8E+03			7.8E+03
				3.3E+00	X						1.36E+09		1		~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					2.5E+04			2.5E+04
				3.1E+00	X						1.36E+09		1	0.1	~Triphosphoric acid, aluminum salt (1:1) [aluminum triphosphate]	13939-25-8					2.4E+04	1.0E+05		2.0E+04
				1.0E+00	P						1.36E+09		1		~Tripotassium phosphate	7778-53-2					7.8E+03			7.8E+03
				1.0E+00	P						1.36E+09		1		~Trisodium phosphate	7601-54-9					7.8E+03			7.8E+03
				3.0E-04	I	3.0E-04	I	V			1.36E+09		1		Phosphine	7803-51-2					2.3E+00		4.3E+04	2.3E+00
				1.0E+00	P	1.0E-02	I				1.36E+09		1		Phosphoric Acid	7664-38-2					7.8E+03		1.4E+06	7.8E+03
				2.0E-05	I			V			1.36E+09	6.92E+03	1		Phosphorus, White	7723-14-0					1.6E-01			1.6E-01
															Phthalates									
1.4E-02	I	2.4E-06	C	2.0E-02	I						1.36E+09		1	0.1	~Bis(2-ethylhexyl)phthalate	117-81-7	5.0E+01	1.8E+02	1.6E+06	3.9E+01	1.6E+02	6.6E+02		1.3E+02
1.9E-03	P			2.0E-01	I						1.36E+09		1	0.1	~Butyl Benzyl Phthalate	85-68-7	3.7E+02	1.3E+03		2.9E+02	1.6E+03	6.6E+03		1.3E+03
				1.0E+00	I						1.36E+09		1	0.1	~Butylphthalyl Butylglycolate	85-70-1					7.8E+03	3.3E+04		6.3E+03
				1.0E-01	I						1.36E+09		1	0.1	~Dibutyl Phthalate	84-74-2					7.8E+02	3.3E+03		6.3E+02
				8.0E-01	I						1.36E+09		1	0.1	~Diethyl Phthalate	84-66-2					6.3E+03	2.6E+04		5.1E+03
				1.0E-01	I			V			1.36E+09	2.13E+04	1		~Dimethylterephthalate	120-61-6					7.8E+02			7.8E+02
				1.0E-02	P						1.36E+09		1	0.1	~Octyl Phthalate, di-N-	117-84-0					7.8E+01	3.3E+02		6.3E+01
				5.0E-01	X						1.36E+09		1	0.1	~Phthalic Acid, p-	100-21-0					3.9E+03	1.6E+04		3.2E+03
				2.0E+00	I	2.0E-02	C				1.36E+09		1	0.1	~Phthalic Anhydride	85-44-9					1.6E+04	6.6E+04	2.8E+06	1.3E+04
				7.0E-02	I						1.36E+09		1	0.1	Picloram	1918-02-1					5.5E+02	2.3E+03		4.4E+02
				1.0E-04	X						1.36E+09		1	0.1	Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					7.8E-01	3.3E+00		6.3E-01
				2.0E-03	X						1.36E+09		1	0.1	Picric Acid (2,4,6-Trinitrophenol)	88-89-1					1.6E+01	6.6E+01		1.3E+01
				7.3E-04	O						1.36E+09		1	0.1	Pirimiphos, Methyl	29232-93-7					5.7E+00	2.4E+01		4.6E+00
3.0E+01	C	8.6E-03	C	7.0E-06	H						1.36E+09		1	0.1	Polybrominated Biphenyls	36355-01-8	2.3E-02	8.2E-02	4.4E+02	1.8E-02	5.5E-02	2.3E-01		4.4E-02
															Polychlorinated Biphenyls (PCBs)									
7.0E-02	G	2.0E-05	G	7.0E-05	I			V			1.36E+09	5.86E+05	1	0.14	~Aroclor 1016	12674-11-2	9.9E+00	2.5E+01	8.2E+01	6.6E+00	5.5E-01	1.6E+00		4.1E-01
2.0E+00	G	5.7E-04	G					V			1.36E+09	2.04E+05	1	0.14	~Aroclor 1221	11104-28-2	3.5E-01	8.8E-01	1.0E+00	2.0E-01				
2.0E+00	G	5.7E-04	G					V			1.36E+09	1.12E+05	1	0.14	~Aroclor 1232	11141-16-5	3.5E-01	8.8E-01	5.5E-01	1.7E-01				
2.0E+00	G	5.7E-04	G					V			1.36E+09	5.91E+05	1	0.14	~Aroclor 1242	53469-21-9	3.5E-01	8.8E-01	2.9E+00	2.3E-01				
2.0E+00	G	5.7E-04	G					V			1.36E+09	5.14E+05	1	0.14	~Aroclor 1248	12672-29-6	3.5E-01	8.8E-01	2.5E+00	2.3E-01				
2.0E+00	G	5.7E-04	G	2.0E-05	I			V			1.36E+09	8.43E+05	1	0.14	~Aroclor 1254	11097-69-1	3.5E-01	8.8E-01	4.1E+00	2.4E-01	1.6E-01	4.7E-01		1.2E-01
2.0E+00	G	5.7E-04	G					V			1.36E+09	1.31E+06	1	0.14	~Aroclor 1260	11096-82-5	3.5E-01	8.8E-01	6.5E+00	2.4E-01				
				6.0E-04	X			V			1.36E+09	1.15E+06	1	0.14	~Aroclor 5460	11126-42-4					4.7E+00	1.4E+01		3.5E+00

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information																Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	2.43E+06	1	0.14	~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.8E-01	4.5E-01	6.0E+00	1.3E-01	1.8E-01	5.5E-01	3.4E+02	1.4E-01
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	1.58E+06	1	0.14	~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.8E-01	4.5E-01	3.9E+00	1.2E-01	1.8E-01	5.5E-01	2.2E+02	1.4E-01
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	1.04E+06	1	0.14	~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.8E-01	4.5E-01	2.6E+00	1.2E-01	1.8E-01	5.5E-01	1.4E+02	1.4E-01
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	1.11E+06	1	0.14	~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.8E-01	4.5E-01	2.7E+00	1.2E-01	1.8E-01	5.5E-01	1.5E+02	1.4E-01
3.9E+03	W	1.1E+00	W	2.3E-08	W	1.3E-06	W	V			1.36E+09	1.58E+06	1	0.14	~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.8E-04	4.5E-04	3.9E-03	1.2E-04	1.8E-04	5.5E-04	2.2E-01	1.4E-04
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	7.33E+05	1	0.14	~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.8E-01	4.5E-01	1.8E+00	1.2E-01	1.8E-01	5.5E-01	1.0E+02	1.4E-01
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	5.90E+05	1	0.14	~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.8E-01	4.5E-01	1.5E+00	1.2E-01	1.8E-01	5.5E-01	8.2E+01	1.4E-01
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	6.01E+05	1	0.14	~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.8E-01	4.5E-01	1.5E+00	1.2E-01	1.8E-01	5.5E-01	8.4E+01	1.4E-01
3.9E+00	W	1.1E-03	W	2.3E-05	W	1.3E-03	W	V			1.36E+09	1.05E+06	1	0.14	~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.8E-01	4.5E-01	2.6E+00	1.2E-01	1.8E-01	5.5E-01	1.5E+02	1.4E-01
1.3E+04	W	3.8E+00	W	7.0E-09	W	4.0E-07	W	V			1.36E+09	7.26E+05	1	0.14	~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	5.3E-05	1.4E-04	5.4E-04	3.6E-05	5.5E-05	1.6E-04	3.0E-02	4.1E-05
2.0E+00	I	5.7E-04	I					V			1.36E+09	5.32E+05	1	0.14	~Polychlorinated Biphenyls (high risk)	1336-36-3	3.5E-01	8.8E-01	2.6E+00	2.3E-01				
4.0E-01	I	1.0E-04	I					V					1	0.14	~Polychlorinated Biphenyls (low risk)	1336-36-3								
7.0E-02	I	2.0E-05	I					V					1	0.14	~Polychlorinated Biphenyls (lowest risk)	1336-36-3								
1.3E+01	W	3.8E-03	W	7.0E-06	W	4.0E-04	W				1.36E+09		1	0.14	~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	5.3E-02	1.4E-01	1.0E+03	3.8E-02	5.5E-02	1.6E-01	5.7E+04	4.1E-02
3.9E+01	W	1.1E-02	W	2.3E-06	W	1.3E-04	W	V			1.36E+09	5.09E+05	1	0.14	~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.8E-02	4.5E-02	1.3E-01	1.2E-02	1.8E-02	5.5E-02	7.1E+00	1.4E-02
						6.0E-04	I				1.36E+09		1	0.1	Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9							8.5E+04	8.5E+04
															Polynuclear Aromatic Hydrocarbons (PAHs)									
				6.0E-02	I			V			1.36E+09	1.41E+05	1	0.13	~Acenaphthene	83-32-9					4.7E+02	1.5E+03		3.6E+02
				3.0E-01	I			V			1.36E+09	5.23E+05	1	0.13	~Anthracene	120-12-7					2.3E+03	7.6E+03		1.8E+03
1.0E-01	E	6.0E-05	E					V	M		1.36E+09	4.41E+06	1	0.13	~Benz[a]anthracene	56-55-3	1.5E+00	4.6E+00	7.4E+01	1.1E+00				
				9.0E-05	X	2.0E-06	X				1.36E+09		1	0.1	~Benzo(e)pyrene	192-97-2					7.0E-01	3.0E+00	2.8E+02	5.7E-01
1.2E+00	C	1.1E-04	C								1.36E+09		1	0.13	~Benzo(i)fluoranthene	205-82-3	5.8E-01	1.6E+00	3.5E+04	4.2E-01				
1.0E+00	I	6.0E-04	I	3.0E-04	I	2.0E-06	I		M		1.36E+09		1	0.13	~Benzo[a]pyrene	50-32-8	1.5E-01	4.6E-01	2.3E+03	1.1E-01	2.3E+00	7.6E+00	2.8E+02	1.8E+00
1.0E-01	E	6.0E-05	E						M		1.36E+09		1	0.13	~Benzo[b]fluoranthene	205-99-2	1.5E+00	4.6E+00	2.3E+04	1.1E+00				
1.0E-02	E	6.0E-06	E						M		1.36E+09		1	0.13	~Benzo[k]fluoranthene	207-08-9	1.5E+01	4.6E+01	2.3E+05	1.1E+01				
				8.0E-02	I			V			1.36E+09	7.99E+04	1	0.13	~Chloronaphthalene, Beta-	91-58-7					6.3E+02	2.0E+03		4.8E+02
1.0E-03	E	6.0E-07	E						M		1.36E+09		1	0.13	~Chrysene	218-01-9	1.5E+02	4.6E+02	2.3E+06	1.1E+02				
1.0E+00	E	6.0E-04	E						M		1.36E+09		1	0.13	~Dibenz[a,h]anthracene	53-70-3	1.5E-01	4.6E-01	2.3E+03	1.1E-01				
1.2E+01	C	1.1E-03	C								1.36E+09		1	0.13	~Dibenzo(a,e)pyrene	192-65-4	5.8E-02	1.6E-01	3.5E+03	4.2E-02				
2.5E+02	C	7.1E-02	C						M		1.36E+09		1	0.13	~Dimethylbenz(a)anthracene, 7,12-	57-97-6	6.1E-04	1.8E-03	1.9E+01	4.6E-04				
				4.0E-02	I						1.36E+09		1	0.13	~Fluoranthene	206-44-0					3.1E+02	1.0E+03		2.4E+02
				4.0E-02	I			V			1.36E+09	2.81E+05	1	0.13	~Fluorene	86-73-7					3.1E+02	1.0E+03		2.4E+02
1.0E-01	E	6.0E-05	E						M		1.36E+09		1	0.13	~Indeno[1,2,3-cd]pyrene	193-39-5	1.5E+00	4.6E+00	2.3E+04	1.1E+00				
2.9E-02	P			7.0E-02	A			V		3.94E+02	1.36E+09	5.86E+04	1	0.13	~Methylnaphthalene, 1-	90-12-0	2.4E+01	6.6E+01		1.8E+01	5.5E+02	1.8E+03		4.2E+02
				4.0E-03	I			V			1.36E+09	5.80E+04	1	0.13	~Methylnaphthalene, 2-	91-57-6					3.1E+01	1.0E+02		2.4E+01
1.2E-01	C	3.4E-05	C	2.0E-02	I	3.0E-03	I	V			1.36E+09	4.63E+04	1	0.13	~Naphthalene	91-20-3	5.8E+00	1.6E+01	3.8E+00	2.0E+00	1.6E+02	5.1E+02	1.4E+01	1.3E+01
1.2E+00	C	1.1E-04	C								1.36E+09		1	0.13	~Nitropyrene, 4-	57835-92-4	5.8E-01	1.6E+00	3.5E+04	4.2E-01				
				9.0E-05	X	2.0E-06	X				1.36E+09		1	0.13	~Perylene	198-55-0					7.0E-01	2.3E+00	2.8E+02	5.4E-01
				3.0E-02	I			V			1.36E+09	2.38E+06	1	0.13	~Pyrene	129-00-0					2.3E+02	7.6E+02		1.8E+02
1.5E-01	I			9.0E-03	I						1.36E+09		1	0.1	Prochloraz	67747-09-5	4.6E+00	1.6E+01		3.6E+00	7.0E+01	3.0E+02		5.7E+01
				6.0E-03	H			V			1.36E+09	4.20E+05	1		Profluralin	26399-36-0					4.7E+01			4.7E+01
				1.5E-02	I						1.36E+09		1	0.1	Prometon	1610-18-0					1.2E+02	4.9E+02		9.5E+01
				4.0E-02	O						1.36E+09		1	0.1	Prometryn	7287-19-6					3.1E+02	1.3E+03		2.5E+02
				7.5E-02	I						1.36E+09		1	0.1	Pronamide	23950-58-5					5.9E+02	2.5E+03		4.7E+02
				1.3E-02	I						1.36E+09		1	0.1	Propachlor	1918-16-7					1.0E+02	4.3E+02		8.2E+01
				5.0E-03	I						1.36E+09		1	0.1	Propanil	709-98-8					3.9E+01	1.6E+02		3.2E+01
1.9E-01	O			4.0E-02	O						1.36E+09		1	0.1	Propargite	2312-35-8	3.6E+00	1.3E+01		2.8E+00	3.1E+02	1.3E+03		2.5E+02
				2.0E-03	I			V		1.11E+05	1.36E+09	6.27E+04	1		Propargyl Alcohol	107-19-7					1.6E+01			1.6E+01
				2.0E-02	I						1.36E+09		1	0.1	Propazine	139-40-2					1.6E+02	6.6E+02		1.3E+02
				2.0E-02	I						1.36E+09		1	0.1	Propham	122-42-9					1.6E+02	6.6E+02		1.3E+02
				1.0E-01	O						1.36E+09		1	0.1	Propiconazole	60207-90-1					7.8E+02	3.3E+03		6.3E+02
						8.0E-03	I	V		3.26E+04	1.36E+09	8.94E+03	1		Propionaldehyde	123-38-6							7.5E+00	7.5E+00
				1.0E-01	X	1.0E+00	X	V		2.64E+02	1.36E+09	6.99E+03	1		Propyl benzene	103-65-1					7.8E+02		7.3E+02	3.8E+02
						3.0E+00	C	V		3.49E+02	1.36E+09	7.04E+02	1		Propylene	115-07-1							2.2E+02	2.2E+02
				2.0E+01	P						1.36E+09		1	0.1	Propylene Glycol	57-55-6					1.6E+05	6.6E+05		1.3E+05
						2.7E-04	A				1.36E+09		1	0.1	Propylene Glycol Dinitrate	6423-43-4							3.9E+04	3.9E+04
				7.0E-01	H	2.0E+00	I	V		1.06E+05	1.36E+09	7.83E+04	1		Propylene Glycol Monomethyl Ether	107-98-2					5.5E+03		1.6E+04	4.1E+03
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		7.77E+04	1.36E+09	1.03E+04	1		Propylene Oxide	75-56-9	2.9E+00		7.8E+00	2.1E+00			3.2E+01	3.2E+01
				1.0E-03	I			V		5.30E+05	1.36E+09	5.54E+04	1		Pyridine	110-86-1					7.8E+00			7.8E+00
				5.0E-04	I						1.36E+09		1	0.1	Quinalphos	13593-03-8					3.9E+00	1.6E+01		3.2E+00
3.0E+00	I										1.36E+09		1	0.1	Quinoline	91-22-5	2.3E-01	8.2E-01		1.8E-01				
				9.0E-03	I						1.36E+09		1	0.1	Quizalofop-ethyl	76578-14-8					7.0E+01	3.0E+02		5.7E+01
						3.0E+04	A						1		Refractory Ceramic Fibers (units in fibers)	E715557								
				3.0E-02	I						1.36E+09		1	0.1	Resmethrin	10453-86-8					2.3E+02	9.9E+02		1.9E+02
				5.0E-02	H			V			1.36E+09	4.65E+05	1		Ronnel	299-84-3					3.9E+02			3.9E+02
				4.0E-03	I						1.36E+09		1	0.1	Rotenone	83-79-4					3.1E+01	1.3E+02		2.5E+01
2.2E-01	C	6.3E-05	C						M		1.36E+09		1	0.1	Safrole	94-59-7	7.0E-01	2.7E+00	2.2E+04	5.5E-01				
				5.0E-03	I						1.36E+09		1		Selenious Acid	7783-00-8					3.9E+01			3.9E+01
				5.0E-03	I	2.0E-02	C				1.36E+09		1		Selenium	7782-49-2					3.9E+01		2.8E+06	3.9E+01
				5.0E-03	C	2.0E-02	C				1.36E+09		1		Selenium Sulfide	7446-34-6					3.9E+01		2.8E+06	3.9E+01
				1.4E-01	O						1.36E+09		1	0.1	Sethoxydim	74051-80-2					1.1E+03	4.6E+03		8.8E+02
						3.0E-03	C				1.36E+09		1		Silica (crystalline, respirable)	7631-86-9							4.3E+05	4.3E+05
				5.0E-03	I						1.36E+09		0.04		Silver	7440-22-4					3.9E+01			3.9E+01
1.2E-01	H			5.0E-03	I						1.36E+09		1	0.1	Simazine	122-34-9	5.8E+00	2.1E+01		4.5E+00	3.9E+01	1.6E+02		3.2E+01
				1.3E-02	I						1.36E+09		1	0.1	Sodium Acifluorfen	62476-59-9					1.0E+02	4.3E+02		8.2E+01
				4.0E-03	I						1.36E+09		1		Sodium Azide	26628-22-8					3.1E+01			3.1E+01
2.7E-01	H			3.0E-02	I						1.36E+09		1	0.1	Sodium Diethyldithiocarbamate	148-18-5	2.6E+00	9.2E+00		2.0E+00	2.3E+02	9.9E+02		1.9E+02
				5.0E-02	A	1.4E-02	C				1.36E+09		1		Sodium Fluoride	7681-49-4					3.9E+02		2.0E+06	3.9E+02
				2.0E-05	I						1.36E+09		1	0.1	Sodium Fluoroacetate	62-74-8					1.6E-01	6.6E-01		1.3E-01
				1.0E-03	H						1.36E+09		1		Sodium Metavanadate	13718-26-8					7.8E+00			7.8E+00
				8.0E-04	P						1.36E+09		1		Sodium Tungstate	13472-45-2					6.3E+00			6.3E+00
				8.0E-04	P						1.36E+09		1		Sodium Tungstate Dihydrate	10213-10-2					6.3E+00			6.3E+00
2.4E-02	H			3.0E-02	I						1.36E+09		1	0.1	Stirofos (Tetrachlorovinphos)	961-11-5	2.9E+01	1.0E+02		2.3E+01	2.3E+02	9.9E+02		1.9E+02

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				6.0E-01	I						1.36E+09		1		Strontium, Stable	7440-24-6					4.7E+03			4.7E+03
				3.0E-04	I						1.36E+09		1	0.1	Strychnine	57-24-9					2.3E+00	9.9E+00		1.9E+00
				2.0E-01	I	1.0E+00	I	V		8.67E+02	1.36E+09	9.35E+03	1		Styrene	100-42-5					1.6E+03		9.7E+02	6.0E+02
				3.0E-03	P						1.36E+09		1	0.1	Styrene-Acrylonitrile (SAN) Trimer (THNA isomer)	57964-39-3					2.3E+01	9.9E+01		1.9E+01
				3.0E-03	P						1.36E+09		1	0.1	Styrene-Acrylonitrile (SAN) Trimer (THNP isomer)	57964-40-6					2.3E+01	9.9E+01		1.9E+01
				1.0E-03	P	2.0E-03	X				1.36E+09		1	0.1	Sulfolane	126-33-0					7.8E+00	3.3E+01	2.8E+05	6.3E+00
				8.0E-04	P						1.36E+09		1	0.1	Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					6.3E+00	2.6E+01		5.1E+00
						1.0E-03	C	V			1.36E+09		1		Sulfur Trioxide	7446-11-9							1.4E+05	1.4E+05
						1.0E-03	C				1.36E+09		1		Sulfuric Acid	7664-93-9							1.4E+05	1.4E+05
2.5E-02	I	7.1E-06	I	5.0E-02	H						1.36E+09		1	0.1	Sulfurous acid, 2-chloroethyl 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester	140-57-8	2.8E+01	9.9E+01	5.4E+05	2.2E+01	3.9E+02	1.6E+03		3.2E+02
				7.0E-02	I						1.36E+09		1	0.1	Tebuthiuron	34014-18-1					5.5E+02	2.3E+03		4.4E+02
				2.0E-02	H						1.36E+09		1	0.1	Temephos	3383-96-8					1.6E+02	6.6E+02		1.3E+02
				1.3E-02	I						1.36E+09		1	0.1	Terbacil	5902-51-2					1.0E+02	4.3E+02		8.2E+01
				2.5E-05	H			V		3.09E+01	1.36E+09	2.64E+05	1		Terbufos	13071-79-9					2.0E-01			2.0E-01
				1.0E-03	I						1.36E+09		1	0.1	Terbutryn	886-50-0					7.8E+00	3.3E+01		6.3E+00
5.0E-03	C	1.3E-06	C					V			1.36E+09	3.99E+03	1		Tert-Butyl Acetate	540-88-5	1.4E+02		8.6E+00	8.1E+00				
				1.0E-04	I						1.36E+09		1	0.1	Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					7.8E-01	3.3E+00		6.3E-01
				3.0E-05	P			V			1.36E+09	5.07E+04	1		Tetrachlorobenzene, 1,2,4,5-	95-94-3					2.3E-01			2.3E-01
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		6.80E+02	1.36E+09	5.68E+03	1		Tetrachloroethane, 1,1,1,2-	630-20-6	2.7E+01		2.2E+00	2.0E+00	2.3E+02			2.3E+02
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		1.90E+03	1.36E+09	1.51E+04	1		Tetrachloroethane, 1,1,2,2-	79-34-5	3.5E+00		7.3E-01	6.0E-01	1.6E+02			1.6E+02
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		1.66E+02	1.36E+09	2.35E+03	1		Tetrachloroethylene	127-18-4	3.3E+02		2.5E+01	2.4E+01	4.7E+01		9.8E+00	8.1E+00
				3.0E-02	I						1.36E+09		1	0.1	Tetrachlorophenol, 2,3,4,6-	58-90-2					2.3E+02	9.9E+02		1.9E+02
1.6E+01	X			6.0E-05	X			V			1.36E+09	1.05E+05	1		Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	4.3E-02			4.3E-02	4.7E-01			4.7E-01
				5.0E-04	I						1.36E+09		1	0.1	Tetraethyl Dithiopyrophosphate	3689-24-5					3.9E+00	1.6E+01		3.2E+00
						8.0E+01	I	V		2.05E+03	1.36E+09	1.22E+03	1		Tetrafluoroethane, 1,1,1,2-	811-97-2							1.0E+04	1.0E+04
				1.0E-04	X						1.36E+09		1	0.1	Tetramethylphosphoramide, -N,N,N',N'' (TMPA)	16853-36-4					7.8E-01	3.3E+00		6.3E-01
				2.0E-03	P						1.36E+09		1	0.00065	Tetryl (Trinitrophenylmethylnitramine)	479-45-8					1.6E+01	1.0E+04		1.6E+01
				2.0E-05	G						1.36E+09		1		Thallic Oxide	1314-32-5					1.6E-01			1.6E-01
				1.0E-05	X						1.36E+09		1		Thallium (I) Nitrate	10102-45-1					7.8E-02			7.8E-02
				1.0E-05	X						1.36E+09		1		Thallium (Soluble Salts)	7440-28-0					7.8E-02			7.8E-02
				1.0E-05	X			V			1.36E+09	1.40E+05	1		Thallium Acetate	563-68-8					7.8E-02			7.8E-02
				2.0E-05	X						1.36E+09		1	0.1	Thallium Carbonate	6533-73-9					1.6E-01	6.6E-01		1.3E-01
				1.0E-05	X						1.36E+09		1		Thallium Chloride	7791-12-0					7.8E-02			7.8E-02
				1.0E-05	G						1.36E+09		1		Thallium Selenite	12039-52-0					7.8E-02			7.8E-02
				2.0E-05	X						1.36E+09		1		Thallium Sulfate	7446-18-6					1.6E-01			1.6E-01
				4.3E-02	O						1.36E+09		1	0.1	Thifensulfuron-methyl	79277-27-3					3.4E+02	1.4E+03		2.7E+02
				1.0E-02	I						1.36E+09		1	0.1	Thiobencarb	28249-77-6					7.8E+01	3.3E+02		6.3E+01
				3.0E-02	H						1.36E+09		1	0.1	Thiocyanic acid, (2-benzothiazolylthio)methyl ester (TCMTB)	21564-17-0					2.3E+02	9.9E+02		1.9E+02
				7.0E-02	X						1.36E+09		1	0.0075	Thiodiglycol	111-48-8					5.5E+02	3.1E+04		5.4E+02
				3.0E-04	H						1.36E+09		1	0.1	Thiofanox	39196-18-4					2.3E+00	9.9E+00		1.9E+00
1.2E-02	O			1.6E-01	O						1.36E+09		1	0.1	Thiophanate, Methyl	23564-05-8	6.0E+01	2.1E+02		4.7E+01	1.3E+03	5.3E+03		1.0E+03
				1.5E-02	O						1.36E+09		1	0.1	Thiram	137-26-8					1.2E+02	4.9E+02		9.5E+01
				6.0E-01	H						1.36E+09		1		Tin	7440-31-5					4.7E+03			4.7E+03
						1.0E-04	A	V			1.36E+09		1		Titanium Tetrachloride	7550-45-0							1.4E+04	1.4E+04
				8.0E-02	I	5.0E+00	I	V		8.18E+02	1.36E+09	4.29E+03	1		Toluene	108-88-3					6.3E+02		2.2E+03	4.9E+02
3.9E-02	C	1.1E-05	C			8.0E-06	C	V			1.36E+09	7.62E+05	1		Toluene-2,4-diisocyanate	584-84-9	1.8E+01		1.9E+02	1.6E+01			6.4E-01	6.4E-01
3.9E-02	C	1.1E-05	C			8.0E-06	C	V		1.71E+03	1.36E+09	6.32E+05	1		Toluene-2,6-diisocyanate	91-08-7	1.8E+01		1.6E+02	1.6E+01			5.3E-01	5.3E-01
				1.0E-04	X						1.36E+09		1	0.1	Toluenediamine, 2,3-	2687-25-4					7.8E-01	3.3E+00		6.3E-01
1.8E-01	X			2.0E-04	X						1.36E+09		1	0.1	Toluenediamine, 2,5-	95-70-5	3.9E+00	1.4E+01		3.0E+00	1.6E+00	6.6E+00		1.3E+00
				1.0E-04	X						1.36E+09		1	0.1	Toluenediamine, 3,4-	496-72-0					7.8E-01	3.3E+00		6.3E-01
				5.0E-03	P						1.36E+09		1	0.1	Toluic Acid, p-	99-94-5					3.9E+01	1.6E+02		3.2E+01
1.6E-02	P	5.1E-05	C								1.36E+09		1	0.1	Toluidine, o- (Methylaniline, 2-)	95-53-4	4.3E+01	1.5E+02	7.5E+04	3.4E+01				
3.0E-02	P			4.0E-03	X						1.36E+09		1	0.1	Toluidine, p-	106-49-0	2.3E+01	8.2E+01		1.8E+01	3.1E+01	1.3E+02		2.5E+01
				3.0E+00	P			V		3.42E-01	1.36E+09	1.38E+03	1		Total Petroleum Hydrocarbons (Aliphatic High)	E1790670					2.3E+04			2.3E+04
				5.0E-03	P	4.0E-01	P	V		1.12E+02	1.36E+09	1.65E+03	1		Total Petroleum Hydrocarbons (Aliphatic Low)	E1790666					3.9E+01		6.9E+01	2.5E+01
				1.0E-02	X	1.0E-01	P	V		6.86E+00	1.36E+09	1.04E+03	1		Total Petroleum Hydrocarbons (Aliphatic Medium)	E1790668					7.8E+01		1.1E+01	9.6E+00
				3.0E-04	P	2.0E-06	P		M		1.36E+09		1	0.13	Total Petroleum Hydrocarbons (Aromatic High)	E1790676					2.3E+00	7.6E+00	2.8E+02	1.8E+00
				1.0E-02	P	6.0E-02	P	V		2.31E+02	1.36E+09	7.75E+03	1		Total Petroleum Hydrocarbons (Aromatic Medium)	E1790674					7.8E+01		4.8E+01	3.0E+01
1.1E+00	I	3.2E-04	I	9.0E-05	P						1.36E+09		1	0.1	Toxaphene	8001-35-2	6.3E-01	2.2E+00	1.2E+04	4.9E-01	7.0E-01	3.0E+00		5.7E-01
				3.0E-05	X						1.36E+09		1	0.1	Toxaphene, Weathered	E1841606					2.3E-01	9.9E-01		1.9E-01
				7.5E-03	I						1.36E+09		1	0.1	Tralomethrin	66841-25-6					5.9E+01	2.5E+02		4.7E+01
				3.0E-04	A			V			1.36E+09	3.36E+03	1		Tri-n-butyltin	688-73-3					2.3E+00			2.3E+00
				8.0E+01	X						1.36E+09		1	0.1	Triacetin	102-76-1					6.3E+05	2.6E+06		5.1E+05
				3.4E-02	O						1.36E+09		1	0.1	Triadimefon	43121-43-3					2.7E+02	1.1E+03		2.1E+02
7.2E-02	O			2.5E-02	O			V			1.36E+09	3.62E+05	1		Triallate	2303-17-5	9.7E+00			9.7E+00	2.0E+02			2.0E+02
				1.0E-02	I						1.36E+09		1	0.1	Triasulfuron	82097-50-5					7.8E+01	3.3E+02		6.3E+01
				8.0E-03	I						1.36E+09		1	0.1	Tribenuron-methyl	101200-48-0					6.3E+01	2.6E+02		5.1E+01
				5.0E-03	I			V			1.36E+09	4.83E+04	1		Tribromobenzene, 1,2,4-	615-54-3					3.9E+01			3.9E+01
				9.0E-03	X						1.36E+09		1	0.1	Tribromophenol, 2,4,6-	118-79-6					7.0E+01	3.0E+02		5.7E+01
				2.0E-04	O						1.36E+09		1	0.1	Tribufos	78-48-8					1.6E+00	6.6E+00		1.3E+00
9.0E-03	P			1.0E-02	P						1.36E+09		1	0.1	Tributyl Phosphate	126-73-8	7.7E+01	2.7E+02		6.0E+01	7.8E+01	3.3E+02		6.3E+01
				3.0E-04	P						1.36E+09		1	0.1	Tributyltin Compounds	E1790679					2.3E+00	9.9E+00		1.9E+00
				3.0E-04	I						1.36E+09		1	0.1	Tributyltin Oxide	56-35-9					2.3E+00	9.9E+00		1.9E+00
											1.36E+09		1	0.1	Trichloramine	10025-85-1								
				3.0E+01	I	5.0E+00	P	V		9.10E+02	1.36E+09	1.29E+03	1		Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					2.3E+05		6.7E+02	6.7E+02
7.0E-02	I			2.0E-02	I						1.36E+09		1	0.1	Trichloroacetic Acid	76-03-9	9.9E+00	3.5E+01		7.8E+00	1.6E+02	6.6E+02		1.3E+02
2.9E-02	H										1.36E+09		1	0.1	Trichloroaniline HCl, 2,4,6-	33663-50-2	2.4E+01	8.5E+01		1.9E+01				
7.0E-03	X			3.0E-05	X						1.36E+09		1	0.1	Trichloroaniline, 2,4,6-	634-93-5	9.9E+01	3.5E+02		7.8E+01	2.3E-01	9.9E-01		1.9E-01
				8.0E-04	X			V			1.36E+09	3.22E+04	1		Trichlorobenzene, 1,2,3-	87-61-6					6.3E+00			6.3E+00
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		4.04E+02	1.36E+09	2.99E+04	1		Trichlorobenzene, 1,2,4-	120-82-1	2.4E+01			2.4E+01	7.8E+01		6.2E+00	5.8E+00
				2.0E+00	I	5.0E+00	I	V		6.40E+02	1.36E+09	1.65E+03	1		Trichloroethane, 1,1,1-	71-55-6					1.6E+04		8.6E+02	8.1E+02
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		2.16E+03	1.36E+09	7.22E+03	1		Trichloroethane, 1,1,2-	79-00-5	1.2E+01		1.3E+00	1.1E+00	3.1E+01		1.5E-01	1.5E-01
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	6.92E+02	1.36E+09	2.21E+03	1		Trichloroethylene	79-01-6	8.8E+00		1.1E+00	9.4E-01	3.9E+00		4.6E-01	4.1E-01

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen.

Toxicity and Chemical-specific Information															Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer Child Hazard Index (HI) = 0.1			
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	C_{sat} (mg/kg)	PEF (m^3/kg)	VF (m^3/kg)	GIABS	ABS_d	Analyte	CAS No.	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=0.1 (mg/kg)	Dermal SL Child THQ=0.1 (mg/kg)	Inhalation SL Child THQ=0.1 (mg/kg)	Noncarcinogenic SL Child THI=0.1 (mg/kg)
				3.0E-01	I			V		1.23E+03	1.36E+09	1.04E+03	1		Trichlorofluoromethane	75-69-4					2.3E+03			2.3E+03
				1.0E-01	I						1.36E+09		1	0.1	Trichlorophenol, 2,4,5-	95-95-4					7.8E+02	3.3E+03		6.3E+02
1.1E-02	I	3.1E-06	I	1.0E-03	P						1.36E+09		1	0.1	Trichlorophenol, 2,4,6-	88-06-2	6.3E+01	2.2E+02	1.2E+06	4.9E+01	7.8E+00	3.3E+01		6.3E+00
				1.0E-02	I						1.36E+09		1	0.1	Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					7.8E+01	3.3E+02		6.3E+01
				8.0E-03	I						1.36E+09		1	0.1	Trichlorophenoxypropionic acid, -2,4,5	93-72-1					6.3E+01	2.6E+02		5.1E+01
				5.0E-03	I			V		1.28E+03	1.36E+09	1.50E+04	1		Trichloropropane, 1,1,2-	598-77-6					3.9E+01			3.9E+01
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	1.40E+03	1.36E+09	1.57E+04	1		Trichloropropane, 1,2,3-	96-18-4	5.1E-03			5.1E-03	3.1E+01		4.9E-01	4.8E-01
				3.0E-03	X	3.0E-04	P	V		3.11E+02	1.36E+09	2.34E+03	1		Trichloropropene, 1,2,3-	96-19-5					2.3E+01		7.3E-02	7.3E-02
				2.0E-02	A						1.36E+09		1	0.1	Tricresyl Phosphate (TCP)	1330-78-5					1.6E+02	6.6E+02		1.3E+02
				3.0E-03	I						1.36E+09		1	0.1	Tridiphane	58138-08-2					2.3E+01	9.9E+01		1.9E+01
						7.0E-03	I	V		2.79E+04	1.36E+09	1.58E+04	1		Triethylamine	121-44-8							1.2E+01	1.2E+01
				2.0E+00	P						1.36E+09		1	0.1	Triethylene Glycol	112-27-6					1.6E+04	6.6E+04		1.3E+04
						2.0E+01	P	V		4.81E+03	1.36E+09	7.12E+02	1		Trifluoroethane, 1,1,1-	420-46-2							1.5E+03	1.5E+03
7.7E-03	I			7.5E-03	I			V			1.36E+09	5.13E+05	1		Trifluralin	1582-09-8	9.0E+01			9.0E+01	5.9E+01			5.9E+01
2.0E-02	P			1.0E-02	P						1.36E+09		1	0.1	Trimethyl Phosphate	512-56-1	3.5E+01	1.2E+02		2.7E+01	7.8E+01	3.3E+02		6.3E+01
				1.0E-02	I	6.0E-02	I	V		2.93E+02	1.36E+09	9.44E+03	1		Trimethylbenzene, 1,2,3-	526-73-8					7.8E+01		5.9E+01	3.4E+01
				1.0E-02	I	6.0E-02	I	V		2.19E+02	1.36E+09	7.91E+03	1		Trimethylbenzene, 1,2,4-	95-63-6					7.8E+01		5.0E+01	3.0E+01
				1.0E-02	I	6.0E-02	I	V		1.82E+02	1.36E+09	6.61E+03	1		Trimethylbenzene, 1,3,5-	108-67-8					7.8E+01		4.1E+01	2.7E+01
				1.0E-02	X			V		2.96E+01	1.36E+09	1.00E+03	1		Trimethylpentene, 2,4,4-	25167-70-8					7.8E+01			7.8E+01
				3.0E-02	I						1.36E+09		1	0.019	Trinitrobenzene, 1,3,5-	99-35-4					2.3E+02	5.2E+03		2.2E+02
3.0E-02	I			5.0E-04	I						1.36E+09		1	0.032	Trinitrotoluene, 2,4,6-	118-96-7	2.3E+01	2.6E+02		2.1E+01	3.9E+00	5.2E+01		3.6E+00
				2.0E-02	P						1.36E+09		1	0.1	Triphenylphosphine Oxide	791-28-6					1.6E+02	6.6E+02		1.3E+02
				2.0E-02	A						1.36E+09		1	0.1	Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					1.6E+02	6.6E+02		1.3E+02
				1.0E-02	X						1.36E+09		1	0.1	Tris(1-chloro-2-propyl)phosphate	13674-84-5					7.8E+01	3.3E+02		6.3E+01
2.3E+00	C	6.6E-04	C					V		4.67E+02	1.36E+09	9.03E+05	1		Tris(2,3-dibromopropyl)phosphate	126-72-7	3.0E-01		3.8E+00	2.8E-01				
2.0E-02	P			7.0E-03	P						1.36E+09		1	0.1	Tris(2-chloroethyl)phosphate	115-96-8	3.5E+01	1.2E+02		2.7E+01	5.5E+01	2.3E+02		4.4E+01
3.2E-03	P			1.0E-01	P						1.36E+09		1	0.1	Tris(2-ethylhexyl)phosphate	78-42-2	2.2E+02	7.7E+02		1.7E+02	7.8E+02	3.3E+03		6.3E+02
				8.0E-04	P						1.36E+09		1		Tungsten	7440-33-7					6.3E+00			6.3E+00
				2.0E-04	A	4.0E-05	A				1.36E+09		1		Uranium	7440-61-1					1.6E+00		5.7E+03	1.6E+00
1.0E+00	C	2.9E-04	C						M		1.36E+09		1	0.1	Urethane	51-79-6	1.5E-01	6.0E-01	4.8E+03	1.2E-01				
		8.3E-03	P	9.0E-03	I	7.0E-06	P				1.36E+09		0.026		Vanadium Pentoxide	1314-62-1			4.6E+02	4.6E+02	7.0E+01		9.9E+02	6.6E+01
				5.0E-03	G	1.0E-04	A				1.36E+09		0.026		Vanadium and Compounds	7440-62-2					3.9E+01		1.4E+04	3.9E+01
				1.0E-03	I			V			1.36E+09	1.23E+05	1		Vernolate	1929-77-7					7.8E+00			7.8E+00
				1.2E-03	O						1.36E+09		1	0.1	Vinclozolin	50471-44-8					9.4E+00	4.0E+01		7.6E+00
				1.0E+00	H	2.0E-01	I	V		2.75E+03	1.36E+09	4.40E+03	1		Vinyl Acetate	108-05-4					7.8E+03		9.2E+01	9.1E+01
		1.5E-05	P			3.0E-03	I	V		2.47E+03	1.36E+09	1.37E+03	1		Vinyl Bromide	593-60-2			2.6E-01	2.6E-01			4.3E-01	4.3E-01
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	3.92E+03	1.36E+09	9.56E+02	1		Vinyl Chloride	75-01-4	9.4E-02		1.6E-01	5.9E-02	2.3E+01		1.0E+01	7.0E+00
				3.0E-04	I						1.36E+09		1	0.1	Warfarin	81-81-2					2.3E+00	9.9E+00		1.9E+00
				2.0E-01	G	1.0E-01	G	V		3.88E+02	1.36E+09	5.47E+03	1		Xylene, m-	108-38-3					1.6E+03		5.7E+01	5.5E+01
				2.0E-01	G	1.0E-01	G	V		4.34E+02	1.36E+09	6.45E+03	1		Xylene, o-	95-47-6					1.6E+03		6.7E+01	6.4E+01
				2.0E-01	G	1.0E-01	G	V		3.90E+02	1.36E+09	5.58E+03	1		Xylene, p-	106-42-3					1.6E+03		5.8E+01	5.6E+01
				2.0E-01	I	1.0E-01	I	V		2.60E+02	1.36E+09	5.74E+03	1		Xylenes	1330-20-7					1.6E+03		6.0E+01	5.8E+01
				3.0E-04	I						1.36E+09		1		Zinc Phosphide	1314-84-7					2.3E+00			2.3E+00
				3.0E-01	I						1.36E+09		1		Zinc and Compounds	7440-66-6					2.3E+03			2.3E+03
				5.0E-02	I						1.36E+09		1	0.1	Zineb	12122-67-7					3.9E+02	1.6E+03		3.2E+02
				8.0E-05	X						1.36E+09		1		Zirconium	7440-67-7					6.3E-01			6.3E-01

TR=1E-06
HQ=0.1

OFFICE OF LAND AND EMERGENCY MANAGEMENT
WASHINGTON, D.C. 20460

January 17, 2024

MEMORANDUM

SUBJECT: Updated Residential Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities

FROM: Barry N. Breen
Principal Deputy Assistant Administrator

TO: Regional Administrators, Regions 1 - 10

PURPOSE

Reducing childhood lead exposure is an Environmental Protection Agency (EPA) priority. Consistent with the best available science, the Agency's Strategy to Reduce Lead Exposures and Disparities in U.S. Communities, and the Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts, the Office of Land and Emergency Management (OLEM) is updating its residential soil lead regional screening level (RSL) and regional removal management level (RML) for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as "Superfund" remedial and removal programs, respectively, and Resource Conservation and Recovery Act (RCRA) Corrective Action program. The information and recommendations in this guidance also apply to federal facility cleanup programs subject to CERCLA section 120, and potentially to federal agencies using response action authorities delegated to them under Executive Order 12580 (OFR, 1987).

Screening Residential Soil Lead Sites

What is a regional screening level (RSL)? RSLs are screening tools used to help identify and define areas that may need further evaluation.

What is a removal management level (RML)? RMLs are screening tools used to help prioritize and define areas that may pose the greatest threat to human health.

The RSLs and RMLs are generally not default preliminary remediation goals (See Footnote 11) and cleanup levels.

When evaluating residential sites with soil lead contamination,[1] OLEM recommends:

[1]For the purpose of this guidance, a residential site with soil lead contamination (residential lead site) is defined as any areas where children have unrestricted access to lead contaminated soil which include, but are not limited to, properties containing single- and multi-family dwellings, apartment complexes, vacant lots in residential areas, schools, day-care

Regional Screening Level

- EPA regions should use a residential soil lead RSL of 200 parts per million (ppm).[2]
- However, EPA regions should use a RSL of 100 ppm[3] if an additional source of lead is identified (e.g., lead water service lines, lead-based paint, non-attainment areas where the air lead concentrations exceed National Ambient Air Quality Standards [NAAQS]). The recommended RSL of 100 ppm considers aggregate lead exposure and increased risk to children living in communities with multiple sources of lead contamination. In making site-specific decisions on when to use an RSL of 100 ppm, EPA regions may use national data sets identified by OLEM for this purpose. EPA regions may also use site-specific sources of information (e.g., data from the local health department or local public water system), alone or in combination with national data sets, to select an appropriate RSL of either 100 ppm or 200 ppm. EPA regions should document the site-specific rationale for the selected RSL.
- Federal-led RCRA corrective action residential soil lead cleanups should use an RSL of 200 ppm or 100 ppm based on the factors discussed above. EPA strongly encourages states that are authorized for RCRA Corrective Action to use these RSLs in their state-led residential soil lead cleanups.

Removal Management Level

- EPA regions should use a residential soil lead RML of 200 ppm.

NOTICE

Please note, the statements in this document are intended solely as guidance. This document is not intended, nor can it be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA will accept public input and evaluate new scientific evidence, as appropriate.

BACKGROUND

Two guidance documents, (1) Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (USEPA, 1994) and (2) Clarification to the 1994 Revised Interim Soil Lead (Pb) Guidance

centers, community centers, playgrounds, parks and other recreational areas and green ways. Under CERCLA and RCRA Corrective Action, screening and cleanup decisions for residential land use are based the most sensitive receptor (young children less than 7 years old). See USEPA, 1998 and 2003.

[2] Since 1994, OLEM has recommended the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) as a risk assessment tool to support environmental cleanup decisions at current and future anticipated residential sites (USEPA, 1994). The IEUBK predicts blood lead levels in young children (birth to 7 years of age) exposed to lead from several sources of exposure and routes. The current version of the model (IEUBKv2) with 5 µg/dL as the 95th percentile target blood lead level and national default lead concentrations predicts a soil lead concentration of approximately 200 ppm. The geometric mean blood lead level is 2.3 µg/dL.

[3] The IEUBKv2 with 3.5 µg/dL as the 95th percentile target blood lead level and national default lead concentrations predicts a soil lead concentration of approximately 100 ppm. The geometric mean blood lead level is 1.7 µg/dL. EPA has not evaluated the IEUBKv2 below 5 µg/dL (upper percentile of the blood lead distribution) (Brown et al., 2022). EPA has a qualitative understanding of uncertainties that may exist in applying the model outside the evaluated range, which is consistent with EPA Guidance on the Development, Evaluation, and Application of Environmental Models (See definition of mechanistic model, page 44, USEPA, 2009). EPA has used models outside the evaluated range when deemed necessary and appropriate for human health risk assessments.

for CERCLA and RCRA Corrective Action Facilities (USEPA, 1998), established OLEM's previously recommended approach for evaluating and cleaning up Superfund and RCRA Corrective Action sites with soil lead contamination. Broadly, these directives recommended a residential soil lead RSL of 400 ppm based on 10 µg/dL as the 95th percentile target blood lead level, described how to develop preliminary remediation goals (PRGs) and cleanup levels, and described a strategy to manage multiple sources of lead exposure. At the time, a blood lead level above 10 µg/dL was recognized to be associated with adverse health outcomes in children (USEPA, 1994). The science on lead has since evolved and demonstrates additional adverse health effects of lead exposure and at lower levels than previously known.

Best Available Science and Data

In 2012, the National Toxicology Program (NTP) Monograph on Health Effects of Low-Level Lead examined the evidence for adverse health effects at blood lead levels of up to 5 µg/dL and 10 µg/dL and found sufficient evidence of many different types of health effects below both levels. The NTP concluded, "In children, there is sufficient evidence that blood [lead] Pb levels <5 µg/dL are associated with increased diagnosis of attention-related behavioral problems, greater incidence of problem behaviors, and decreased cognitive performance as indicated by (1) lower academic achievement, (2) decreased intelligence quotient (IQ), and (3) reductions in specific cognitive measures" (HHS, 2012, page xviii). Further, the NTP found "sufficient evidence that blood Pb levels <5 µg/dL are associated with antisocial behavioral problems or actual criminal behavior in children from 6 to 15 years of age." For adults, the NTP found "sufficient evidence that blood Pb levels <5 µg/dL are associated with decreased renal function" and "sufficient evidence that maternal blood Pb levels <5 µg/dL are associated with reduced fetal growth" (Ibid.). Although the evidence was less definitive, the NTP also found associations of blood Pb levels <5 µg/dL with delayed puberty and decreased kidney function in children and with essential tremor in adults. The NTP concluded "that there is sufficient evidence that blood Pb levels <10 ug/dL in adults are associated with adverse effects on cardiovascular function" (HHS, 2012, page xxii).

EPA's 2013 Integrated Science Assessment for Lead (ISA) states "It is clear that Pb [lead] exposure in childhood presents a risk; further, there is no evidence of a threshold below which there are no harmful effects on cognition from Pb [lead] exposure" (USEPA, 2013, page xxxviii). Although the ISA reports, "Clear evidence of cognitive function decrements (as measured by Full Scale IQ, academic performance, and executive function) in young children (4 to 11 years old) with mean or group blood Pb [lead] levels measured at various life stages and time periods between 2 and 8 µg/dL," (USEPA, 2013, page xxxiii) it is critical to note that there is not a threshold for toxicity somewhere between blood lead levels of 2 and 8 µg/dL. Rather, a "threshold for cognitive function decrements is not discernable from the available evidence" (USEPA, 2013, page 1-20). Although there are a greater number of studies available to support effects at 5 µg/dL, cognitive function decrements in children have been found at all levels examined, including at levels as low as 2 µg/dL as identified in the 2013 ISA. The ISA also concludes that lead exposure has a causal relationship with hypertension and coronary heart disease (USEPA, 2013, page 1-29). The recommended RSLs of 200 ppm and 100 ppm are predicted using the current version of the Integrated Exposure Uptake Biokinetic Model for Lead in

Children (IEUBK) to result in geometric mean blood lead levels (2.3 µg/dL and 1.7 µg/dL, respectively) that are 0.3 µg/dL above and below, respectively 2 µg/dL.

The Agency for Toxic Substances and Disease Registry's 2020 Toxicological Profile for Lead reviewed 694 epidemiological studies that evaluated the health effects of lead in all organ systems. This updated Toxicological Profile concluded that "[f]or the most studied endpoints (neurological, renal, cardiovascular, hematological, immunological, reproductive, and developmental), effects occur at the lowest PbBs [blood leads] studied (≤5 µg/dL)" (ATSDR, 2020, page 3). Some of the more recent studies included in the Toxicological Profile provide "supporting evidence that exposures to Pb [lead] may produce effects on cognitive function in populations whose PbBs [blood leads] are well below 5 µg/dL and may extend to levels below 1 µg/dL" (ATSDR, 2020, page 168).

RATIONALE FOR UPDATED GUIDANCE

As previously stated, evolving science on lead has demonstrated additional adverse impacts of lead exposure well below 10 µg/dL since the 1994 guidance was issued. Moreover, children could be exposed to multiple sources of lead other than contaminated soil/dust (e.g., lead water service lines, lead-based paint, or non-attainment areas where the air lead concentrations exceed NAAQS) at Superfund and RCRA Corrective Action sites. Studies[4] conducted at or near Superfund sites provide evidence that aggregate lead exposure has generally resulted in blood lead levels that are higher than those of most U.S. children as indicated by the observation of a disproportionate number of elevated blood lead levels in such communities. Further, the 2013 ISA found that childhood, race and ethnicity, proximity to lead sources, residential factors (housing age), and poor nutrition may lead to increased risk of lead related health effects (USEPA, 2013, Table 1-7, page 1-79).

While evidence shows adverse health effects at the lowest levels studied, CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) mandate that EPA develop protective exposure levels for our sites, establishing a risk management paradigm informed by many factors including health effects at issue and the population at risk. Based on the best available science, OLEM is recommending a lower residential soil lead RSL and RML of 200 ppm and further reducing the RSL to 100 ppm when there is aggregate lead exposure. Lowering the RSL and RML is expected to increase the number of residential properties evaluated for potential cleanup under CERCLA and RCRA Corrective Action authorities.

From a risk management perspective, effectively assessing potential impacts to children from lead exposure[5] informs further evaluation of the site. This information is integral to selecting the most appropriate combination of CERCLA or RCRA Corrective Action response actions to reduce the risk from site-specific lead contamination. Through these recommendations, EPA is helping ensure that Superfund and RCRA Corrective Action residential soil lead cleanups adequately reduce childhood exposures, which, if unaddressed, could lead to lifelong adverse health effects.

[4] Klemick et. al., 2020; Khoury and Diamond, 2003; Terragraphics, 2004; Frank, et. al., 2019; Zota, et. al., 2011; Ye, et. al., 2022; U.S. EPA, 2013.

[5] CERCLA and RCRA Corrective Action residential soil lead cleanups protect the most sensitive receptor and thereby protect all other residents in the process (including pregnant women, older children, and other adults).

IMPLEMENTATION

Managing and Prioritizing Residential Soil Lead Cleanups

This guidance should be considered for all residential lead sites subject to CERCLA response and RCRA Corrective Action authorities, including those previously addressed and/or deleted from the National Priorities List (NPL).[6] EPA expects that a significant number of residential properties could undergo evaluation and cleanup because of this guidance. The existing prioritization process, which occurs at the regional level,[7] will continue. That process entails review of existing site information and overall risk in a manner consistent with the NCP and national program guidance and policies. EPA regions should work collaboratively with state, tribal, and public health agencies to prioritize addressing sites, considering factors such as current levels of exposure and communities with increased risk. Consistent with national policy, EPA will make resource decisions for residential lead sites in a manner that balances resources across all Superfund sites.

Evaluations of previously addressed sites could be conducted in support of a CERCLA five-year review or other technical review. EPA regions should consider historical site-specific documentation to determine: the extent of previous cleanup, including cleanup levels and the remedial and/or removal action objectives; the exposure assumptions used in the risk assessment at the time of response selection, including the use of site-specific environmental data (e.g., lead concentrations in various media and bioavailability); if the current version of the IEUBK blood lead level estimates are consistent with revised target blood lead levels outlined in this guidance (5 µg/dL or 3.5 µg/dL 95th percentile target blood lead level); and other appropriate considerations. EPA regions should include an assessment of the actual exposure scenarios (e.g., gardening, excavation, age of children in contact with soil, paved and unpaved surfaces) throughout both the remediated and un-remediated areas within the site, in addition to evaluating whether potential changes in cleanup levels are necessary and appropriate.

Because EPA expects a significant number of properties to undergo evaluation, EPA regions are not expected to be able to address all properties immediately. As EPA regions are prioritizing residential lead sites for evaluation and potential cleanup, OLEM continues to recommend early risk reduction strategies, which could include a combination of engineering controls (e.g., reliable barriers to mitigate risk from lead exposure) and non-engineering response actions (e.g., education and health intervention programs in conjunction with exposure reduction actions like institutional controls).[8] EPA will continue

[6] Regarding completed residential soil lead cleanups, there are post-remedy review authorities for RCRA cleanups; one is the authority to reopen permits based on new information.

[7] EPA intends to engage with other Federal agencies conducting actions under CERCLA or RCRA Corrective Action associated with lead releases from these Federal Facilities, with input from state and tribal environmental agencies, to develop a Federal Facility-specific implementation guidance. EPA's Federal Facilities Restoration and Reuse Office (FFRRO) works with EPA regions and other federal agencies to develop creative, cost-effective solutions to environmental challenges at Federal Facility Superfund Sites. When prioritizing properties at federal facilities, other federal agencies serving as the lead for these facilities should discuss prioritizing reassessment and potential response actions with its cleanup regulators (e.g., EPA and the state at NPL Sites or Sites with Superfund Alternative Approach Agreements).

[8] See Use of Early Actions at Superfund National Priorities List Sites and Sites with Superfund Alternative Approach Agreements, August 23, 2019.

to take appropriate and timely response actions under available CERCLA or RCRA Corrective Action authorities at sites where the release of lead poses an imminent and substantial danger to public health.

Integration of Removal and Remedial Authorities at Residential Lead Sites

It is important to consider the statutory and regulatory differences between removal actions and remedial actions, as well as each authority's limitation. When CERCLA was enacted, the general intent was for the program to use emergency or time-critical removal authority to address the most immediate threats, to consider the use of non-time critical removal authority when a planning period of at least six months exists before on-site activities must be initiated, and to use remedial authority for the less immediate threats. Absent time sensitivity, remedial authority generally would be used to address complex site problems that will likely require a costly, complicated response. It is important to carefully consider the specifics of each site and to clearly document the basis for determining the appropriate authority given site circumstances. Emergency and time-critical removal authorities should continue to be used in alignment with agency statutes, regulations, policy, and guidance to address the most immediate public health and environmental threats.

Collaboration at Superfund Residential Lead Sites

Multiple sources of lead contamination could be present at Superfund sites where children are at risk. The Superfund program promotes collaboration to provide a more holistic approach to reducing lead exposures at residential lead Superfund sites. Many federal, local, state, and tribal agencies have diverse legal authorities to address sources of lead exposure in communities; therefore, EPA Regions should collaborate with these entities as part of an overall site management strategy to prevent and reduce lead exposures in communities.[9]

Developing PRGs and Cleanup Levels for Residential Lead Sites

OLEM recommends using the most current version of the IEUBK to assess risk from exposure or potential exposure to soil lead contamination.[10] In the absence of more stringent regulations and standards constituting applicable, or relevant and appropriate requirements (ARARs), OLEM recommends that regions should use the most current version of the IEUBK with 5 µg/dL as the 95th percentile target blood lead level and site-specific environmental data (e.g., lead concentrations in various media and bioavailability) to develop PRGs[11] and cleanup levels for residential land use. If an

[9] The Superfund program conducted the Superfund Lead Collaboration Pilot to gather best practices for enhancing collaboration when multiple sources of lead are identified in communities near Superfund residential lead sites. OLEM will recommend these best practices where appropriate.

[10] Risk assessment questions can be directed to the site's risk assessor or the Technical Review Workgroup for Metals and Asbestos (TRW) Lead Committee. See https://www.epa.gov/superfund/lead-superfund-sites-risk-assessment.

[11] See 40 C.F.R. § 300.430(e)(2)(i) ("Initially, preliminary remediation goals are developed based on readily available information, such as chemical-specific ARARs [applicable or relevant and appropriate requirements] or other reliable information…. Remediation goals [cleanup levels] shall establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following: (A) Applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws, if available."). See USEPA, 1997.

additional source of lead (e.g., lead water service lines, lead-based paint, non-attainment areas where the lead concentrations exceed NAAQS) is identified, OLEM recommends 3.5 µg/dL as the 95th percentile target blood lead level. This adjustment considers increased risk to children living in communities with multiple sources of lead contamination. EPA regions should adjust PRGs and cleanup levels to account for uncertainty, technical limitations (i.e., detection/quantification limits),[12] and site-specific soil lead background.

Consistent with the Role of Background in the CERCLA Cleanup Program, cleanup levels should not be set at values below natural or anthropogenic background. When the IEUBK-derived cleanup level is lower than site-specific background, the cleanup level should be set at background. EPA regions should consult the 2002 Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites when establishing site-specific soil lead background. In addition to the use of statistical tests, an important component of defining background concentrations is the choice of appropriate background samples, which should include consideration of the conceptual site model, natural geological lead sources for the locality, and historical/current anthropogenic activities unrelated to site releases of lead. Careful choice of residential soil samples representing discrete exposure units is also important (e.g., segregating yard samples from the house drip zone, which often has elevated lead concentrations resulting from exterior paint debris). Additional information is contained in Frequently Asked Questions About the Development and Use of Background Concentrations at Superfund Sites: Part One, General Concepts.

Relationship to TSCA §403 Hazard Standards

Residential soil lead cleanups under the Superfund, RCRA Corrective Action and Toxic Substances Control Act (TSCA) programs seek to protect the health of the most vulnerable populations (children). The studies that take place at CERCLA or RCRA Corrective Action sites involve multiple hazardous substances with potentially numerous sources of contamination and multiple pathways of exposure that require cleanup levels be developed with site-specific information. In contrast, the TSCA §403 hazard standards for bare residential soil only apply to pre-1978 target housing and certain child-occupied facilities. These hazard standards are minimum national standards that apply to lead-based paint activities (i.e., inspections, lead-hazard screens, risk assessments and abatements) to help prioritize the cleanup of residential and child-occupied facilities affected by lead based paint.

Applicability to Superfund Site Assessment and Listing

RSLs and RMLs are not used in the Hazard Ranking System (HRS) scoring calculations.[13] Sites not eligible for the NPL are assigned a no further remedial action planned (NFRAP) decision. A change in RSLs or RMLs itself will not affect HRS scoring at sites with prior NFRAP decisions or result in additional NPL sites from the NFRAP universe. EPA can reassess a NFRAP site for potential NPL eligibility if

[12] See NCP 40 CFR 300.430(e)(2)(i).

[13] The Superfund site assessment program determines if a site is eligible for placement on the NPL primarily based on application of criteria contained in the Hazard Ranking System (HRS) (40 CFR Part 300 – Appendix A- The Hazard Ranking System). The HRS is a scoring system that uses information from initial, limited investigations to assess the relative threat posed by sites for NPL listing.

additional information arises and generally relies on states and tribes to inform EPA of the need to reassess a NFRAP site for potential response action.

The EPA site assessment program also considers whether involvement by the Superfund removal program is needed at any point during the site assessment process. EPA regions should be aware of this revised guidance on RMLs when reviewing lead sampling results associated with site assessments and should consult with the Superfund removal program as appropriate.

CONCLUSION

Reducing exposure to lead can improve communities' health and wellbeing. EPA residential soil lead cleanups —combined with the education and action of individuals and communities—have proven to be an effective part of an overall strategy for reducing blood-lead levels in children. With this guidance, EPA is updating its approach for reducing lead exposure in a manner consistent with the best available science.

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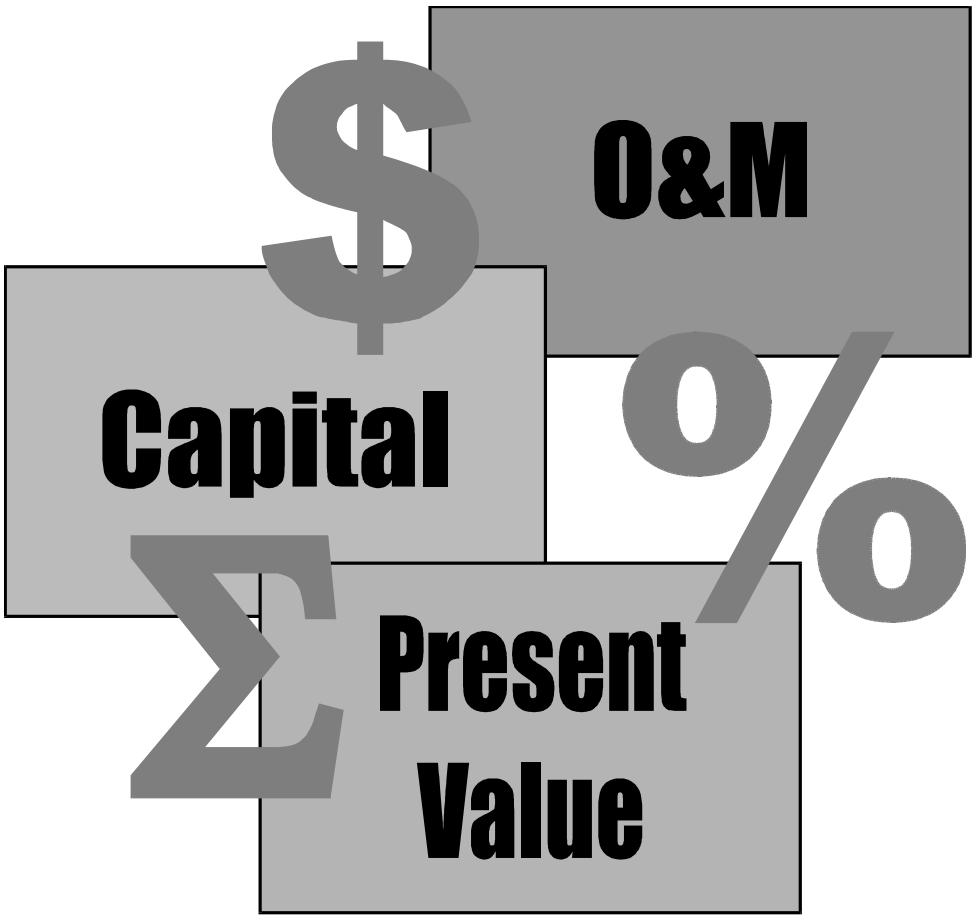
A Guide to Developing and Documenting Cost Estimates During the Feasibility Study



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ABSTRACT

This guidance document addresses cost estimates of remedial alternatives developed during the remedial investigation/feasibility study. The goals of this guidance are to improve the consistency, completeness, and accuracy of cost estimates developed to support the Superfund remedy selection process. To help achieve these goals, the document presents clear procedures and expectations, a checklist of cost elements, and example formats. It also identifies resources for estimating costs during the feasibility study. This guide is designed to help those with varying levels of cost estimating expertise, including cost estimators, design engineers, technical support contractors, remedial project managers, and program managers.

This document updates and clarifies previous USEPA guidance for developing and documenting remedial alternative cost estimates during the feasibility study. Previous guidance superceded by this document are Chapter 3 of *Remedial Action Costing Procedures Manual, October 1987 (EPA/600/8-87/049),* and Section 6.2.3.7 of *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA - Interim Final, October 1988 (EPA/540/G-89/004).*

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Table of Contents

Acronyms vi

Chapter 1 Introduction 1-1
- 1.1 Purpose of Guide 1-2
- 1.2 Scope of Guide 1-2
- 1.3 How to Use the Guide 1-3

Chapter 2 Background 2-1
- 2.1 Overview of Superfund Process 2-1
- 2.2 Role of Project Definition in Cost Estimates 2-2
- 2.3 Cost Estimating During the Superfund Process 2-3
- 2.4 Cost Estimating During the Feasibility Study 2-4

Chapter 3 Capital and O&M Costs 3-1
- 3.1 Definitions 3-1
- 3.2 Relationship of Capital and O&M Costs to Superfund Phases 3-2
- 3.3 Cost Element Checklists 3-3

Chapter 4 Present Value Analysis 4-1
- 4.1 Define the Period of Analysis 4-1
- 4.2 Calculate Annual Cash Outflows 4-3
- 4.3 Select a Discount Rate 4-4
- 4.4 Calculate the Present Value 4-6

Chapter 5 How to Develop the Cost Estimate 5-1
- 5.1 Describe the Alternative 5-1
- 5.2 Identify Cost Element Structure 5-3
- 5.3 Estimate Construction/O&M Activities Costs 5-5
- 5.4 Apply Contingency 5-9
- 5.5 Estimate Professional/Technical Services Costs 5-12
- 5.6 Institutional Controls 5-14
- 5.7 Present Value Analysis 5-15
- 5.8 Sensitivity Analysis 5-15
- 5.9 Review Estimate 5-17

Chapter 6 How to Document the Cost Estimate 6-1
- 6.1 Detailed Cost Backup 6-1
- 6.2 Individual Cost Summary 6-1
- 6.3 Comparative Cost Summary 6-1
- 6.4 Cost Estimate of Proposed or Selected Remedy 6-2

Chapter 7 References 7-1

Table of Contents

List of Appendices

Appendix A	Internet Resources	A-1
Appendix B	Cost Adjustment Factors	B-1
Appendix C	Example Cost Templates	C-1
Appendix D	Glossary	D-1

Table of Contents

List of Exhibits

Exhibit 2-1 The Superfund Pipeline 2-2
Exhibit 2-2 Relationship of Project Definition to Cost Estimate for a Remedial Action Project 2-3
Exhibit 2-3 Expected Cost Estimate Accuracy Along the Superfund Pipeline 2-4
Exhibit 3-1 Relationship of Capital and O&M Costs to Superfund Phases 3-2
Exhibit 3-2 Capital Cost Element Checklist 3-5
Exhibit 3-3 Annual O&M Cost Element Checklist 3-12
Exhibit 3-4 Periodic Cost Element Checklist 3-15
Exhibit 4-1 Non-Discounted vs. Discounted Costs for an Example Project with a 100 Year Duration 4-3
Exhibit 4-2 Example Array of Constant Dollar Costs for Present Value Analysis 4-4
Exhibit 4-3 Comparison of Present Value of Six Remedial Alternatives 4-6
Exhibit 4-4 Annual Discount Factors at 7% 4-7
Exhibit 4-5 Example Present Value Calculation for a Remedial Alternative 4-8
Exhibit 4-6 Multi-Year Discount Factors at 7% 4-9
Exhibit 5-1 Steps to Develop a Basic Cost Estimate for a Remedial Alternative 5-2
Exhibit 5-2 Example Cost Element Structure 5-4
Exhibit 5-3 Example Calculation of Sub-Element Unit Cost 5-8
Exhibit 5-4 Example Estimation of Cost Element 5-9
Exhibit 5-5 Relationship of Scope, Bid, and Total Contingency 5-10
Exhibit 5-6 Example FS-Level Scope Contingency Percentages 5-11
Exhibit 5-7 Example Contingency Application 5-12
Exhibit 5-8 Example Percentages for Professional/Technical Services Capital Costs 5-13
Exhibit 5-9 Example Estimation of Professional/Technical Services Costs 5-14
Exhibit 5-10 Example Estimation of Institutional Controls Costs 5-15
Exhibit 5-11 Example Present Value Analysis 5-15
Exhibit 5-12 Example Sensitivity Analysis 5-17
Exhibit 5-13 Key Questions to Ask when Reviewing a Remedial Alternative Cost Estimate 5-18
Exhibit 6-1 Example Cost Worksheet 6-4
Exhibit 6-2 Example Remedial Alternative Cost Summary 6-5
Exhibit 6-3 Example Comparative Cost Summary 6-7
Exhibit A-1 Internet Resources – Government A-2
Exhibit A-2 Internet Resources – Non-Government A-11
Exhibit B-1 ENR Building Cost Index B-1
Exhibit B-2 USACE Area Cost Factors as of March 10, 2000 ..... B-2
Exhibit B-3 HTRW Productivity Factors – Light Work B-4
Exhibit B-4 HTRW Productivity Factors – Heavy Work B-5

Acronyms

AACE	Association for the Advancement of Cost Engineering
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EC2	Environmental Cost Engineering Committee
FR	Federal Register
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility Study
G&A	General and Administrative
HCAS	Historical Cost Analysis System
HTRW	Hazardous, Toxic, or Radioactive Waste
ICEG	Interagency Cost Estimating Group
MCACES	Micro Computer Aided Cost Engineering System
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NRRB	National Remedy Review Board
O&M	Operation and Maintenance
OMB	Office of Management and Budget
OSWER	Office of Solid Waste and Emergency Response
PRP	Potentially Responsible Party
PV	Present Value
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RACER	Remedial Action Cost Engineering and Requirements
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
USACE	United States Army Corps of Engineers
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
UPB	Unit Price Book
WBS	Work Breakdown Structure



Chapter One
Introduction

In the Superfund program,[1] the remedial investigation/feasibility study (RI/FS) process is used to characterize the nature and extent of risks posed by hazardous waste sites and to evaluate potential remedial options. During the feasibility study (FS) phase of this process, cost estimates are developed for each remedial action alternative being evaluated.

The U.S. Environmental Protection Agency (USEPA) first published guidance for developing and documenting remedial alternative cost estimates during the FS as part of the *Remedial Action Costing Procedures Manual* (USEPA 1987). That document provided the basis for the discussion of cost estimating in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988). Since these documents were published, remedial alternative cost estimates prepared during feasibility studies generally have followed this basic guidance, but have typically varied in approach and content. Additionally, the number of available cost estimating resources has increased during this time. To take advantage of lessons learned and help improve the consistency, completeness, and accuracy of remedy cost estimates during the FS, this guide was prepared to update and clarify previous USEPA guidance in this policy area. Specific guidance superceded by this guide are Chapter 3 of *Remedial Action Costing Procedures Manual* (USEPA 1987) and Section 6.2.3.7 of *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988).

Key Issues for Cost Estimates in Feasibility Study Reports

Cost estimates of remedial alternatives provided in feasibility study reports should clearly present the following information:

- Expected accuracy range of the cost estimate (e.g., –30 to +50 percent for detailed analysis of alternatives)
- Source references for quantity and unit cost information
- Contingency to account for possible cost overruns
- Basis for applied contingency
- Costs for professional and technical services
- Period of present value analysis (e.g., 50 years)
- Basis for period of present value analysis (e.g., time required to achieve remedial action objectives)
- Discount rate used in present value analysis (e.g., 7 percent)
- Basis for discount rate used in present value analysis (e.g., per USEPA policy)
- Major assumptions and sources of uncertainty in the overall estimate
- Analysis of sensitivity of cost estimate to uncertain factors
- Logical and organized presentation of cost estimate summaries and detailed backup information

[1] As used by this guide, "Superfund" refers to the program operated under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

1.1 Purpose of Guide

The purpose of this guide is to provide a current reference for developing and documenting cost estimates of remedial action alternatives during the FS. The goals of this guide include improving the consistency, completeness, and accuracy of cost estimates prepared during the FS. To help achieve these goals, the guide presents clear procedures and expectations, presents a checklist of cost elements and example formats, and points out resources for cost estimating.

This guide is designed to help those with varying levels of cost estimating expertise, including cost estimators, design engineers, technical support contractors, remedial project managers, and program managers.

1.2 Scope of Guide

This guide addresses cost estimates of remedial alternatives developed during the FS in support of the Superfund remedy selection process. Therefore, Superfund terms are primarily used to describe the concepts presented. However, many of these cost engineering concepts are universal in nature and could be applied to other environmental cleanup projects or programs.[2]

While cost estimates are developed at different stages of the Superfund process (Chapter 2), this guide specifically addresses the FS phase. Cost estimates are developed during the FS primarily for the purpose of comparing remedial alternatives during the remedy selection process, not for establishing project budgets or negotiating Superfund enforcement settlements.[3] During remedy selection, the cost estimate of the preferred alternative is typically carried over from the FS to the proposed plan for public comment. The subsequent cost estimate included in the record of decision (ROD) reflects any changes to the remedial alternative that occurs during the remedy selection process as a result of new information or public comment.

Finally, this guide does not address how to use cost estimates in making a remedy selection decision or how to make a cost-effectiveness determination in the Superfund program. USEPA guidance that addresses this issue can be found in *The Role of Cost in the Superfund Remedy Selection Process* (USEPA 1996).

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[2] Examples include Superfund removal actions, Superfund enforcement settlements, Resource Conservation and Recovery Act (RCRA) corrective actions, Federal facilities cleanups, brownfields cleanups, underground storage tank remediation, installation restoration program, base realignment and closure, formerly used defense sites, and cleanup programs under State authorities.

[3] The FS remedial alternative cost estimate can be used as starting point for budgeting purposes, but adjustments may be needed based on individual agency requirements. For example, estimates may need to be revised based on project scope requirements, escalation factors may need to be added, or discount factors may need to be removed.

1.3 How to Use the Guide

This guide is intended to provide the user with the basic information necessary to develop and document cost estimates for remedial action alternatives during the FS. This guide is not meant to contain all of the information necessary to complete the cost estimate, but to be a primary reference, pointing to other resources as necessary. The objectives of each chapter and appendix are listed below:

- Chapter 1: Introduce the guide, including its purpose, scope, and use.
- Chapter 2: Provide background information on applicable regulatory and cost engineering concepts, including the Superfund process, role of project definition in cost estimates, cost estimating within Superfund, and cost estimating during the FS.
- Chapter 3: Provide a cost element checklist to help identify capital, annual operation and maintenance (O&M), and periodic costs to include in the cost estimate for a remedial action alternative.
- Chapter 4: Provide guidelines for conducting a present value analysis, including period of analysis and discount rate.
- Chapter 5: Provide steps to develop the basic cost estimate for a remedial action alternative, including alternative description, identification of cost element structure, estimation of cost elements, application of contingency, present value analysis, sensitivity analysis, and review of estimate.
- Chapter 6: Provide information on how to document the cost estimates of remedial action alternatives developed during the FS, including an example cost summary.
- Chapter 7: Provide a list of references used in the document.
- Appendix A: Provide a list of government and non-government resources on the Internet that can be used to help develop remedial alternative cost estimates during the FS.
- Appendix B: Provide information on how to adjust costs for geographic location, escalation, and for impacts of health and safety requirements on productivity.
- Appendix C: Provide example templates for cost estimate summaries and backup information.
- Appendix D: Provide a glossary of key terms used in the document.

Rules of thumb for cost estimating during the FS, identified by the  symbol, are highlighted periodically within the document text. These rules of thumb, many of which provide typical cost percentages, are based on engineering judgement and not on detailed analysis of historical cost data. Also, highlight boxes throughout the document provide information on topics that are important, but not necessarily central to the discussion at hand. Web site addresses cited in the document were current at the time of publication.



Chapter Two
Background

Estimating the cost of remedial action alternatives during the FS requires a basic understanding of applicable regulatory and cost engineering concepts. Therefore, this chapter provides background information on these subjects, including an overview of the Superfund process, discussion of the role of project definition in cost estimates, cost estimating within the Superfund process, and cost estimating during the FS.

2.1 Overview of Superfund Process

The Superfund "pipeline" (Exhibit 2-1) illustrates the major phases and decision points of the Superfund remedial response program.

The RI/FS process is used to gather the information necessary to select a remedy that will meet the statutory and regulatory requirements of the Superfund cleanup program. The remedial investigation (RI) includes sampling and analysis to characterize the nature and extent of contamination; baseline risk assessment to assess current and potential future risks to human health and the environment; and treatability studies, as appropriate, to evaluate the effectiveness of treatment or recovery technologies to reduce the toxicity, mobility, or volume of hazardous substances or contaminated media.

The FS consists of two main phases: (1) development and screening of remedial action alternatives; and (2) comparison of each alternative that passes screening in a detailed analysis. A range of remedial action alternatives is developed during the FS as data become available from the RI site characterization, with treatability studies helping to reduce uncertainties concerning cost and performance of treatment alternatives.

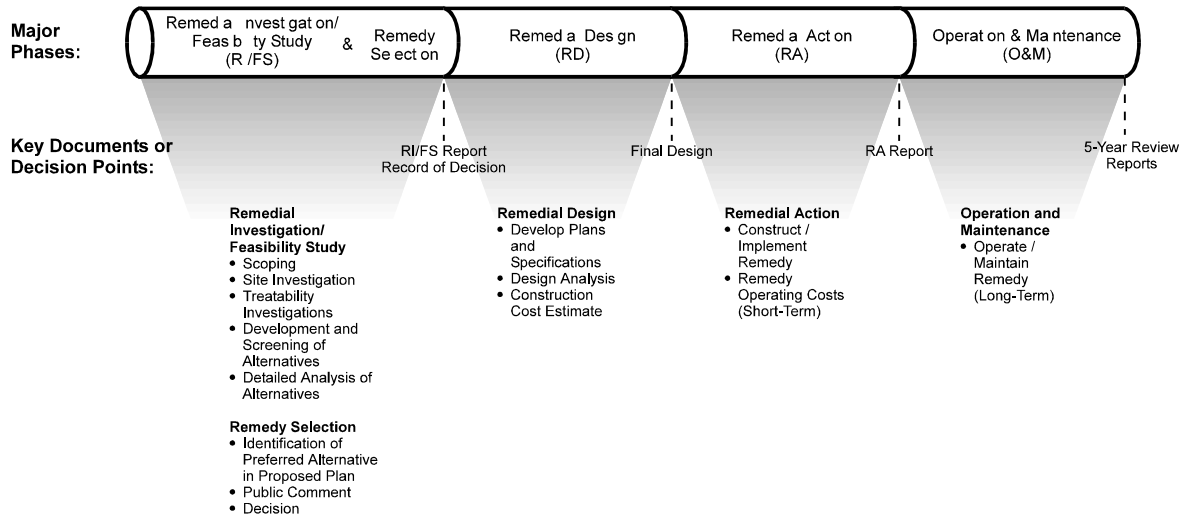
For Further Information

For further information on the Superfund remedy selection process, see the following publications:

- National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Subpart E - Hazardous Substance Response, Section 300.430 – Remedial Investigation/ Feasibility Study and Selection of Remedy (40 CFR Part 300) (*http://www.epa.gov/docs/epacfr40/chapt-I.info/subch-J/*)
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final (USEPA 1988)
- A Guide to Selecting Superfund Remedial Actions (USEPA 1990)
- The Role of Cost in the Superfund Remedy Selection Process (USEPA 1996) (*http://www.epa.gov/superfund/resources/cost_dir/index.htm*)
- Rules of Thumb for Superfund Remedy Selection (USEPA 1997) (*http://www.epa.gov/superfund/resources/rules/index.htm*)
- A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (USEPA 1999) (*http://www.epa.gov/superfund/resources/remedy/rods/index.htm*)

During remedy selection, a preferred alternative is identified, presented in a proposed plan, and documented in a ROD following evaluation of public comment.[1] Plans, specifications, and other documents necessary to construct or implement the remedy are developed during remedial design (RD). Remedial action (RA) is the actual implementation of the remedy. Operation and maintenance (O&M) is used to maintain the effectiveness of the remedial action. More information on the differences between the RA and O&M phases and how they relate to estimating the cost of remedial action alternatives is provided in Chapter 3.

Exhibit 2-1
The Superfund Pipeline



2.2 Role of Project Definition in Cost Estimates

The Association for the Advancement of Cost Engineering (AACE) International defines a cost estimate as "an evaluation of all the costs of the elements of a project or effort as defined by an agreed-upon scope" (AACE 1990). The total estimated cost of a project is primarily dependent on how well, or to what degree, the project is defined (i.e., "scope" or completeness of design).

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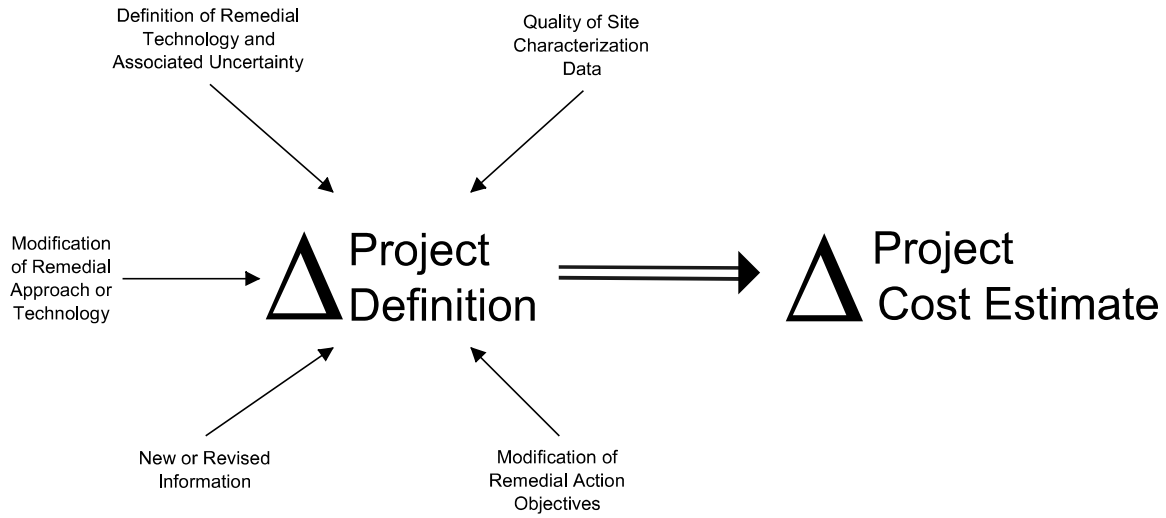
[1] Cost is one of nine criteria established by USEPA to guide remedy selection decision making and is a critical factor in the process of identifying a preferred remedy. In addition, CERCLA and the NCP require that every remedy selected must be cost-effective. See *The Role of Cost in the Superfund Remedy Selection Process* (USEPA 1996) for a more complete discussion.

A change (Δ) in project definition will result in a change (Δ) in the project cost estimate. This relationship, including factors that may affect a change in project definition and, therefore, a change in the cost estimate for a remedial action project, is illustrated in Exhibit 2-2.

Exhibit 2-2
Relationship of Project Definition to Cost Estimate for a Remedial Action Project



2.3 Cost Estimating During the Superfund Process

As a project moves from the planning stage into the design and implementation stage, the level of project definition increases, thus allowing for a more accurate cost estimate. An "early" estimate of the project's life cycle costs is made during the FS to make a remedy selection decision.[2]

At the FS stage, the design for the remedial action project is still conceptual, not detailed, and the cost estimate is considered to be "order-of-magnitude." The cost engineer must make assumptions about the detailed design in order to prepare the cost estimate. As a project progresses, the design becomes more complete and the cost estimate becomes more "definitive," thus increasing the accuracy of the cost estimate. This process is depicted in Exhibit 2-3 for remedial action projects in the Superfund program.[3]

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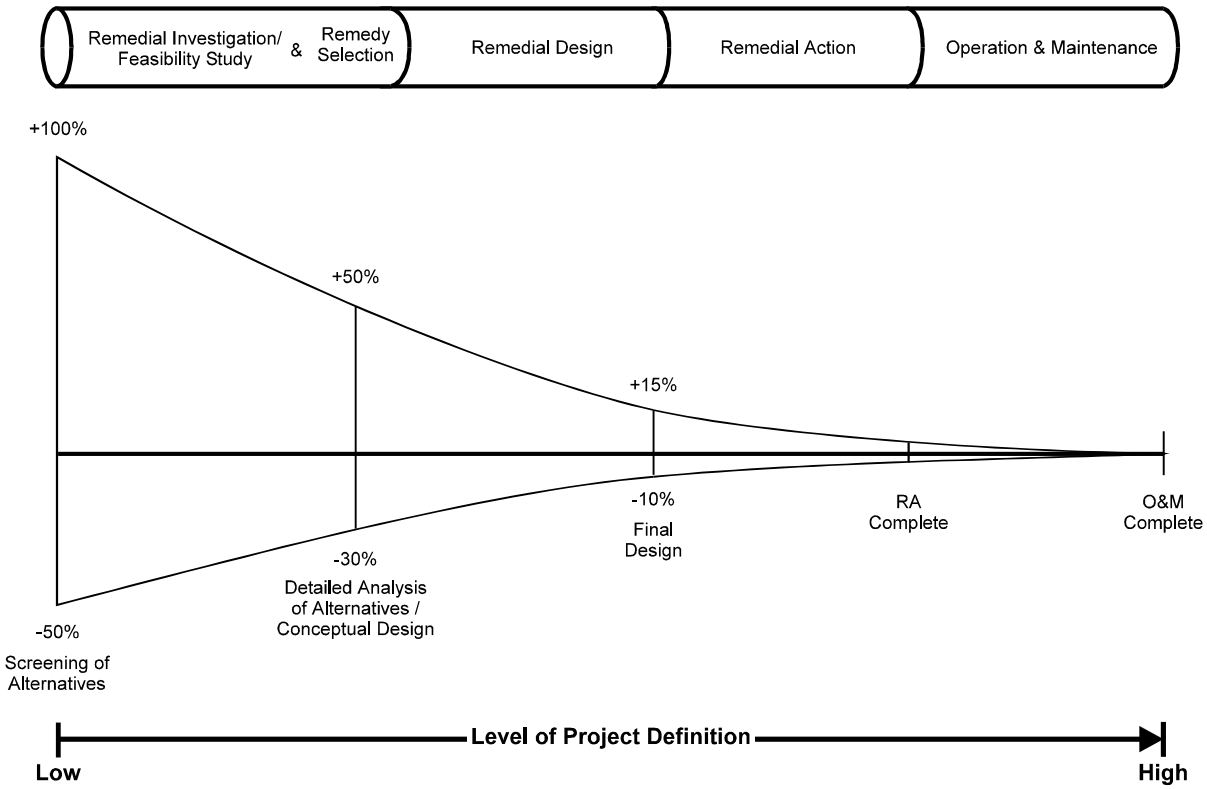
[2] The term "life cycle cost" refers to the total project cost across the life span of a project, including design, construction, operation and maintenance, and closeout activities. The cost estimate developed during the FS is a projection of the life cycle cost of a remedial action project, not including the RI/FS or earlier phases.

[3] The accuracy range curves shown in Exhibit 2-3, representing both construction and operation costs, are for illustrative purposes only. The specific percentages correlate with generally accepted rules of thumb for cost estimating accuracy and are not meant to imply that these goals will be precisely achieved.

Exhibit 2-3
Expected Cost Estimate Accuracy Along the Superfund Pipeline



2.4 Cost Estimating During the Feasibility Study

During the FS, cost estimates are developed for each remedial action alternative for comparison purposes. The accuracy of these estimates is linked to the quality of the RI data, which helps define the scope of each alternative. Because the RI/FS cannot remove all uncertainty no matter how good the data may be, the expected accuracy of cost estimates during the FS is less than that of estimates developed during later stages of the Superfund process.

Cost estimates are developed at both the "screening of alternatives" and "detailed analysis of alternatives" phases of the FS, with expected accuracy ranges of –50 to +100 percent and –30 to +50 percent, respectively, as shown in Exhibit 2-3.[4] Cost estimates developed during these two phases are further described in the following paragraphs.

---

[4] If the number of viable alternatives developed during the FS process is limited, the "screening of alternatives" step is not always performed, nor is it required (Section 4.1.2.1 of RI/FS guidance [USEPA 1988]). However, the "detailed analysis of alternatives" is performed regardless to evaluate each alternative against the NCP evaluation criteria.

Screening of Alternatives

Screening-level cost estimates are used to screen out disproportionately expensive alternatives in determining what alternatives should be retained for detailed analysis. The National Oil and Hazardous Substances Contingency Plan (NCP) includes the following language in its description of the cost criterion for screening of alternatives:

> "The costs of construction and any long-term costs to operate and maintain the alternatives shall be considered." (40 CFR 300.430(e)(7)(iii))

Screening-level cost estimates should focus on relative accuracy in order to make comparative estimates so that decisions between alternatives can be appropriately considered as the accuracy of the cost estimates improves beyond the screening process. The procedures used to develop these estimates are similar to those used for the detailed analysis, except that alternatives are not as well refined and cost components are not as well developed. The screening-level accuracy range of –50 to +100 percent means that, for an estimate of $100,000, the actual cost of an alternative is expected to be between $50,000 and $200,000.

The basis for a screening-level cost estimate can include a variety of sources, including cost curves, generic unit costs, vendor information, standard cost estimating guides, historical cost data, and estimates for similar projects, as modified for the specific site. Both capital and O&M costs should be considered, where appropriate, at the screening level.

Direct and Indirect Cost Terminology

There may be some variability in the use of the terms "direct cost" and "indirect cost." This is due to a difference in perspective. To the "owner" of the project (e.g., government or potentially responsible party [PRP]), the "direct costs" of cleanup are the equipment, labor, and material costs necessary to construct the remedial action (including contractor markups, such as overhead and profit). From this perspective, the "indirect costs" are all other costs not part of the actual construction project but necessary to implement the remedial action (e.g., engineering, legal, construction management, and other technical and professional services). However, to the "implementor" of the project (e.g., construction contractor), the "direct costs" of cleanup are those costs that can be attributed to a single task of construction work, while the "indirect costs" are those that cannot be assigned to a specific activity (e.g., contractor markups).

Due to the potential for confusion caused by these differences in perspective, the specific terms "direct cost" and "indirect cost" are not used in the remainder of this guide. Rather, a distinction is made between costs associated with specific construction or O&M activities and costs for professional/technical services necessary to support those activities. Contractor markups would be included along with the labor, equipment, and material costs for specific construction or O&M activities. This terminology should avoid confusion, while still addressing both aspects of cost that are identified in the NCP for the Superfund remedy selection process.

Detailed Analysis of Alternatives

Cost estimates developed during the detailed analysis phase are used to compare alternatives and support remedy selection. The NCP includes the following language in its description of the cost criterion for the detailed analysis and remedy selection:

> "The types of costs that shall be assessed include the following: (1) Capital costs, including both direct and indirect costs (2) Annual operations and maintenance costs; and (3) Net present value of capital and O&M costs." (40 CFR 300.430 (e)(9)(iii)(G))

Remedial action alternative cost estimates for the detailed analysis are intended to provide a measure of total resource costs over time (i.e., "life cycle costs") associated with any given alternative.[5] As such, these estimates generally are based on more detailed information and should achieve a greater level of accuracy than screening-level estimates. The detailed analysis level accuracy range of –30 to +50 percent means that, for an estimate of $100,000, the actual cost of an alternative is expected to be between $70,000 and $150,000.

[5] These life cycle estimates should not include costs that would be incurred by the site owner or government independent of the remedial action (e.g., U.S. Department of Energy program management costs, unrelated facility or site maintenance costs). Nor should these estimates include other "external costs" not associated with the implementation of the remedial action (e.g., economic impacts to residents or businesses as a result of remediation activity).



Chapter Three
Capital and O&M Costs

The NCP states that the types of costs to be assessed in the FS include capital and annual O&M costs. This chapter provides definitions and checklists that can be used to identify capital and O&M costs for remedial action alternatives.

3.1 Definitions

Included under the general categories of capital and O&M costs identified in the NCP are capital, annual O&M, and periodic costs (capital or O&M), as defined below. These definitions are consistent with past USEPA guidance and do not change the intent of the NCP.

Capital Costs

Capital costs are those expenditures that are required to construct a remedial action. They are exclusive of costs required to operate or maintain the action throughout its lifetime. Capital costs consist primarily of expenditures initially incurred to build or install the remedial action (e.g., construction of a groundwater treatment system and related site work).

Capital costs include all labor, equipment, and material costs, including contractor markups such as overhead and profit, associated with activities such as mobilization/demobilization; monitoring; site work; installation of extraction, containment, or treatment systems; and disposal. Capital costs also include expenditures for professional/technical services that are necessary to support construction of the remedial action.

Annual O&M Costs

Operation and maintenance (O&M) costs are those post-construction costs necessary to ensure or verify the continued effectiveness of a remedial action. These costs are estimated mostly on an annual basis.

Annual O&M costs include all labor, equipment, and material costs, including contractor markups such as overhead and profit, associated with activities such as monitoring; operating and maintaining extraction, containment, or treatment systems; and disposal. Annual O&M costs also include expenditures for professional/technical services necessary to support O&M activities.

Periodic Costs

Periodic costs are those costs that occur only once every few years (e.g., five-year reviews, equipment replacement) or expenditures that occur only once during the entire O&M period or remedial timeframe (e.g., site closeout, remedy failure/replacement). These costs may be either capital or O&M costs, but because of their periodic nature, it is more practical to consider them separately from other capital or O&M costs in the estimating process.

3.2 Relationship of Capital and O&M Costs to Superfund Phases

A Superfund response action can occur in two phases: (1) remedial action and (2) O&M. In general, remedial action is defined by CERCLA to include activities required to prevent or mitigate the migration of contaminants into the environment. As such, a "remedial action" may not be complete when construction is complete, as in the case of a pump and treat remedy that may require many years of operation. In these cases, remedial action may include tasks that are traditionally considered to be O&M (see "Regulatory Definitions" to right for further explanation). Per CERCLA, O&M typically occurs after the remedial action has been completed and may include the tasks necessary to continue preventing or mitigating the migration of contaminants into the environment (e.g., long term surveillance and monitoring). Therefore, the RA phase of the Superfund pipeline can include both construction and short-term O&M activities, while the O&M phase consists primarily of long-term O&M (Exhibit 3-1).

Regulatory Definitions for RA and O&M

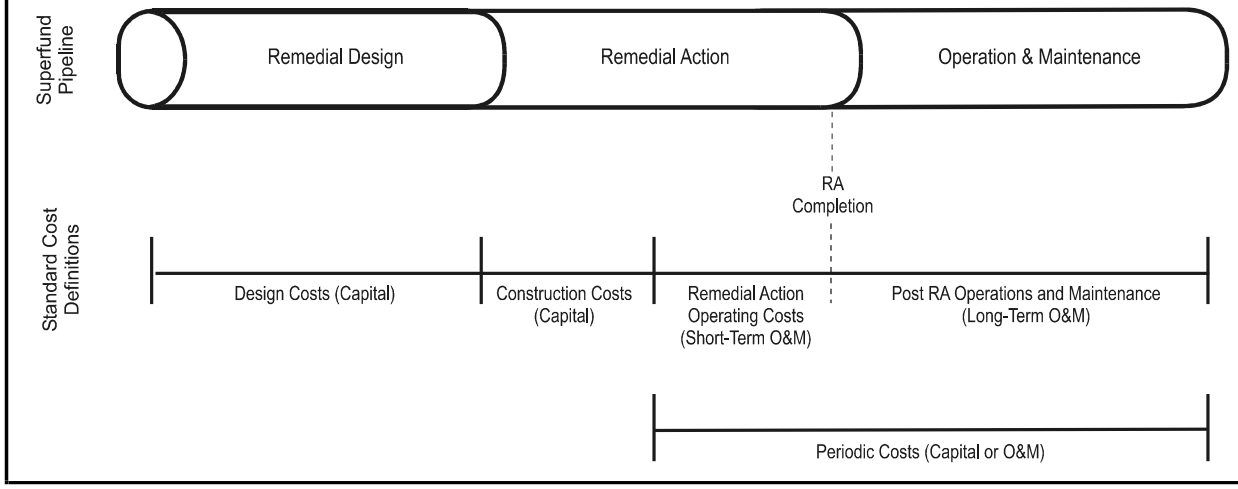
Under the Superfund program, O&M typically begins only after the remedial action has achieved remedial action objectives and remediation goals stated in the ROD and is determined to be operational and functional (40 CFR 300.435(f)(1)). A remedy becomes "operational and functional" normally within one year after construction is completed.

For Fund-financed remedial actions to treat or restore groundwater or surface water quality to a level protective of human health and the environment, the operation of the remedy is considered part of the remedial action phase for a period of up to 10 years after the remedial action becomes operational and functional (40 CFR 300.435(f)(3)). Activities necessary to maintain the effectiveness of the remedy past this period are considered to be O&M, thereby shifting financial responsibility from the Federal government to the government of the State in which the site is located.

For remedial alternative cost estimates developed during the FS, the conventional distinctions between capital and O&M costs should be used. As shown in Exhibit 3-1 on the "standard cost definitions" line, capital costs considered during the FS include design and construction while O&M costs include both short-term and long-term O&M. Periodic costs (e.g., replacement or repair costs, five-year review costs) can occur at any time during the O&M period (both short-term and long-term).

Exhibit 3-1

Relationship of Capital and O&M Costs to Superfund Phases



3.3 Cost Element Checklists

Checklists can be used to help evaluate capital and O&M costs for each remedial action alternative and to reduce the possible exclusion of key cost elements. A cost estimate generally will be more "complete" if as many cost elements as possible are accounted for, even though uncertainty may remain about their quantity or unit cost. Checklists also promote consistency between estimates.

Checklists are provided in Exhibits 3-2, 3-3, and 3-4 for capital, annual O&M, and periodic cost elements, respectively. The checklists are designed to be flexible, and by design, do not follow any standard work breakdown structure (WBS) or numbering system. The checklists are not all-inclusive and, therefore, the listed cost elements should not be assumed to apply to every remedial action alternative. Rather, the checklists can be used to identify applicable cost elements, which can be added to or modified as needed. Exhibits 3-2, 3-3, and 3-4 provide descriptions of cost elements, as well as example sub-elements.

Work Breakdown Structures

Cost estimates for Federal hazardous, toxic, or radioactive waste (HTRW) cleanup projects typically use a work breakdown structure (WBS) to identify cost elements. The Environmental Cost Engineering Committee (EC2), formerly known as the Interagency Cost Estimating Group (ICEG), has played a key role in WBS development. EC2 is comprised of cost professionals from the USEPA, U.S. Department of Energy (USDOE), U.S. Army Corps of Engineers (USACE), U.S. Navy, and U.S. Air Force. Several work breakdown structures have been developed, each of which can be useful for identifying potential cost elements to include in a remedial alternative FS cost estimate. These include:

- HTRW Remedial Action (RA) / Operation & Maintenance (O&M) WBS, February 1996 (*http://www.frtr.gov/cost/ec2/wbs1.html*)
- Phased Based HTRW WBS, April 1998 (*http://www.frtr.gov/cost/ec2/wbs2.html*)
- Environmental Cost Element Structure (ECES), September 1999 (*http://www.em.doe.gov/aceteam/eces.html*)

While the 1996 HTRW WBS (required by USACE) focuses on the RA and O&M phases, the ECES is more comprehensive and covers cost elements from initial studies through long term monitoring.

Capital Cost Elements

Capital cost elements from the checklist in Exhibit 3-2 are listed below:

Construction Activities

- Mobilization / Demobilization
- Monitoring, Sampling, Testing, and Analysis
- Site Work
- Surface Water Collection or Containment
- Groundwater Extraction or Containment
- Gas/Vapor Collection or Control
- Soil Excavation
- Sediment/Sludge Removal or Containment
- Demolition and Removal
- Cap or Cover
- On-Site Treatment (specify treatment technology)
- Off-Site Treatment / Disposal
- Contingency

Professional/Technical Services

- Project Management
- Remedial Design
- Construction Management

Institutional Controls

The elements listed as construction activities would be incurred as part of the physical construction of the remedial action. Contingency covers unknowns or unanticipated conditions associated with construction activities. Project management, remedial design, and construction management are professional/technical services to support construction of the remedial action. Institutional controls, which are legal or administrative measures used to limit or restrict site access or human exposure to contamination, can be a major component of a remedial alternative and therefore warrant separate consideration.

The terminology for each cost element should be made as alternative-specific as possible (i.e., terminology from the checklist should not necessarily be used directly). For example, "Sediment/Sludge Removal or Containment" could simply be "Contaminated Sludge Removal" if only removal of sludge, not sediment, is to occur. For on-site treatment, the applicable treatment technology (e.g., "Soil Vapor Extraction") should be specified (see "Example" to right).

Costs of construction activities are typically estimated on an element-by-element basis. Contractor markups such as overhead and profit should generally be included in these cost elements, rather than listed separately in the capital cost summary. Contingency is typically added as a percentage to the total cost of construction activities. Professional/technical services are typically estimated as a percentage of the total cost of construction activities plus contingency. A more detailed discussion of contingency is provided in Chapter 5. Institutional controls are typically estimated on an element-by-element basis. The development and documentation of capital costs are further described in Chapters 5 and 6, respectively.

Example Capital Cost Element Structure

An example of how capital cost elements and sub-elements might be structured for a remedial alternative that uses air sparging (AS), soil vapor extraction (SVE), and a passive treatment wall (i.e., permeable reactive barrier) to treat contaminated soil and groundwater is as follows:

- Mobilization/Demobilization
  - Construction Equipment
  - Submittals/Implementation Plans
  - Temporary Facilities & Utilities
  - Post-Construction Submittals
- Monitoring, Sampling, Testing, and Analysis
  - SVE Monitoring Wells
  - Treatment Wall Monitoring Wells
- Site Work
  - Clearing and Grubbing
  - Seeding/Mulch/Fertilizer
- Air Sparging / Soil Vapor Extraction
  - Mobilize SVE System
  - AS Injection Wells
  - AS Blower
  - AS Piping
  - SVE System
  - SVE Extraction Wells
  - SVE Piping
  - Electrical Hookup
  - Startup and Testing
- Passive Treatment Wall
  - Construct Slurry Trench
  - Install Reactive Media
- Off-Site Treatment/Disposal
  - Off-Site Transport of Soil Cuttings
  - Off-Site Disposal of Soil Cuttings
  - Wastewater Discharge/Testing
- Project Management
- Remedial Design
- Construction Management
- Institutional Controls
  - Institutional Controls Plan
  - Groundwater Use Restriction
  - Site Information Database

Exhibit 3-2
Capital Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Construction Activities		
Mobilization/ Demobilization	Bringing equipment and personnel to the site (mobilization) or removing equipment and personnel (demobilization) for purposes of constructing or installing the remedial action. Includes setup/construction and/or removal of temporary facilities and utilities. Does not include mobilization or demobilization specific to constructing or installing an on-site treatment facility.	☐ Construction Equipment ☐ Submittals/Implementation Plans __ Air Monitoring Plan __ Construction Quality Control Plan __ Construction Schedule __ Environmental Protection Plan __ Materials Handling/Transportation/Disposal Plan __ Permits __ Sampling and Analysis Plan __ Site Safety and Health Plan __ Site Security Plan __ Site Work Plan __ Storm Water Pollution Prevention Plan __ Training & Medical Certifications ☐ Temporary Facilities __ Office Trailers __ Storage Facilities __ Security Fencing & Signs __ Roads and Parking __ Decontamination Facilities ☐ Temporary Utilities ☐ Temporary Relocation of Roads/Structures/Utilities ☐ Post-Construction Submittals __ As-Built Drawings __ O&M Manuals __ QA/QC Documentation ☐ Site Security Personnel ☐ _____ ☐ _____

Exhibit 3-2 (cont.)
Capital Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Construction Activities (cont.)		
Monitoring, Sampling, Testing, and Analysis	Sampling, testing, on- or off-site analysis, data management, and quality assurance/ quality control. Includes monitoring to evaluate remedy performance and/or compliance with regulations.	☐ Meteorological Monitoring ☐ Air Monitoring and Sampling ☐ Radiation Monitoring ☐ Health and Safety Monitoring ☐ Personal Protective Equipment ☐ Monitoring Wells ☐ Geotechnical Instrumentation ☐ Soil Sampling ☐ Sediment Sampling ☐ Surface Water Sampling ☐ Groundwater Sampling ☐ Radioactive Waste Sampling ☐ Asbestos Sampling ☐ Laboratory Chemical Analysis ☐ On-Site Chemical Analysis ☐ Radioactive Waste Analysis ☐ Geotechnical Testing ☐ Chemical Data Management ☐ _____ ☐ _____
Site Work	Activities to establish the infrastructure necessary for the project (i.e., site preparation). Also includes permanent site improvements and restoration of areas or site features disturbed during site remediation. Site work is generally assumed to be "clean work," meaning that there is no contact with contaminated media or materials. Excludes all site work specific to constructing or installing an on-site treatment facility.	☐ Demolition ☐ Clearing and Grubbing ☐ Earthwork __ Stripping __ Stockpiling __ Excavation __ Borrow __ Grading __ Backfill __ Topsoil ☐ Roads/Parking/Curbs/Walks ☐ Vegetation and Planting __ Topsoil __ Seeding/Mulch/Fertilizer __ Sodding __ Erosion Control Fabric __ Shrubs/Trees/Ground Cover ☐ Fencing/Signs/Gates ☐ Utilities __ Electrical __ Telephone/Communications __ Water/Sewer/Gas ☐ Storm Drainage/Subdrainage ☐ Sediment Barriers ☐ _____ ☐ _____

Exhibit 3-2 (cont.)
Capital Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Construction Activities (cont.)		
Surface Water Collection or Containment	Collection or containment of contaminated surface water. Excludes treatment, off-site transportation, or off-site treatment/ disposal of contaminated surface water.	☐ Pumping ☐ Draining ☐ Channel/Waterway ☐ Berm/Dike ☐ Lagoon/Basin/Tank ☐ _____ ☐ _____
Groundwater Extraction or Containment	Extraction or containment of contaminated groundwater. Excludes treatment, off-site transportation, or off-site treatment/disposal of contaminated groundwater.	☐ Extraction/Injection Well __ Vertical __ Horizontal ☐ Extraction Trench ☐ Pumps ☐ Piping ☐ Lagoon/Basin/Tank ☐ Subsurface Drains ☐ Subsurface Barrier __ Slurry Wall __ Grout Curtain __ Sheet Piling ☐ _____ ☐ _____
Gas/Vapor Collection / Control	Collection or control of off-gas or air emissions from contaminated sources.	☐ Collection Well System ☐ Collection Trench System ☐ Collection System at Lagoon Cover ☐ Fugitive Dust Control ☐ Vapor/Gas Emissions Control ☐ _____ ☐ _____
Soil Excavation	Excavation and handling of contaminated soil. Excludes treatment, off-site transportation, or off-site treatment/disposal of contaminated soil.	☐ Excavation ☐ Hauling ☐ Stockpiling ☐ _____ ☐ _____

Exhibit 3-2 (cont.)
Capital Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Construction Activities (cont.)		
Sediment / Sludge Removal or Containment	Removal or containment of contaminated sediment or sludge. Excludes treatment, off-site transportation, or off-site treatment/disposal of contaminated sediment or sludge.	☐ Excavation ☐ Dredging ☐ Vacuuming ☐ Lagoon/Basin/Tank ☐ _____ ☐ _____
Demolition and Removal	Demolition/removal of contaminated or hazardous materials or structures. Excludes treatment, off-site transportation, or off-site disposal of contaminated or hazardous materials or structures.	☐ Drum Removal ☐ Tank Removal ☐ Piping Removal ☐ Structure Removal ☐ Asbestos Abatement ☐ Contaminated Paint Removal ☐ Ordnance Removal and Destruction ☐ _____ ☐ _____
Cap or Cover	Construction of a multi-layered cap or cover over contaminated materials or media (e.g., soil, sediment, sludge) to prevent or reduce exposure and minimize infiltration of surface water and production of leachate.	☐ Subgrade Preparation ☐ Gas Collection Layer ☐ Low Permeability Clay Layer ☐ Bentonite ☐ Geosynthetic Clay Layer ☐ Geotextile ☐ Geomembrane ☐ Granular Drainage Layer ☐ Geonet ☐ Waste Placement (Cut/Fill) ☐ Protective Soil Layer ☐ Asphalt/Concrete Pavement ☐ Topsoil ☐ Erosion Control Fabric ☐ Seeding/Mulch/Fertilizer ☐ _____ ☐ _____

Exhibit 3-2 (cont.)
Capital Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Construction Activities (cont.)		
On-Site Treatment[1]	Construction or installation of a complete and usable on-site facility for treatment of contaminated media (e.g., soil, solids, sediment, sludge, surface water, groundwater), including in situ and ex situ techniques. Includes all mobilization and site work required for the treatment facility.	☐ Mobilization/Demobilization ☐ Site Work ☐ Structures ☐ Process Equipment and Appurtenances ☐ Non-Process Equipment ☐ Startup and Testing ☐ Equipment Upgrade/Replacement ☐ _____ ☐ _____
Off-Site Treatment / Disposal	Final placement of contaminated media, material, or treatment residuals at off-site commercial facilities, such as solid or hazardous waste landfills and incinerators, that charge fees to accept waste based on certain criteria.	☐ Material Handling/Loading ☐ Transportation to Off-Site Facility ☐ Treatment/Disposal Fees ☐ _____ ☐ _____
Contingency	Costs added to cover unknowns, unforeseen circumstances, or unanticipated conditions related to construction or installation of the remedial action.	☐ Scope Contingency ☐ Bid Contingency

[1] Specify treatment technology. Examples include solidification/stabilization, biopile, low temperature thermal desorption, soil vapor extraction, passive treatment wall, air stripping, carbon adsorption, constructed wetland, etc. More than one technology may be associated with an individual alternative, depending on approach and media to be treated.

Exhibit 3-2 (cont.)
Capital Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Professional/Technical Services		
Project Management	Services to support construction or installation of remedial action not specific to remedial design or construction management.	☐ Planning ☐ Community Relations ☐ Bid/Contract Administration ☐ Cost and Performance Reporting ☐ Permitting ☐ Legal ☐ Construction Completion Report ☐ _____ ☐ _____
Remedial Design	Services to design the remedial action, including pre-design activities to collect the necessary data.	☐ Field Data Collection and Analysis ☐ Design Survey ☐ Treatability Study __ Bench-Scale __ Pilot-Scale __ Field-Scale ☐ Preliminary/Intermediate/Final Design __ Design Analysis __ Plans & Specifications __ Construction Cost Estimate __ Construction Schedule ☐ _____ ☐ _____
Construction Management	Services to manage construction or installation of remedial action, excluding any similar services provided as part of construction activities.	☐ Submittal Review ☐ Change Order Review ☐ Design Modifications ☐ Construction Observation ☐ Construction Survey ☐ Construction Schedule Tracking ☐ QA/QC Documentation ☐ O&M Manual ☐ Record Drawings ☐ _____ ☐ _____
Institutional Controls	Non-engineering (i.e., administrative or legal) measures to reduce or minimize potential for exposure to site contamination or hazards (i.e., limit site access or restrict site access).	☐ Institutional Controls Plan ☐ Restrictive Covenants ☐ Zoning ☐ Property Easements ☐ Deed Notice ☐ Advisories ☐ Groundwater Use Restrictions ☐ Site Information Database ☐ _____ ☐ _____

Annual O&M Cost Elements

Annual operation and maintenance cost elements from the checklist in Exhibit 3-3 are listed below:

O&M Activities

- Monitoring, Sampling, Testing, and Analysis
- Extraction, Containment, or Treatment Systems
- Off-Site Treatment / Disposal
- Contingency

Professional/Technical Services

- Project Management
- Technical Support

Institutional Controls

The elements listed as O&M activities are incurred as part of physical operation and maintenance activities. Contingency covers unknowns or unanticipated conditions. Project management and technical support are professional/technical services to support O&M activities. Institutional controls may require annual update or maintenance to ensure potential for exposure to site contamination or hazards is reduced or minimized.

As with capital costs, the terminology for each element should be made alternative-specific, as applicable (see "Example" above).

Example Annual O&M Cost Element Structure

An example of how annual O&M cost elements and sub-elements might be structured for a remedial alternative that uses air sparging (AS), soil vapor extraction (SVE), and a passive treatment wall to treat contaminated soil and groundwater is as follows:

- Performance Monitoring
  - SVE Vapor Monitoring
  - SVE Emissions Monitoring
  - Treatment Wall – Groundwater Sampling
  - Treatment Wall – Groundwater Analysis
- Site Monitoring
  - Groundwater Sampling
  - Groundwater Laboratory Analysis
- Air Sparging / Soil Vapor Extraction
  - Operations Labor
  - Maintenance Labor
  - Equipment Repair
  - Utilities
- Off-Site Treatment/Disposal
  - Wastewater Discharge/Testing
- Project Management
- Technical Support
- Institutional Controls
  - Site Information Database

Annual O&M costs can vary and may be estimated for different time periods, depending on the operating conditions and requirements. For example, the first five years of a groundwater monitoring program may require semiannual sampling, while the next twenty years may only require annual sampling. Likewise, an installed cap or cover may require more frequent inspections during the first year of O&M than during subsequent years.

Costs of O&M activities are typically estimated on an element-by-element basis. Contractor markups such as overhead and profit should generally be included in these cost elements, rather than listed separately. Contingency (Chapter 5) is typically added as a percentage to the total cost of O&M activities. Professional/technical services are typically estimated as a percentage of the total cost of O&M activities plus contingency. Chapters 5 and 6 provide more information on development and documentation of annual O&M costs.

Exhibit 3-3
Annual O&M Cost Element Checklist

Cost Element	Description	Example Sub-Elements
O&M Activities		
Monitoring, Sampling, Testing, and Analysis[1]	Sampling, testing, on- or off-site analysis, data management, and quality assurance/quality control during the O&M period. Can include monitoring to evaluate remedy performance, compliance with regulations, or monitoring to track migration of contaminant plume.	☐ Meteorological Monitoring ☐ Air Monitoring and Sampling ☐ Radiation Monitoring ☐ Health and Safety Monitoring ☐ Personal Protective Equipment ☐ Monitoring Wells ☐ Soil Sampling ☐ Sediment Sampling ☐ Surface Water Sampling ☐ Groundwater Sampling ☐ Process Water Sampling ☐ Process Air Sampling ☐ Laboratory Chemical Analysis ☐ On-Site Chemical Analysis ☐ Chemical Data Management ☐ _____ ☐ _____
Extraction, Containment, or Treatment Systems[2]	Operation and maintenance of on-site systems to extract, contain, or treat contaminated media (e.g., soil, sediment, sludge, surface water, groundwater).	☐ Operations Labor ☐ Maintenance Labor ☐ Equipment Upgrade/Replacement/Repair ☐ Spare Parts ☐ Equipment Ownership/Rental/Lease ☐ Consumable Supplies ☐ Bulk Chemicals ☐ Raw/Process Materials ☐ Utilities ☐ _____ ☐ _____

[1] Site monitoring, performance monitoring, or compliance monitoring.

[2] Specify extraction, containment, or treatment system. Examples include groundwater extraction system, engineered cap or cover, soil vapor extraction system, groundwater treatment facility, etc. More than one system may be associated with an individual alternative.

Exhibit 3-3 (cont.)
Annual O&M Cost Element Checklist

Cost Element	Description	Example Sub-Elements
O&M Activities (cont.)		
Off-Site Treatment / Disposal	Treatment and/or disposal of wastes generated during operation and maintenance (e.g., on-site treatment residuals, monitoring wastes) at off-site commercial facilities, such as solid or hazardous waste landfills and incinerators.	☐ Material Handling/Loading ☐ Transportation to Off-Site Facility ☐ Treatment/Disposal Fees ☐ _____ ☐ _____
Contingency	Costs to cover unknowns, unforeseen circumstances, or unanticipated conditions associated with annual O&M of the remedial action.	☐ Scope Contingency ☐ Bid Contingency
Professional/Technical Services		
Project Management	Services to manage O&M activities not specific to technical support listed below.	☐ Planning ☐ Community Relations ☐ Cost and Performance Reporting ☐ Permitting ☐ Legal ☐ _____ ☐ _____
Technical Support	Services to monitor, evaluate, and report progress of remedial action.	☐ O&M Manual Updates ☐ O&M Oversight ☐ Progress Reports ☐ _____ ☐ _____
Institutional Controls	Annual update or maintenance of non-engineering measures to reduce or minimize potential for exposure to site contamination or hazards.	☐ Institutional Controls Plan ☐ Restrictive Covenants ☐ Zoning ☐ Property Easements ☐ Deed Notice ☐ Advisories ☐ Groundwater Use Restrictions ☐ Site Information Database ☐ _____ ☐ _____

Periodic Cost Elements

Periodic cost elements from the checklist in Exhibit 3-4 are listed below:

Construction / O&M Activities

- Remedy Failure or Replacement
- Demobilization of On-Site Extraction, Containment, or Treatment Systems
- Contingency

Professional/Technical Services

- Five Year Reviews
- Groundwater Performance and Optimization Study
- Remedial Action Report

Institutional Controls

Example Periodic Cost Element Structure

An example of periodic cost elements and sub-elements that might apply for a remedial alternative that uses air sparging (AS), soil vapor extraction (SVE), and a passive treatment wall is as follows:

- Five Year Reviews
- Demobilization of AS/SVE System
- Well Abandonment
- Remedial Action Report
- Update Institutional Controls Plan

Contingency is typically applied to the total of construction/O&M activities cost elements for the year in which they occur. Professional/technical services are typically estimated on an element-by-element basis, rather than as a percentage, for periodic costs. Chapters 5 and 6 provide more information on development and documentation of periodic costs.

Exhibit 3-4
Periodic Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Construction/O&M Activities		
Remedy Failure or Replacement	Construction activity to replace an installed remedy or key components of the remedy.	☐ Mobilization/Demobilization ☐ Site Work ☐ Structures ☐ Process Equipment and Appurtenances ☐ Non-Process Equipment ☐ Startup and Testing ☐ _____ ☐ _____
Demobilization of On-Site Extraction, Containment, or Treatment Systems[1]	Construction activity to dismantle or take down extraction, containment, or treatment facilities or equipment upon completion of remedial action.	☐ Demolition and Removal ☐ Well Abandonment ☐ _____ ☐ _____
Contingency	Costs to cover unknowns, unforeseen circumstances, or unanticipated conditions associated with construction/O&M activities.	☐ Scope Contingency ☐ Bid Contingency
Professional/Technical Services		
Five Year Reviews	Services to prepare five-year review reports (if hazardous substances, pollutants, or contaminants remain on-site above levels that allow for unrestricted use and unlimited exposure).	☐ Site Visit ☐ Field Data Collection ☐ Data Review and Analysis ☐ Report Preparation ☐ _____ ☐ _____
Groundwater Performance and Optimization Study	Services to analyze and optimize on-going groundwater pump and treat systems.	☐ Site Visit ☐ Field Data Collection ☐ Data Review and Analysis ☐ Report Preparation ☐ _____ ☐ _____

[1] Specify extraction, containment, or treatment system. Examples include groundwater extraction system, soil vapor extraction system, groundwater treatment facility, etc. More than one system may be associated with an individual alternative.

Exhibit 3-4 (cont.)
Periodic Cost Element Checklist

Cost Element	Description	Example Sub-Elements
Professional/Technical Services (cont.)		
Remedial Action Report	Services to prepare remedial action report upon completion of remedial action.	☐ Site Visit ☐ Field Data Collection ☐ Data Review and Analysis ☐ Report Preparation ☐ _____ ☐ _____
Institutional Controls	Periodic update or maintenance of non-engineering measures to reduce or minimize potential for exposure to site contamination or hazards.	☐ Institutional Controls Plan ☐ Restrictive Covenants ☐ Zoning ☐ Property Easements ☐ Deed Notice ☐ Advisories ☐ Groundwater Use Restrictions ☐ Site Information Database ☐ _____ ☐ _____



Chapter Four
Present Value Analysis

Remedial action projects typically involve construction costs that are expended at the beginning of a project (e.g., capital costs) and costs in subsequent years that are required to implement and maintain the remedy after the initial construction period (e.g., annual O&M costs, periodic costs). Present value analysis is a method to evaluate expenditures, either capital or O&M, which occur over different time periods. This standard methodology allows for cost comparisons of different remedial alternatives on the basis of a single cost figure for each alternative. This single number, referred to as the present value, is the amount needed to be set aside at the initial point in time (base year) to assure that funds will be available in the future as they are needed, assuming certain economic conditions (see "Present Value Basics" to right).[1]

A present value analysis of a remedial alternative involves four basic steps:

1. Define the period of analysis.
2. Calculate the cash outflows (payments) for each year of the project.
3. Select a discount rate to use in the present value calculation.
4. Calculate the present value.

The following chapter sections describe the general requirements for each of these steps.

Present Value Basics

The present value (PV) of a future payment is calculated using the following equation:

$$PV = \frac{x_t}{(1+i)^t}$$

where x_t is the payment in year t (t = 0 for present or base year) and i is the discount rate. For example, suppose one needs to make a $1,000 payment in Year 5. Using a discount rate of 5%, the present value would be:

$$= \frac{\$1{,}000}{(1+0.05)^5} = \$783$$

Therefore, $783 would need to be set aside or invested in Year 0, at a discount or interest rate of 5%, in order to have $1,000 in Year 5.

For a stream or series of future payments, the total present value from 1 to n years would be calculated as:

$$PV_{total} = \sum_{t=1}^{t=n} \frac{x_t}{(1+i)^t}$$

If a $1,000 payment is needed for each of the next five years, then the total present value of these payments, at a discount rate of 5%, would be:

$$= \sum_{t=1}^{t=5} \frac{\$1{,}000}{(1+0.05)^t} = \$4{,}329$$

Therefore, $4,329 would need to be set aside in Year 0 to make a $1,000 payment in each of the next five years.

4.1 Define the Period of Analysis

The period of analysis is the period of time over which present value is calculated. In general, the period of analysis should be

[1] This guide uses primarily "present value," although "net present value" and "present worth" are other commonly used terms.

equivalent to the project duration, resulting in a complete life cycle cost estimate for implementing the remedial alternative. The project duration generally begins with the planning, design, and construction of the remedial alternative, continues through short- and long-term O&M, and ends with project completion and closeout. Each remedial alternative may have a different project duration. For example, one alternative may have a two-year construction period and no future O&M. Another alternative may have no construction period and many years of O&M.

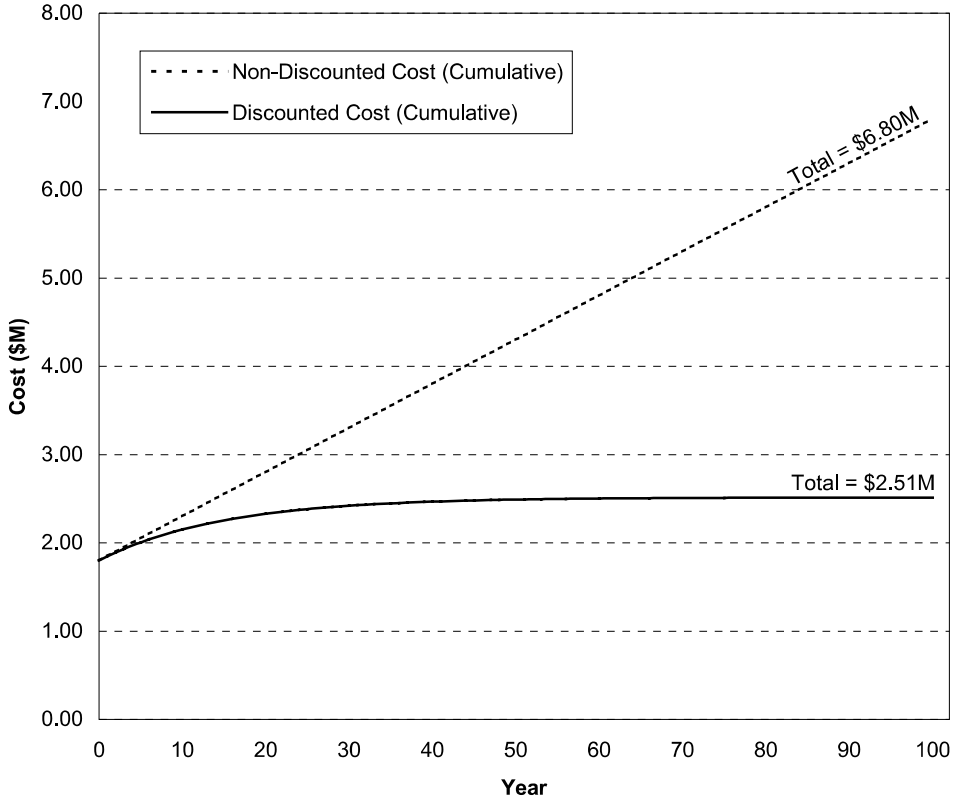
Past USEPA guidance recommended the general use of a 30-year period of analysis for estimating present value costs of remedial alternatives during the FS (USEPA 1988). While this may be appropriate in some circumstances, and is a commonly made simplifying assumption, the blanket use of a 30-year period of analysis is not recommended. Site-specific justification should be provided for the period of analysis selected, especially when the project duration (i.e., time required for design, construction, O&M, and closeout) exceeds the selected period of analysis.[2]

For long-term projects (e.g., project duration exceeding 30 years), it is recommended that the present value analysis include a "no discounting" scenario. A non-discounted constant dollar cash flow over time demonstrates the impact of a discount rate on the total present value cost and the relative amounts of future annual expenditures. Non-discounted constant dollar costs are presented for comparison purposes only and should not be used in place of present value costs in the Superfund remedy selection process. Exhibit 4-1 illustrates the impact of discounting for an example with a $1,800,000 initial capital cost and a $50,000 annual O&M cost spread out over 100 years at a discount rate of 7 percent. Section 4.4 provides more information on how the period of analysis is used in calculating present value.

The period of present value analysis should not necessarily be limited to the commonly-used assumption of 30 years. Explanation should be provided whenever the period of analysis is less than the estimated project duration.

[2] For example, a radioactive waste containment facility may require a 10,000-year design life (i.e., project duration) in order to protect human health and the environment, but the period of analysis for the cost estimate may be bounded at 1,000 years for calculation purposes.

Exhibit 4-1
Non-Discounted vs. Discounted Costs for an Example Project with a 100 Year Duration



4.2 Calculate Annual Cash Outflows

The second step of the present value analysis is to add up the capital and O&M cash outflows for each year of the project (i.e., annual cash outflow). These include capital costs to construct the remedial alternative, annual O&M costs to operate and maintain the remedial alternative over its planned life, and periodic costs for those capital or O&M costs that occur only once every few years. Usually, most or all of the capital costs are expended during the construction and startup of the project, before annual O&M begins. Although the present value of periodic costs is small for those that occur near the end of the project duration (e.g., closeout costs), these costs should be included in the present value analysis. See Chapter 3 for a complete discussion of capital and O&M cost elements for which annual cash outflows should be calculated.

Most FS cost analyses begin with a simplifying assumption that the duration of initial construction and startup will be less than one year (i.e., construction work will occur in "year zero" of the project). This "year zero" assumption can be modified if a preliminary project schedule has been developed and it is known that capital construction costs will be expended beyond one year.

☝ ***For FS present value analyses, most capital costs are assumed to occur in Year 0.***

Annual cash outflows for FS present value analyses should be estimated in constant dollars, denominated in terms of the base year (i.e., Year 0). Constant dollars, also called "real dollars," are not affected by general price inflation (i.e., they represent "units of stable purchasing power"). Thus, the cost of a particular good or service would be the same in Year 0, Year 1, Year 2, etc.

- ***Constant dollars, or "real dollars," are used for the present value analysis (i.e., no adjustment is made for inflation).***

The results of this step in the present value analysis should be an array of all costs in constant dollars for each year of the project, as shown by the example in Exhibit 4-2.

Exhibit 4-2
Example Array of Constant Dollar Costs for Present Value Analysis

Year	Capital Costs ($)	Annual O&M Costs ($)	Periodic Costs ($)	Total Cost ($)
0	1,800,000	0	0	1,800,000
1	0	50,000	0	50,000
2	0	50,000	0	50,000
3	0	50,000	0	50,000
4	0	50,000	0	50,000
5	0	50,000	10,000	60,000
6	0	50,000	0	50,000
7	0	50,000	0	50,000
8	0	50,000	0	50,000
9	0	50,000	0	50,000
10	0	50,000	50,000	100,000

4.3 Select a Discount Rate

The third step in the present value analysis is to select a discount rate. A discount rate, which is similar to an interest rate, is used to account for the time value of money. A dollar is worth more today than in the future because, if invested in an alternative use today, the dollar could earn a return (i.e., interest). Thus, discounting reflects the productivity of capital. If the capital were not employed in a specific use, it would have productive value in alternative uses. The choice of a discount rate is important because the selected rate directly impacts the present value of a cost estimate, which is then used in making a remedy selection decision. The higher the discount rate, the lower the present value of the cost estimate.

USEPA policy on the use of discount rates for RI/FS cost analyses is stated in the preamble to the NCP (55 FR 8722) and in Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-20 entitled "*Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis*" (USEPA 1993). Based on the NCP and this directive, a discount rate of 7% should be used in developing present value cost estimates for remedial action alternatives during the FS. This specified rate of 7% represents a "real" discount rate in that it approximates the marginal pretax rate of return on an average investment in the

private sector in recent years and has been adjusted to eliminate the effect of expected inflation. Therefore, this rate should be used with "constant" or "real" dollars that have not been adjusted for inflation (i.e., a dollar spent in future years is worth the same as a dollar spent in the present year), which is the typical situation for RI/FS cost analyses.

The 7% discount rate was established through an economic analysis performed by the Office of Management and Budget (OMB). USEPA's policy regarding the use of discount rates in present value calculations performed during the FS will be reevaluated periodically or when OMB updates Circular A-94.[3] Any changes to this policy will be contained in an update of OSWER Directive 9355.3-20, which can be found at *http://www.epa.gov/superfund/*.

OMB Circular A-94

The Office of Management and Budget (OMB) Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs,* provides guidance for the use of discount rates in economic analyses performed by the Federal government. The circular is available at *http://www.whitehouse.gov/OMB/circulars/a094/a094.html* or by contacting the OMB publications office at (202) 395-7332.

Appendix C of OMB Circular A-94, which contains discount rates that may be applicable to Federal facility sites, is updated annually in January/February.

There may be circumstances in which it would be appropriate to consider the use of a lower or higher discount rate than 7% for the FS present value analysis. If a different discount rate is selected for the analysis, a specific explanation should be provided. For cost estimates that have large future year expenditures or where the discount rate assumption is a sensitive cost factor, a sensitivity analysis can be performed to evaluate the impacts of the discount rate assumption on the present value cost. See Chapter 5 for a more complete discussion of sensitivity analyses.

For Federal facility sites being cleaned up using Superfund authority, it is generally appropriate to apply the real discount rates found in Appendix C of OMB Circular A-94. These rates, which are also used in the President's annual budget submission to Congress, are based on interest rates from Treasury notes and bonds. Because the Federal government has a different "cost of capital" than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Although an analogous situation exists for Federal-lead sites that will be cleaned up by USEPA using the Superfund trust fund (i.e., Fund-lead sites), there is always a chance that the site will actually be remediated by a private, or "potentially-responsible," party (i.e., PRP-lead cleanup). Therefore, the 7% discount rate should generally be used in calculating net present value costs for all non-Federal facility sites.



A real discount rate of 7 percent should generally be used for all non-Federal facility sites. Real discount rates from Appendix C of OMB Circular A-94 should generally be used for all Federal facility sites.

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[3] Appendix C of OMB Circular A-94 is updated on an annual basis around the time of the President's budget submission to Congress (i.e., January/February timeframe). However, the 7% discount rate contained in the main portion of the circular is not updated on an annual basis.

For FS cost analyses, the same discount rate should be used in evaluating all remedial alternatives for a site, even if the period of analysis differs from one to another. Exhibit 4-3 shows a present value comparison of six remedial alternatives with varying amounts of initial capital costs, annual O&M costs, and years of analysis. Alternative F has the second highest total cost in base year dollars, but the lowest present value cost. This is because much of its total costs are in the future, which become quite small after the discount rate is applied. The cost of Alternative C is less than that of alternative D, but its present value is higher, since it has large upfront capital costs. This example illustrates the effect of varying initial capital cost, annual O&M costs, and period of analysis on the present value cost of alternatives.

The same discount rate should be used for all remedial alternatives, even if the period of analysis varies from one to another.

Exhibit 4-3
Comparison of Present Value of Six Remedial Alternatives

Remedial Alternative	Initial Capital Cost ($000)	Annual O&M Cost ($000)	Period of Analysis* (Years)	Total Cost ($000)	Present Value at 7% ($000)
Alternative A	0	0	0	0	0
Alternative B	3,650	583	15	12,400	8,960
Alternative C	10,800	548	30	27,200	17,600
Alternative D	2,850	696	50	37,700	12,500
Alternative E	5,500	230	80	23,900	8,770
Alternative F	2,000	120	220	28,400	3,710

* In this example, the period of analysis is the same as project duration.

4.4 Calculate the Present Value

The last step is to calculate the present value. The present value of a remedial alternative represents the sum of the present values of all future payments associated with the project. For example, if the project will entail capital and O&M costs each year for 12 years, the present value is the sum of the present values of each of the 12 payments, or expenditures.

The present value of a future payment is the actual value that will be disbursed, discounted at an appropriate rate of interest. Present value for payment x_t in year t at a discount rate of i is calculated as follows:

$$PV = \frac{1}{(1+i)^t} \cdot x_t$$

The first operand in this equation, $1/(1+i)^t$, can be referred to as a "discount factor." Exhibit 4-4 provides annual discount factors at a rate of 7% for up to 200 years. Exhibit 4-5 illustrates the use of these factors for a remedial alternative with construction costs of $1,800,000 in Year 0, annual O&M costs of $50,000 for ten years, and periodic costs of $10,000 in Years 5 and 10 and $40,000 in Year 10.[4]

Exhibit 4-4
Annual Discount Factors at 7%

Year	Factor	Year	Factor	Year	Factor	Year	Factor	Year	Factor
1	0.935	23	0.211	45	0.0476	67	0.0107	89	0.00243
2	0.873	24	0.197	46	0.0445	68	0.0100	90	0.00227
3	0.816	25	0.184	47	0.0416	69	0.00939	91	0.00212
4	0.763	26	0.172	48	0.0389	70	0.00877	92	0.00198
5	0.713	27	0.161	49	0.0363	71	0.00820	93	0.00185
6	0.666	28	0.150	50	0.0339	72	0.00766	94	0.00173
7	0.623	29	0.141	51	0.0317	73	0.00716	95	0.00162
8	0.582	30	0.131	52	0.0297	74	0.00669	96	0.00151
9	0.544	31	0.123	53	0.0277	75	0.00625	97	0.00141
10	0.508	32	0.115	54	0.0259	76	0.00585	98	0.00132
11	0.475	33	0.107	55	0.0242	77	0.00546	99	0.00123
12	0.444	34	0.100	56	0.0226	78	0.00511	100	0.00115
13	0.415	35	0.0937	57	0.0211	79	0.00477	110	0.000586
14	0.388	36	0.0875	58	0.0198	80	0.00446	120	0.000298
15	0.362	37	0.0818	59	0.0185	81	0.00417	130	0.000151
16	0.339	38	0.0765	60	0.0173	82	0.00390	140	0.0000770
17	0.317	39	0.0715	61	0.0161	83	0.00364	150	0.0000391
18	0.296	40	0.0668	62	0.0151	84	0.00340	160	0.0000199
19	0.277	41	0.0624	63	0.0141	85	0.00318	170	0.0000101
20	0.258	42	0.0583	64	0.0132	86	0.00297	180	0.00000514
21	0.242	43	0.0545	65	0.0123	87	0.00278	190	0.00000261
22	0.226	44	0.0509	66	0.0115	88	0.00260	200	0.00000133

Annual discount factor $= \frac{1}{(1+i)^t}$ where i = 0.07 and t = year (i.e., the present value of one dollar paid in year t at 7%)

[4] For present value analyses during the FS, distinction is generally not made as to what time of the year the total cost for each year is incurred (e.g., beginning, middle, or end). This simplifying assumption would not necessarily be used for budgeting purposes, but is appropriate for FS cost estimating purposes.

Exhibit 4-5
Example Present Value Calculation for a Remedial Alternative

Year	Capital Costs ($)	Annual O&M Costs ($)	Periodic Costs ($)	Total Cost ($)	Discount Factor at 7%	Total Present Value Cost at 7% ($)
0	1,800,000	0	0	1,800,000	1.000	1,800,000
1	0	50,000	0	50,000	0.935	46,800
2	0	50,000	0	50,000	0.873	43,700
3	0	50,000	0	50,000	0.816	40,800
4	0	50,000	0	50,000	0.763	38,200
5	0	50,000	10,000	60,000	0.713	42,800
6	0	50,000	0	50,000	0.666	33,300
7	0	50,000	0	50,000	0.623	31,200
8	0	50,000	0	50,000	0.582	29,100
9	0	50,000	0	50,000	0.544	27,200
10	0	50,000	50,000	100,000	0.508	50,800
Total	1,800,000	560,000		2,360,000	-	2,180,000

For a stream or series of payments from 1 to *n* years, the total present value is:

$$PV_{total} = \sum_{t=1}^{t=n} \frac{1}{(1+i)^t} \cdot x_t$$

When the annual cost, x_t, is constant over a period of years, beginning at Year 1, the calculations can be simplified by using a multi-year discount factor, which is the sum of the first operand in the above equation. Exhibit 4-6 provides multi-year discount factors at a rate of 7% for up to 200 years, as well as the formula to calculate multi-year discount factors at discount rates other than 7%. For example, the factor for 30 years at 7% is 12.409. Thus, the present value of $1,000 per year for 30 years is $1,000 x 12.409 = $12,400.

Exhibit 4-6
Multi-Year Discount Factors at 7%

Years	Factor	Years	Factor	Years	Factor	Years	Factor
1	0.935	29	12.278	57	13.984	85	14.240
2	1.808	30	12.409	58	14.003	86	14.243
3	2.624	31	12.532	59	14.022	87	14.246
4	3.387	32	12.647	60	14.039	88	14.249
5	4.100	33	12.754	61	14.055	89	14.251
6	4.767	34	12.854	62	14.070	90	14.253
7	5.389	35	12.948	63	14.084	91	14.255
8	5.971	36	13.035	64	14.098	92	14.257
9	6.515	37	13.117	65	14.110	93	14.259
10	7.024	38	13.193	66	14.121	94	14.261
11	7.499	39	13.265	67	14.132	95	14.263
12	7.943	40	13.332	68	14.142	96	14.264
13	8.358	41	13.394	69	14.152	97	14.266
14	8.745	42	13.452	70	14.160	98	14.267
15	9.108	43	13.507	71	14.169	99	14.268
16	9.447	44	13.558	72	14.176	100	14.269
17	9.763	45	13.606	73	14.183	110	14.277
18	10.059	46	13.650	74	14.190	120	14.281
19	10.336	47	13.692	75	14.196	130	14.284
20	10.594	48	13.730	76	14.202	140	14.285
21	10.836	49	13.767	77	14.208	150	14.285
22	11.061	50	13.801	78	14.213	160	14.285
23	11.272	51	13.832	79	14.218	170	14.286
24	11.469	52	13.862	80	14.222	180	14.286
25	11.654	53	13.890	81	14.226	190	14.286
26	11.826	54	13.916	82	14.230	200	14.286
27	11.987	55	13.940	83	14.234		
28	12.137	56	13.963	84	14.237		

Multi-year discount factor $= \sum_{t=1}^{t=n} \frac{1}{(1+i)^t} = \frac{(1+i)^n - 1}{i(1+i)^n}$, where i = 0.07, t = year, and n = total years

(i.e., the present value of one dollar paid per year from 1 to *n* years at 7%)

NOTE: These factors only apply when annual costs are constant.

Multi-year factors shown in Exhibit 4-6 cannot be used when periodic costs are added to the annual O&M cost for the years in which they occur. In cases like these, when future expenditures are not constant from year to year, discount factors taken from Exhibit 4-4 (or other list of factors if 7% is not used) should be applied to each future year's expenditure to convert into present value.

As Exhibits 4-4 and 4-6 indicate, discounted values of even large costs incurred far in the future tend to be negligible. For example, for a 200-year project with constant annual costs of $500,000 at 7%, 99.9% of the discounted O&M costs are incurred in the first 100 years, 97% in the first 50 years, and 88% in the first 30 years. The period of present value analysis, however, should not be shortened to less than the project duration (Section 4.1), particularly when O&M costs are significant, or when major costs, such as replacement or corrective maintenance, are expected to occur in the future. In addition, evaluation of a "no discounting" scenario would be recommended pursuant to discussion in Section 4.1.

In addition to calculating discount factors as shown in Exhibits 4-4 and 4-6, present value can be calculated using functions found in many spreadsheet software programs. For example, the PV function in Excel can be used to calculate the present value of a series of future payments by providing the interest rate, total number of payments, and payment made each period. When using spreadsheet functions or formulas, it is important that calculations be independently checked to ensure that the functions are being applied correctly.



Chapter Five
How to Develop the Cost Estimate

This chapter presents steps to develop a basic cost estimate for a remedial alternative during the FS. Although a variety of estimating methods or tools may be utilized, these steps follow a general activity-based approach, where the cost estimate is divided into discrete, quantifiable activities or elements for each alternative. The steps are as follows:

1. Describe the alternative.
2. Identify the cost element structure for capital, annual O&M, and periodic costs.
3. Estimate construction/O&M activities costs.
4. Apply contingency.
5. Estimate professional/technical services costs.
6. Estimate institutional controls costs, if applicable.
7. Conduct present value analysis.
8. If appropriate, conduct a sensitivity analysis.
9. Review estimate.

These steps are presented as a flowchart in Exhibit 5-1 and described in further detail in the following chapter sections.

Types of Cost Estimating Methods

Two main types of methods used to estimate the cost of remedial alternatives are the detailed and parametric approach.

The detailed approach estimates costs on an item-by-item basis. Detailed methods typically rely on quantity take-offs and compiled sources of unit cost data for each item, taken from either a built-in database (if part of a software package, for example) or other sources (e.g., cost estimating references). This method, also known as "bottom up" estimating, is used when design information is available.

The parametric approach relies on relationships between cost and design parameters. These relationships are usually "statistically-based" or "model-based." Statistically-based approaches rely on "scaled-up" or "scaled-down" versions of projects where historical cost data is available. Model-based approaches utilize a generic design that is linked to a cost database and adjusted by the user for site-specific information. This method, also known as "top down" estimating, is used when design information is not available.

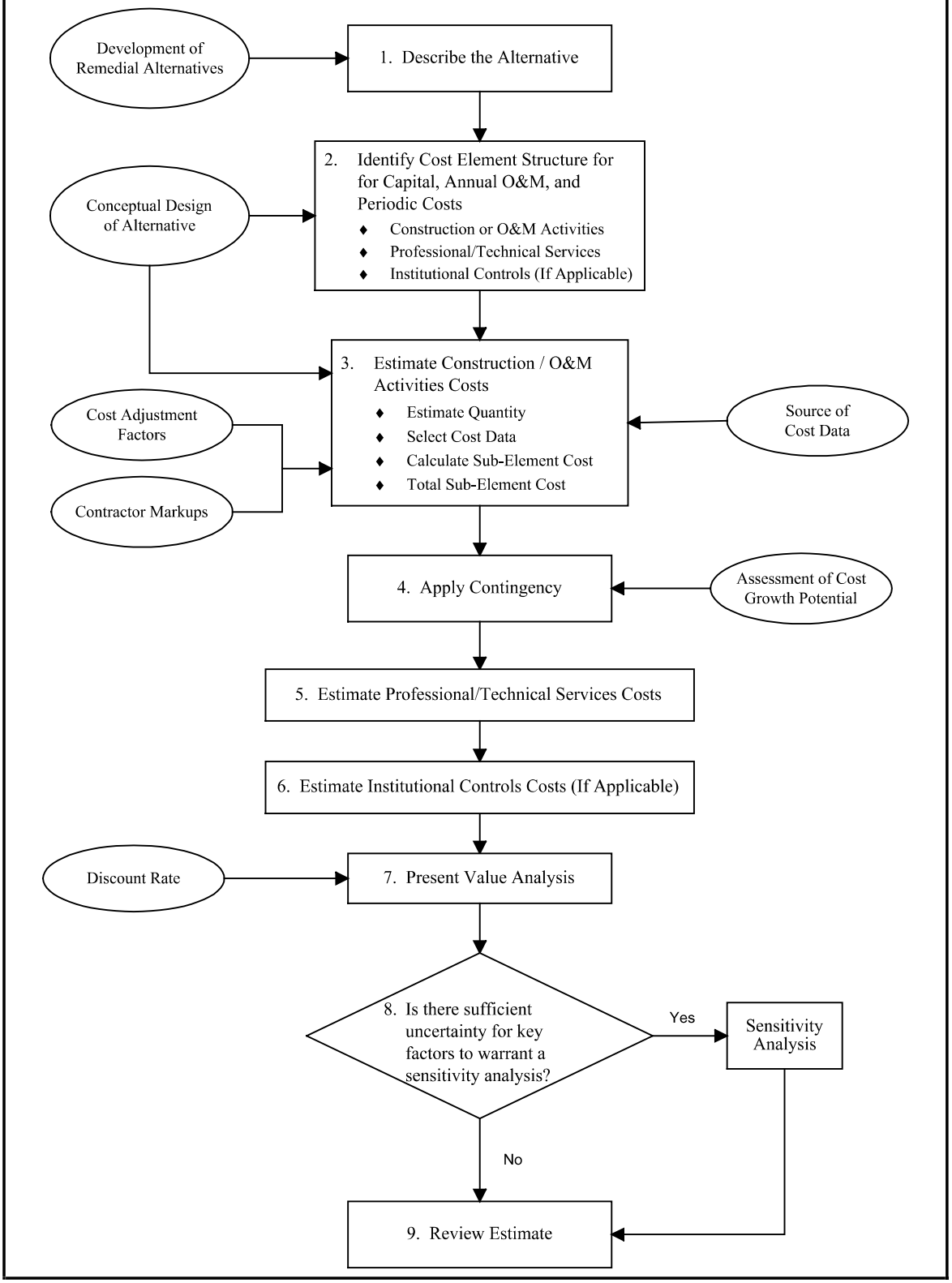
Some resources that utilize these methods can be found in Appendix A.

5.1 Describe the Alternative

As the first step in development of the cost estimate, the remedial alternative should be described in general terms. An example of a descriptive narrative for an alternative that utilizes the technologies of air sparging, soil vapor extraction, and passive treatment wall is as follows:

> "Alternative 3 consists of air sparging and soil vapor extraction to treat soil and groundwater contaminated with volatile organic compounds in the source area. Also includes a passive treatment wall along the leading edge of the plume to treat groundwater migrating off-site. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-15. Periodic costs occur in Years 5, 10, and 15."

Exhibit 5-1
Steps to Develop a Basic Cost Estimate for a Remedial Alternative



In addition to the above, the name and location of the site, phase of project (e.g., FS), and date of estimate preparation should be noted. The remedial alternative, as part of the alternative development process, will typically be described in greater detail in the body of the FS report. This detail should state remedial action objectives, including cleanup goals. At the time the estimate is developed, a conceptual design of the remedial alternative should have been completed or should be in progress. The identification of the cost element structure (Step 2), as well as estimation of quantities (included in Step 3), is directly related to the conceptual design of the alternative (i.e., level of project definition). The narrative, as shown in the above example, is not meant to describe every detail of the alternative, but provide a point of reference for developing the cost estimate.

5.2 Identify Cost Element Structure

Following the description, the second step is to identify the cost element structure for the alternative. A separate structure should be identified for capital, annual O&M, and periodic costs. This can be done with the help of checklists presented in Chapter 3 or standard work breakdown structures. For capital, annual O&M, and periodic cost element structures, the following steps apply:

1. Identify construction or O&M activities cost elements.
2. Identify professional/technical services cost elements.
3. Identify institutional controls cost elements, if applicable.

Construction or O&M activities include labor, equipment, and material costs for the contractor constructing the remedial action or for the contractor operating, maintaining, and/or monitoring the remedial action. Sub-elements should be identified, as required, to adequately describe each construction or O&M activity.

Professional/technical services support construction or operation and maintenance of the remedial action. Sub-elements for professional/technical services costs may be identified, as appropriate. Institutional controls can be a one-time (e.g., capital) or recurring cost (e.g., annual O&M, periodic). Sub-elements should generally be identified for institutional controls, as appropriate.

An example cost element structure for a remedial alternative that utilizes the technologies of air sparging (AS), soil vapor extraction (SVE), and a passive treatment wall is shown in Exhibit 5-2.

Exhibit 5-2
Example Cost Element Structure

Capital Costs

- Mobilization / Demobilization
  - Construction Equipment and Facilities
  - Submittals/Implementation Plans
  - Temporary Facilities & Utilities
  - Post-Construction Submittals
- Monitoring, Sampling, Testing, and Analysis
  - SVE Monitoring Wells
  - Treatment Wall Monitoring Wells
- Site Work
  - Clearing and Grubbing
  - Seeding/Mulch/Fertilizer
- Air Sparging / Soil Vapor Extraction
  - Mobilize SVE System
  - AS Injection Wells
  - AS Blower
  - AS Piping
  - SVE System
  - SVE Extraction Wells
  - SVE Piping
  - Electrical Hookup
  - Startup and Testing
- Passive Treatment Wall
  - Construct Slurry Trench
  - Install Reactive Media
- Off-Site Treatment/Disposal
  - Off-Site Transport of Soil Cuttings
  - Off-Site Disposal of Soil Cuttings
  - Wastewater Discharge/Testing
- Project Management
- Remedial Design
- Construction Management
- Institutional Controls
  - Institutional Controls Plan
  - Groundwater Use Restriction
  - Site Information Database

Annual O&M Costs

- Performance Monitoring
  - SVE Vapor Monitoring
  - SVE Emissions Monitoring
  - Treatment Wall - Groundwater Sampling
  - Treatment Wall - Groundwater Analysis
- Site Monitoring
  - Groundwater Sampling
  - Groundwater Laboratory Analysis
- Air Sparging / Soil Vapor Extraction
  - Operations Labor
  - Maintenance Labor
  - Equipment Repair
  - Utilities
- Off-Site Treatment/Disposal
  - Wastewater Discharge/Testing
- Project Management
- Technical Support
- Institutional Controls
  - Site Information Database

Periodic Costs

- Five Year Reviews
- Demobilization of AS/SVE System
- Well Abandonment
- Remedial Action Report
- Update Institutional Controls Plan

5.3 Estimate Construction/O&M Activities Costs

Following the description and identification of cost element structure, the cost of each construction or O&M activity is estimated. If the cost element is broken down into sub-elements, the cost of each sub-element should be estimated and then added for a cost element subtotal. The steps in this process include:

1. Estimate quantity.
2. Select cost data.
3. Calculate sub-element cost, including adjustments and application of markups.
4. Total sub-element costs.

These steps are described in more detail below.

Estimate Quantity

The estimation of quantities is directly related to the quality and quantity of site characterization data. For example, the estimated quantity of soil or groundwater contaminated above a cleanup goal or action level (i.e., quantity to be "cleaned up") is dependent upon data collected during the RI to determine nature and extent of contamination. Likewise, the estimated soil vapor extraction rate or groundwater pumping rate is dependent on the methods used to estimate air permeability or hydraulic conductivity (e.g., estimated values based on soil type, field pumping tests), as well as the operating capacity of the equipment (e.g., sizing of pumps, blowers, etc.). Other factors can affect the quantity estimate, such as the expected "swell" or "fluff" in volume of excavated material for an ex situ soil cleanup and the anticipated number of aquifer volumes to remove for an ex situ groundwater cleanup.

Quantity calculations used to support a cost estimate should be adequately documented. Supporting information can include boring logs, chemical analysis results, and scaled drawings to show lateral and vertical extent of contamination and to estimate physical characteristics such as porosity and dry unit weight which affect the quantity estimate. Assumptions used to estimate quantities should be clearly presented.

Using the example cost element structure shown in Exhibit 5-2, example quantities for capital costs would be the number of SVE monitoring wells, acres of clearing and grubbing, lineal feet of SVE piping, cubic yards of reactive media, etc. Example quantities for annual O&M costs would be the number of groundwater sampling events for site monitoring, number of months of operations labor for the AS/SVE system, etc.

Select Cost Data

Cost data can be selected from a variety of sources, including:

- Cost estimating guides/references
- Vendor or contractor quotes

- Experience with similar projects
- Cost estimating software/databases

Cost estimating guides or references (e.g., unit price books) can provide costs for a wide variety of construction activities, including those related to remedial actions. Some guides are specifically tailored to estimate costs for environmental remediation projects. Cost data in these references are sometimes broken down into labor, equipment, and material categories, and may or may not include contractor markups. Generally, each cost is associated with a specific labor and equipment crew and production rate. Costs are typically provided on a national average basis for the year of publication of the reference. Some of these guides or references are listed in Appendix A.

Quotes from vendors or construction contractors can provide costs that are more site-specific in nature than costs taken from standard guides and references. These quotes usually include contractor markups and are usually provided as a total cost rather than categorized as labor, equipment, or materials. If possible, more than one vendor quote should be obtained. Quotes from multiple sources can be averaged, or the highest quote can be used in the cost estimate if the collected quotes seem to be at the low end of the industry range. Vendors or contractors can also be an important source of design-related information, including operating capacity, production rates, operating life, and maintenance schedules that may have implications for O&M costs.

Experience with similar projects, including both estimates and actual costs, can also be used as a source of cost data. Engineering judgement should be exercised where cost data taken from another project needs to be adjusted to take into account site- or technology-specific parameters. Sources of actual cost data from government remediation projects are maintained by various Federal agencies. These sources include the Historical Cost Analysis System (HCAS) (*http://www.frtr.gov/cost/ec2/index.html*) and Federal Remediation Technologies Roundtable (FRTR) cost and performance reports (*http://www.frtr.gov/cost/*). HCAS and the FRTR reports are two initiatives that are currently being used to collect and record treatment technology costs in a standardized format. Some of these sources of historical cost data are listed in Appendix A.

Cost estimating software and databases can also be used as sources of cost data. The majority of available software tools are designed to estimate the cost for all or selected cost elements of an alternative. Government-sponsored software tools include Micro Computer Aided Cost Engineering System (MCACES), which is used by the U.S. Army Corps of Engineers and is linked to the Unit Price Book (UPB) database (*http://www.hnd.usace.army.mil/traces/*), and the Remedial Action Cost Engineering and Requirements (RACER), which is sponsored by the U.S. Air Force (*http://www.talpart.com/products/racer/index.html*). Some of these software or databases, both private and publicly sponsored, are listed in Appendix A.

Calculate Sub-Element Cost

Calculating the cost of each sub-element consists of calculating a unit cost from a source of cost data, including adjustments for site- or project-specific factors, and multiplying by the estimated quantity. Adjustments may include the following:

- Apply productivity factors per health and safety level of protection
- Escalate costs to base year of estimate
- Apply area cost factors
- Add contractor markups

As the level of health and safety protection (e.g., personal protective equipment, monitoring requirements) is increased, productivity is decreased and costs are increased. For applicable cost elements, factors that reflect decreased productivity due to required health and safety levels of protection should be applied to labor and equipment costs. More information on productivity factors and how to apply them is provided in Appendix B.

Health and Safety Impacts

Factors that may affect both capital and O&M cost elements due to health and safety precautions include:

- Decontamination facilities and operations
- Protective equipment cost and disposal
- Additional labor for health and safety personnel
- Rest periods required to prevent heat stress or cold weather impacts
- Time to suit-up, decontaminate, and change air tanks
- Personnel training
- Health and safety briefings and meetings

Some of these costs can be accounted for in overhead or specific cost elements. How to account for the impacts of health and safety level of protection on labor and equipment productivity is described in Appendix B.

Unit costs that are obtained from sources that are one year old or more need to be updated or escalated to the base year, which is usually the current year. This can be done using escalation factors as described in Appendix B.

Area cost factors should be applied to unit costs from sources based on a national average (e.g., standard cost guides) or from other geographic locations (e.g., similar projects). Area cost factors are further described in Appendix B.

Contractor markups, or overhead and profit, which may vary between sub-elements, should be added. Markups include overhead and profit for the prime contractor and any subcontractors. Markups should generally be applied to individual cost elements or sub-elements, but, alternatively, can be applied to the total of those elements, if the source of cost data for each is the same. Markups should not be duplicated or applied to elements that have already been "marked up."

The source of cost data can dictate how, or if, markups should be applied. For example, a vendor or contractor quote may include overhead and profit (i.e., "burdened"), whereas a unit price taken from a standard cost estimating guide may not (i.e., "non-burdened"). Typically, costs taken from pricing guides need to have overhead and profit added.

Overhead includes two main types: (1) job or field office overhead, also known as general conditions, and (2) home office overhead, also known as general and administrative (G&A) costs. Field office overhead can include costs for field supervision and office personnel, temporary facilities and utilities, telephone and communications, permits and licenses, travel and per diem, personal protective equipment, quality control, insurance, bond, and taxes. Home office overhead is the contractor's overall cost of doing business, as shared by the project. Profit is the return on the contractor's investment in the project.

- ***Field office overhead can range from about 5 to 25 percent of total project costs that range from greater than $500,000 to less than $50,000, respectively. Home office overhead is usually about 5 percent of total project cost.***

- ***Profit typically ranges from 8 to 10 percent of total project cost.***

An example of how a unit cost for a sub-element might be calculated is shown in Exhibit 5-3 for construction cost of a soil vapor extraction well.

Exhibit 5-3
Example Calculation of Sub-Element Unit Cost

Costs per extraction well:

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Mob/demob	1	LS	-	-	-	100	100
Setup & Decon	1	HR	-	-	-	125	125
Drill & Install	15	FT	-	-	-	55	825
Wellhead Completion	1	LS	-	-	-	950	950
IDW Handling	1	HR	-	-	-	175	175
Drilling Oversight	7	HR	110	-	-	110	770
SUBTOTAL							2,945
Prime Contractor Overhead						15%	442
SUBTOTAL							3,387
Prime Contractor Profit						10%	339
TOTAL UNIT COST							$3,725

In this example, costs are based on a quote from a local drilling subcontractor, itemized by activity. The assumed health and safety level of protection is built into the quote; therefore, no outside adjustment is made for health and safety productivity. Likewise, no costs are escalated, since the base year is the current year, and no area cost factor is applied, since the quote is local. Subcontractor overhead and profit are included in the quote. Prime contractor overhead and profit are added. Unit prices taken from standard cost estimating guides typically are broken down into labor, equipment, and materials categories. However, since these were not provided in the quote, these are not shown except for oversight, which is based on typical labor rates in the area for a geologist and technician.

Using the above example, if eight soil vapor extraction wells are to be installed, then the total cost of this sub-element would be 8 x $3,725 = $29,800.

Total Sub-Element Costs

After the cost for each sub-element has been calculated, then the cost of the associated cost element can be calculated by totaling the sub-element costs. An example is shown in Exhibit 5-4 for construction cost of an air sparging / soil vapor extraction system.

Exhibit 5-4
Example Estimation of Cost Element

Air Sparging / Soil Vapor Extraction				
Mobilize SVE System	1	EA	$1,534	$1,534
Impermeable Surface Cover	105,000	SF	$0.84	$88,200
SVE Extraction Wells	8	EA	$3,725	$29,803
AS Injection Wells	2	EA	$4,645	$9,290
SVE System	1	EA	$93,510	$93,510
AS Blower	1	EA	$5,712	$5,712
SVE Piping	400	LF	$8.66	$3,464
AS Piping	100	LF	$5.03	$503
Electrical Hookup	1	LS	$9,898	$9,898
Startup and Testing	1	LS	$10,936	$10,936
SUBTOTAL				$252,851

This example includes the sub-element "SVE Extraction Well" from Exhibit 5-3.

5.4 Apply Contingency

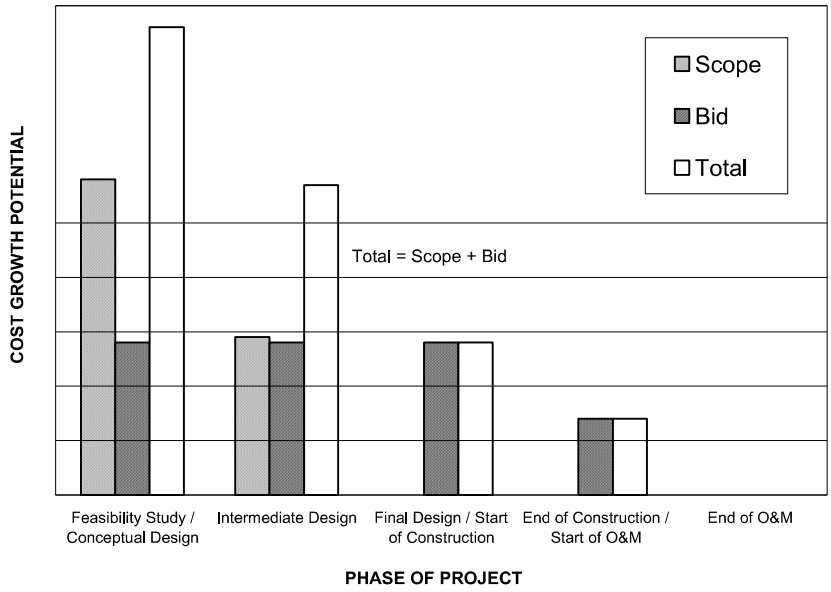
Contingency is factored into a cost estimate to cover unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the data on hand at the time the estimate is prepared. It is used to reduce the risk of possible cost overruns.

For the purposes of the FS, contingency is typically applied as a percentage of the total cost of construction or O&M activities costs, rather than applied to individual cost elements. The contingency percentage is based on either a qualitative or quantitative assessment of "cost growth," or "cost risk," potential.[1] Detailed quantitative methods used to evaluate cost growth potential include element by element risk scoring and weighting techniques and risk analysis software such as CostRisk, which is currently under development for use by USACE. A more common approach for the FS, however, is to assign a contingency percentage based on engineering judgement.

The two main types of contingency are scope and bid. Scope contingency covers unknown costs due to scope changes that may occur during design. Bid contingency covers unknown costs associated with constructing or implementing a given project scope. The relationship of scope, bid, and total contingency as a project moves through its various phases is illustrated in Exhibit 5-5.

[1] Factors that affect the potential for cost growth in remediation projects include the project definition and the complexity of the media, waste, and technical aspects of the project.

Exhibit 5-5
Relationship of Scope, Bid, and Total Contingency



Scope Contingency

Scope contingency represents project risks associated with an incomplete design. This type of contingency represents costs, unforeseeable at the time of estimate preparation, which are likely to become known as the remedial design proceeds (Exhibit 5-5). For this reason, scope contingency is sometimes referred to as "design" contingency, which is the term commonly used by the USACE. In general, scope contingency should decrease as design progresses and should be 0% at the 100% design stage.

At the early stages of remedial design (e.g., FS which represents 0%-10% design completion), concepts are not typically developed enough to identify all project components or quantities. Contributing factors include limited experience with certain technologies, potential requirements due to regulatory or policy changes, and inaccuracies in defining quantities or characteristics. Scope contingency would be expected to be higher for newer or emerging remedial technologies than for more well-documented systems. For these reasons, scope contingency may vary between alternatives.

Scope contingency typically ranges from 10 to 25 percent. Higher values may be justified for alternatives with greater levels of cost growth potential.

Exhibit 5-6 shows example rule-of-thumb percentage ranges to use for scope contingency during the FS, based on type of remedial technology. A low percentage for scope contingency indicates an opinion that the project scope will undergo minimal change during

design. A high percentage indicates an opinion that the project scope may change considerably between the FS and final design.

Exhibit 5-6
Example FS-Level Scope Contingency Percentages

Remedial Technology	Scope Contingency (%)
Soil Excavation	15-55
Groundwater Treatment (Multiple)	15-35
On-Site Incineration	15-35
Extraction Wells	10-30
Vertical Barriers	10-30
Synthetic Cap	10-20
Sludge Stabilization	10-20
Off-Site Disposal	5-15
Off-Site Incineration	5-15
Drum Processing	5-15
Bulk Liquid Processing	5-15
Groundwater Treatment (Single)	5-10
Clay Cap	5-10
Surface Grading/Diking	5-10
Revegetation	5-10

While not accounting for every type of remedial technology, this exhibit provides a range of values to consider for scope contingency. Engineering judgement should be used whenever selecting a scope contingency percentage and the value used should be clearly identified in the cost estimate. The values in Exhibit 5-6 may be weighted by cost element, either qualitatively or quantitatively, to derive a single value to apply to the total of construction or O&M activities costs.

Bid Contingency

Bid contingency represents costs, unforeseeable at the time of estimate preparation, which are likely to become known as the remedial action construction or O&M proceeds (Exhibit 5-5). For this reason, bid contingency is sometimes referred to as "construction" contingency, which is the term commonly used by the USACE.

Bid contingency accounts for changes that occur after the construction contract is awarded. This contingency represents a reserve for quantity overruns, modifications, change orders, and/or claims during construction. Considerations include the technological, geotechnical, and other unknowns applicable to the construction phase. Examples include changes due to adverse weather, material or supply shortages, or new regulations.

- ***Bid contingency typically ranges from 10 to 20 percent.***

Bid and scope contingency may be added together and applied to the total of construction or O&M activities costs as shown in the example in Exhibit 5-7 for capital costs.

Exhibit 5-7
Example Contingency Application

Capital Costs:	
Mobilization / Demobilization	$106,723
Monitoring, Sampling, Testing, and Analysis	$60,838
Site Work	$12,940
Air Sparging / Soil Vapor Extraction	$252,851
Passive Treatment Wall	$2,028,564
Off-Site Treatment / Disposal	$1,550
SUBTOTAL	$2,463,465
Contingency (10% scope + 15% bid)	615,866

In general, for a cost estimate developed during the FS, the same level of risk associated with remedial design for capital costs can be carried over to annual O&M costs. In addition, the relative number of unknowns associated with operating and maintaining a remedial action would be expected to be at least the same or greater than those associated with construction.



The total contingency value (bid + scope) that is applied to annual O&M costs is typically equal to or greater than the contingency applied to capital costs.

Using the example in Exhibit 5-6, the total contingency to apply to the total of "O&M activities" costs might be 30 percent (10% scope + 20% bid), or slightly greater than that for capital "construction activities" costs.

5.5 Estimate Professional/Technical Services Costs

Professional/technical services cost elements can be broken down into sub-elements and estimated in similar fashion to construction or O&M activities costs (Section 5.3). However, these costs are most often estimated by applying a percentage to the total of construction or O&M activities costs plus contingency. The total capital, annual O&M, or periodic cost, therefore, is the total of construction or O&M activities costs, contingency, and professional/technical services. Professional/technical services cost elements include:

- Project Management
- Remedial Design
- Construction Management
- Technical Support

For professional/technical services capital costs, Exhibit 5-8 shows rule-of-thumb percentages that can be used for project management, remedial design, and construction management as a percentage of total construction cost. The percentages shown apply to the average remediation project and are provided as a guide. These values may be adjusted up

for more complex projects or down for less complex projects, based on engineering judgement, which might consider actual cost data from similar projects.

Exhibit 5-8
Example Percentages for Professional/Technical Services Capital Costs

Capital Cost Element	< $100K (%)	$100K-$500K (%)	$500K-$2M (%)	$2M-$10M (%)	> $10M (%)
Project Management	10	8	6	5	5
Remedial Design	20	15	12	8	6
Construction Management	15	10	8	6	6

Professional/technical services costs are further described below.

Project Management

Project management, which can apply to either capital or O&M cost, includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of institutional controls (e.g., licensing).

- ***For capital costs, project management can be estimated using Exhibit 5-8. For O&M costs, project management generally ranges from 5 to 10 percent of total annual O&M cost.***

Remedial Design

Remedial design applies to capital cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases.

- ***The percentage of total capital cost for remedial design can be estimated using Exhibit 5-8.***

Construction Management

Construction management applies to capital cost and includes services to manage construction or installation of the remedial action, except any similar services provided as part of regular construction activities. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings.

- ***The percentage of total capital cost for construction management can be estimated using Exhibit 5-8.***

Technical Support

Technical support during O&M includes services to monitor, evaluate, and report progress of remedial action (i.e., all O&M professional/technical services not provided under project management). This includes oversight of O&M activities, update of O&M manual, and progress reporting.

- ***O&M technical support generally ranges from 10 to 20 percent of total annual O&M cost.***

An example of how professional/technical services cost elements would be estimated using percentages and added to the total of construction cost elements plus contingency is shown in Exhibit 5-9 for capital costs.

Exhibit 5-9
Example Estimation of Professional/Technical Services Costs

CONSTRUCTION SUBTOTAL	$2,463,465
Contingency (10% scope + 15% bid)	615,866
SUBTOTAL	$3,079,331
Project Management (5%)	153,967
Remedial Design (8%)	246,346
Construction Management (6%)	184,760
TOTAL	$3,664,404

5.6 Institutional Controls

Institutional controls, which can have one-time or recurring costs (capital, annual O&M, or periodic), are non-engineering or legal/administrative measures to reduce or minimize the potential for exposure to site contamination or hazards by limiting or restricting site access.

Examples include institutional controls plan, restrictive covenants, property easements, zoning, deed notices, advisories, groundwater use restrictions, and site information database. An institutional controls plan would describe the controls for a site and how to implement them. A site information database would provide a system for managing data necessary to characterize the current nature and extent of contamination.

Institutional controls are project-specific costs that can be an important component of a remedial alternative and, as such, should generally be estimated separately from other costs, usually on a sub-element basis. Institutional controls may need to be updated or maintained, either annually or periodically. Contingency is generally not applied to institutional control

cost elements. An example of how institutional controls cost elements would be estimated as for capital costs is shown in Exhibit 5-10.

Exhibit 5-10
Example Estimation of Institutional Controls Costs

Institutional Controls				
Institutional Controls Plan	1	EA	$5,000	$5,000
Groundwater Use Restriction	1	LS	$3,200	$3,200
Site Information Database	1	LS	$4,800	$4,800
SUBTOTAL				$13,000

5.7 Present Value Analysis

To allow for comparison of different alternatives on the basis of a single cost figure, the present value of capital, annual O&M, and periodic costs should be analyzed according to the procedures in Chapter 4. Discount factors, either single-year or multi-year, should be carefully selected depending on the period of analysis to which they are applied. An example present value analysis of the different types of cost for a remedial alternative is shown in Exhibit 5-11.

Exhibit 5-11
Example Present Value Analysis

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE
Capital Cost	0	$3,677,404	$3,677,404	1.000	$3,677,404
Annual O&M Cost	1-15	$4,590,763	$306,051	9.108	$2,787,511
Periodic Cost	5	$14,800	$14,800	0.713	$10,552
Periodic Cost	10	$14,800	$14,800	0.508	$7,518
Periodic Cost	15	$48,458	$48,458	0.362	$17,542
		$8,346,000			$6,501,000

5.8 Sensitivity Analysis

Sensitivity analysis is a type of uncertainty analysis that measures the project impact of changing one or more input values. In the development of a remedial alternative cost estimate, a sensitivity analysis should be considered for those factors that have a relatively-high degree of uncertainty and that, with only a small change in their value, could significantly affect the overall cost of the alternative. This type of analysis is considered separate from a "cost growth" or "cost risk" analysis used to determine the amount of

contingency to apply to the cost estimate (Section 5.4). However, a sensitivity analysis could be used to support a contingency analysis (e.g., to help select site-specific contingency factors).

Factors to consider in a cost sensitivity analysis for a remedial alternative include:

- Nature and Extent of Contamination – Estimated volumes of contaminated media or material and degree of contamination (i.e., concentrations) are dependent on assumptions about site conditions.
- Remedy Failure / Effective Life of Technology - The potential failure of a remedy or components thereof would require substantial additional costs for replacement of the remedy or its components. Particularly relevant for technologies or processes that are unproven and lack sufficient performance history.
- Project Duration – The time required for a remedial action, or components thereof, to achieve remedial action objectives can be a major factor, particularly for those actions requiring many years of O&M.
- Discount Rate – Although a rate of 7% should normally be used to compare alternatives, a range of values both below and above 7% can be used to investigate uncertainty concerning future economic conditions.

A sensitivity analysis might vary the values for these factors (e.g., low, medium, high), while keeping the values for other factors the same, and noting the impact on the total estimated cost. Advantages of a sensitivity analysis include:

- Helps identify critical factors where additional data collection resources may need to be spent during subsequent phases of remedial design.
- Provides potential answers to "what if" scenarios.
- Does not require the use of probabilities as do other methods, such as Monte Carlo analysis.

The results of a sensitivity analysis should be reported in terms of total present value for each scenario. The baseline, or original estimate, should be included for comparison. An example of how the results of a sensitivity analysis might be presented is shown in Exhibit 5-12. Scenario 1 is the baseline. In Scenario 2, the project duration is extended by ten years. In Scenario 3, a major capital expenditure is required in Year 8 (e.g., replacement of reactive iron in a treatment wall).

Exhibit 5-12
Example Sensitivity Analysis

YEAR	PRESENT VALUE COST 1	2	3
0	$3,677,404	$3,677,404	$3,677,404
1	$286,029	$286,029	$286,029
2	$267,317	$267,317	$267,317
3	$249,829	$249,829	$249,829
4	$233,485	$233,485	$233,485
5	$228,762	$228,762	$228,762
6	$203,935	$203,935	$203,935
7	$190,593	$190,593	$190,593
8	$178,124	$178,124	$1,358,767
9	$166,471	$166,471	$166,471
10	$163,104	$163,104	$163,104
11	$145,403	$145,403	$145,403
12	$135,890	$135,890	$135,890
13	$127,000	$127,000	$127,000
14	$118,692	$118,692	$118,692
15	$128,490	$116,291	$128,490
16		$103,670	
17		$96,888	
18		$90,549	
19		$84,626	
20		$82,914	
21		$73,915	
22		$69,080	
23		$64,560	
24		$60,337	
25		$65,318	
TOTAL	**$6,501,000**	**$7,280,000**	**$7,681,000**

1. Baseline - original estimate.
2. Project duration is increased by 10 years.
3. Reactive iron for treatment wall is replaced in Year 8.

5.9 Review Estimate

The last step in the process is to review the estimate for completeness. Exhibit 5-13 is a checklist to help review the cost estimate for a remedial alternative.

Exhibit 5-13
Key Questions to Ask when Reviewing a Remedial Alternative Cost Estimate

1. Has a description of the alternative been provided?

   - If so, are key processes or technologies identified per the development process and conceptual design of alternative?
   - Have the site, location, and project phase been noted?

2. Have the capital, annual O&M, and periodic cost element structures been fully developed?

   - Have all applicable construction or O&M activities costs elements been identified?
   - Have all applicable professional/technical services cost elements been identified?
   - Have all applicable institutional controls cost elements been identified?

3. Have quantities for construction and O&M activities cost elements been estimated with sufficient backup?

   - Have calculation sheets, drawings, vendor information, or similar supporting data been included?
   - Have assumptions used to estimate quantities been clearly identified?

4. Have unit costs for construction and O&M activities cost elements been estimated with sufficient backup?

   - Is the source of cost data identified? Is the source appropriate?
   - Are sub-elements described in sufficient detail with assumptions clearly identified?
   - Have all assumptions been taken into account?
   - Have labor, equipment, and materials been included?
   - Has crew production rate or cost been adjusted to account for inefficiency associated with health and safety level of protection?
   - If a cost has been taken from another estimate or a published cost reference, has it been adjusted it to account for different location (area cost factor) and for different time (escalation to base year)?
   - Has subcontractor, if applicable, and prime contractor markups (i.e., overhead, profit) been added?
   - Are the percentages used for overhead and profit appropriate?
   - Have any markups been duplicated?
   - Are quotations from suppliers and subcontractors documented in the backup?

5. Has contingency been applied to the total of construction or O&M activities costs?

   - Have both scope and bid contingency been considered?
   - Are the values used for percentages appropriate, considering the technologies utilized by the alternative?

Exhibit 5-13 (cont.)
Key Questions to Ask when Reviewing a Remedial Alternative Cost Estimate

6. Have the applicable professional/technical services costs been added?

   - If estimated on a percentage basis, are the values used appropriate, considering the total project cost and complexity?

7. If applicable, have the costs associated with implementing and maintaining institutional controls been estimated?

8. Were guidelines followed for the present value analysis?

   - Is the period of present value analysis different than the anticipated project duration (i.e., time required for design, construction, O&M, and closeout)? If so, is explanation provided?
   - Are all capital, annual O&M, and periodic costs included in the present value analysis?
   - Is the discount rate used consistent with USEPA policy (e.g., 7%)? If not, is explanation provided?
   - Is the same discount rate used across all of the alternatives analyzed?
   - If discount factors were used, have the appropriate single-year or multi-year factors been applied, considering the period of analysis for each type of cost (i.e., capital, annual O&M, periodic)?

9. Is there sufficient uncertainty for key factors to warrant a sensitivity analysis? If a sensitivity analysis was done, are results presented clearly in terms of total present value of the alternative?



Chapter Six

How to Document the Cost Estimate

Cost estimates of remedial alternatives developed during the FS should be documented within the FS report such that costs and underlying assumptions are clearly presented and understood. Documentation for the FS should be structured using the following three components:

- Detailed cost backup
- Cost summary of individual remedial alternatives
- Comparative cost summary of all remedial alternatives

These components are described further in the following three chapter sections. The fourth section provides information on post-RI/FS documentation of the cost estimate of the proposed or selected remedy.

6.1 Detailed Cost Backup

Detailed cost backup for remedial alternative cost estimates should be provided in an appendix to the FS report. This material can include cost calculation sheets, quantity calculation sheets, records of communication for vendor quotes, and conceptual design calculations. If cost estimating software is used to estimate all or part of the costs for remedial alternatives, input/output from these software applications should be provided as part of the detailed backup.

For each cost element or sub-element, a standard worksheet can be used to document the calculation of the total unit cost as shown in Exhibit 6-1 for the example of an SVE extraction well. This type of cost worksheet, together with quantity calculation sheets and other supporting information, can be used to trace each cost shown in the cost summary of an alternative to its underlying assumptions.

6.2 Individual Cost Summary

The cost estimate of each remedial alternative should be presented in a one- to two-page cost summary table such as the example shown in Exhibit 6-2. The individual cost summary should present all capital costs, annual O&M costs, any periodic costs, and present value analysis for the remedial alternative. The cost summary should be an activity-based format that identifies all cost elements and sub-elements of the alternative. Individual cost summaries should be provided within the individual analysis section of the FS report or within a cost estimate appendix to the FS report.

6.3 Comparative Cost Summary

The total estimated cost for all remedial alternatives should be presented within the comparative analysis section of the FS report in a summary table such as the example shown in Exhibit 6-3. Alternatively, costs for remedial alternatives can be compared as part of the

detailed analysis table, typically provided in FS reports to compare the alternatives against each of the nine NCP criteria. The total cost presented for each alternative should include total capital cost, annual O&M cost, total periodic cost (if any), and total present value. The project duration in years should be noted as this impacts the present value analysis. It should also be noted when the period of present value analysis differs from the project duration. If there are different annual O&M costs for different periods of time, this may need to be broken out in the comparative cost summary.

6.4 Cost Estimate of Proposed or Selected Remedy

Following the RI/FS, as part of the remedy selection process, the cost estimate of the selected remedy is summarized in the record of decision (ROD). In addition, cost information for proposed remedies that meet certain cost-based criteria is submitted to the National Remedy Review Board (NRRB) for review. The following paragraphs, primarily intended for the audience of remedial project managers and program managers, provide more detail on these two topics.

Record of Decision

The same type of one- to two-page format shown in Exhibit 6-2 for remedial alternative cost estimates developed during the FS can be used to present the cost summary of the selected remedy in the ROD. During remedy selection, the preferred alternative presented in the proposed plan can undergo changes as a result of public comment or new information such as additional site characterization data. Any changes to the selected remedy should be reflected in the cost summary presented in the ROD. In addition, if the remedy selection process has spanned a considerable amount of time (e.g., more than 1 year), the estimated costs should be escalated to a new base year. Standard cost estimate disclaimer language should be added to acknowledge the uncertainty associated with cost estimates (see highlight box to right). For more information on the presentation of estimated remedy costs in the ROD, see *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents* (USEPA 1999).

Standard Cost Estimate Disclaimer Language

"The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the administrative record file, an explanation of significant differences, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within –30 to +50 percent of the actual project cost."

Source: *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA 1999)

National Remedy Review Board

The NRRB is a peer review group comprised of USEPA managers and senior technical policy experts that reviews proposed Superfund cleanup decisions meeting cost-based review criteria to assure that they are consistent with Superfund law, regulations, and guidance. In general, the NRRB reviews those cleanup decisions that exceed specific cost criteria. For

more information on the NRRB, its procedures, and cost criteria that trigger reviews, visit *http://www.epa.gov/superfund/programs/nrrb/*.

The following provides guidance for submitting remedy cost estimate information to the NRRB that should accompany briefing materials to allow the NRRB to more accurately assess the cost-effectiveness of the proposed remedy:

1. The summary materials should contain sufficient information to provide an estimate of total resource costs over time (i.e., life cycle costs). Pursuant to the NCP, this estimate should include the capital costs, annual operations and maintenance costs, and net present value of capital and O&M costs. Cost information should be provided for the preferred alternative, as well as each alternative evaluated in the detailed analysis of the FS (or which will be listed in the proposed plan).

2. Cost estimate summaries should address the following:

    a. The key cost components/elements for both RA and O&M activities;

    b. The major sources of uncertainty in the cost estimate;

    c. The discount rate used;

    d. The time expected to achieve remedial action objectives and remediation goals;

    e. Periodic capital and/or O&M costs anticipated in future years of the project (e.g., remedy replacement or rebuild);

    f. The methods and resources used for preparing the cost estimate (e.g., estimating guides, vendor quotes, computer cost models).

3. For "contingency remedy decisions," the total project costs for implementing the contingency should be provided in addition to the costs for the conditional action. This estimate should include treatability study costs, if applicable.

4. The assumptions used to develop the cost estimate should be consistent with the stated remedial action objectives and remediation goals (e.g., duration of the cost estimate should match time to achieve cleanup objectives).

This kind of information is generally considered useful in other management-level review settings as well.

Exhibit 6-1
Example Cost Worksheet

Alternative 3
Capital Cost Sub-Element
SVE EXTRACTION WELL

COST WORKSHEET

Site: Former Industrial Site
Location: Any City, Any State
Phase: Feasibility Study (-30% to +50%)
Base Year: 2000

Prepared By: MPM **Date:** 4/12/00
Checked By: JMR **Date:** 4/12/00

Work Statement:

Install SVE extraction well to total depth of 15 feet with 10-foot factory-slotted screen. Installation includes drilling with hollow-stem auger, continuous soil sampling, installation of 4-inch Schedule 40 PVC blank and screen with filter pack and grout seal, setup and decontamination, containerization of investigation-derived waste (IDW), and wellhead completion (concrete, flush-mount vault with lock, tee with valve and flexible coupling). Health and safety protection is Level D.

Cost Analysis:

Costs per extraction well:

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL	
Mob/demob	1	LS	-	-	-	100	100	% of mob/demob for all wells
Setup & Decon	1	HR	-	-	-	125	125	
Drill & Install	15	FT	-	-	-	55	825	Includes well materials
Wellhead Completion	1	LS	-	-	-	950	950	Includes vault, tee with fittings
IDW Handling	1	HR	-	-	-	175	175	Includes drums
Drilling Oversight	7	HR	110	-	-	110	770	$65/hr geo + $45/hr technician
SUBTOTAL							2,945	
Prime Contractor Overhead						15.0%	442	
SUBTOTAL							3,387	
Prime Contractor Profit						10.0%	339	
TOTAL UNIT COST							$3,725	

Source of Cost Data:

3-20-00 quote from John Smith, ABC Drilling Services, tel. no. 999-999-9999. Rates for geologist and technician are based on typical labor rates for area.

Cost Adjustment Checklist:

	FACTOR:	NOTES:
☑	H&S Productivity (labor & equip only)	Quote is for Level D.
☑	Escalation to Base Year	Current year (2000) is base year.
☑	Area Cost Factor	Quote is from local vendor.
☑	Subcontractor Overhead and Profit	Included in quote.
☑	Prime Contractor Overhead and Profit	Includes 15% overhead and 10% profit.

Exhibit 6-2
Example Remedial Alternative Cost Summary

Alternative 3
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: Former Industrial Site
Location: Any City, Any State
Phase: Feasibility Study (-30% to +50%)
Base Year: 2000
Date: April 12, 2000

Description: Alternative 3 consists of air sparging in combination with soil vapor extraction to treat soil and groundwater in the source area. Also includes passive treatment wall along leading edge of plume to treat groundwater migrating off-site. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-15. Periodic costs occur in Years 5, 10, and 15.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization / Demobilization					
Construction Equipment & Facilities	1	LS	$8,829	$8,829	Excavators, loaders, etc.
Submittals/ Implementation Plans	1	LS	$33,761	$33,761	QAPP, SSHP, etc.
Temporary Facilities & Utilities	1	LS	$49,664	$49,664	Fence, roads, signs, trailers, etc.
Post-Construction Submittals	1	LS	$14,469	$14,469	Post-const. reports
SUBTOTAL				$106,723	
Monitoring, Sampling, Testing, and Analysis					
Monitoring Wells - SVE	7	EA	$1,577	$11,040	Install to water table depth
Monitoring Wells - Trtmt. Wall - Shallow	5	EA	$2,965	$14,826	Shallow well at each of 5 clusters
Monitoring Wells - Trtmt. Wall - Deep	5	EA	$6,212	$31,061	Deep well at each of 5 clusters
Geotechnical Testing	17	EA	$230	$3,910	MW screen interval soil samples
SUBTOTAL				$60,838	
Site Work					
Clearing and Grubbing	5	AC	$1,161	$5,804	Work area
Seeding/Mulch/Fertilizer	5	AC	$1,427	$7,136	Revegetate work area
SUBTOTAL				$12,940	
Air Sparging / Soil Vapor Extraction					
Mobilize SVE System	1	EA	$1,534	$1,534	Mobile unit
Impermeable Surface Cover	105,000	SF	$0.84	$88,200	Low density polyethylene liner
SVE Extraction Wells	8	EA	$3,725	$29,803	4" wells to water table depth
AS Injection Wells	2	EA	$4,645	$9,290	Well depth = midpoint of aquifer
SVE System	1	EA	$93,510	$93,510	Mobile unit (250 scfm)
AS Blower	1	EA	$5,712	$5,712	
SVE Piping	400	LF	$8.66	$3,464	Pipe, valves, fittings, etc.
AS Piping	100	LF	$5.03	$503	Pipe, valves, fittings, etc.
Electrical Hookup	1	LS	$9,898	$9,898	
Startup and Testing	1	LS	$10,936	$10,936	
SUBTOTAL				$252,851	
Passive Treatment Wall					
Construct Slurry Trench	1,800	CY	$187	$337,194	Operate excavator/clamshell
Install Reactive Media	1,800	CY	$940	$1,691,370	Prepare & inject iron/guar gum slurry
SUBTOTAL				$2,028,564	
Off-Site Treatment / Disposal					
Off-Site Transport of Soil Cuttings	25	EA	$15	$375	Transport of drums to SWLF
Disposal of Soil Cuttings	25	EA	$35	$875	SWLF drum disposal fee
Wastewater Discharge/Testing	300	GAL	$1.00	$300	City fee - development water
SUBTOTAL				$1,550	
SUBTOTAL				$2,463,465	
Contingency	25%			615,866	10% scope + 15% bid
SUBTOTAL				$3,079,331	
Project Management	5%			153,967	
Remedial Design	8%			246,346	
Construction Management	6%			184,760	
Institutional Controls					
Institutional Controls Plan	1	EA	$5,000	$5,000	Describe controls / implementation
Groundwater Use Restriction	1	LS	$3,200	$3,200	Legal fees
Site Information Database	1	LS	$4,800	$4,800	Setup data management system
SUBTOTAL				$13,000	
TOTAL CAPITAL COST				**$3,677,404**	

Exhibit 6-2 (cont.)
Example Remedial Alternative Cost Summary

Alternative 3
IN SITU TREATMENT

COST ESTIMATE SUMMARY

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Performance Monitoring					
SVE Vapor Monitoring	96	EA	$308	$29,532	1 sample/month * 8 extraction wells
SVE Emissions Monitoring	12	EA	$308	$3,692	1 sample/month - SVE exhaust
Treatment Wall - Groundwater Sampling	4	QTR	$2,449	$9,795	Sample 10 wells/qtr
Treatment Wall - Groundwater Lab Analysis	4	QTR	$5,714	$22,856	Analysis for above
SUBTOTAL				$65,875	
Site Monitoring					
Groundwater Sampling	4	QTR	$1,820	$7,280	Sample 8 wells/qtr VOCs, WQ, metals
Groundwater Laboratory Analysis	4	QTR	$5,460	$21,839	Analysis for above
SUBTOTAL				$29,119	
Air Sparging / Soil Vapor Extraction					
Operations Labor	12	MO	$6,120	$73,440	136 manhours per month
Maintenance Labor	12	MO	$720	$8,640	16 manhours per month
Equipment Repair	1	LS	$500	$500	
Utilities	12	MO	$1,928	$23,134	Electricity + fuel
SUBTOTAL				$105,714	
Off-Site Treatment / Disposal					
Wastewater Discharge/Testing	1,600	GAL	$1.00	$1,600	City fee - purge & knockout water
SUBTOTAL				$202,308	
Contingency	30%			60,692	10% scope + 20% bid
SUBTOTAL				$263,001	
Project Management	5%			13,150	
Technical Support	10%			26,300	
Institutional Controls - Site Info Database	1	LS	$3,600	$3,600	Update and maintain database
TOTAL ANNUAL O&M COST				**$306,051**	

PERIODIC COSTS:

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Five Year Review Report	5	1	EA	$12,000	$12,000	1 report at end of Year 5
Update Institutional Controls Plan	5	1	EA	$2,800	$2,800	Update plan
SUBTOTAL					$14,800	
Five Year Review Report	10	1	EA	$12,000	$12,000	1 report at end of Year 10
Update Institutional Controls Plan	10	1	EA	$2,800	$2,800	Update plan
SUBTOTAL					$14,800	
Demobilize AS/SVE System	15	1	LS	$21,375	$21,375	Remove equipment and piping
Well Abandonment	15	27	EA	$350	$9,450	
Contingency (% of Sum)		25%			7,706	% of construction activities
Project Mgt. (% of Sum + Cont.)		5%			1,927	% of construction + contingency
Remedial Action Report	15	1	EA	$8,000	$8,000	
SUBTOTAL					$48,458	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$3,677,404	$3,677,404	1.000	$3,677,404	
Annual O&M Cost	1-15	$4,590,763	$306,051	9.108	$2,787,511	
Periodic Cost	5	$14,800	$14,800	0.713	$10,552	5-year review, update i.c. plan
Periodic Cost	10	$14,800	$14,800	0.508	$7,518	5-year review, update i.c. plan
Periodic Cost	15	$48,458	$48,458	0.362	$17,542	Demob, abandon, RA report
		$8,346,000			$6,501,000	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$6,501,000**	

Exhibit 6-3
Example Comparative Cost Summary

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: Former Industrial Site
Location: Any City, Any State
Phase: Feasibility Study (-30% to +50%)
Base Year: 2000
Date: April 12, 2000

DESCRIPTION	Alternative 1 No Action	Alternative 2 Limited Action/ Natural Attenuation	Alternative 3 In Situ Treatment	Alternative 4 Ex Situ Treatment
Total Project Duration (Years)	0	30	15	15
Capital Cost	$0	$147,000	$3,677,000	$5,300,000
Annual O&M Cost	$0	$41,000	$306,000	$146,000
Total Periodic Cost	$0	$68,000	$72,000	$43,000
Total Present Value of Alternative	**$0**	**$690,000**	**$6,501,000**	**$6,649,000**



Chapter Seven
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Appendix A
Internet Resources

This appendix provides a list of Internet resources that may be useful for the development of cost estimates of remedial alternatives during the FS. USEPA and USACE cannot endorse nor vouch for the content of any web site other than their own. All listed web site addresses were current at the time of appendix publication. In addition to description of content, the following icons are used next to resource listings to indicate what type of information each contains:

- Policy
- Technical
- $ Cost
- Software/Database
- Publication

These identifiers are used separately or together, depending on the resource. Exhibit A-1 presents Internet resources that are sponsored and maintained by government agencies and organizations. Exhibit A-2 presents private or non-government Internet resources. Major resource categories in Exhibit A-1 include:

- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- U.S. Department of Energy
- U.S. Department of Defense
- Other or Interagency

Major categories in Exhibit A-2 for non-government resources include:

- Private Firms/Companies
- Professional Societies/Organizations

Exhibit A-1
Internet Resources – Government

U.S. Environmental Protection Agency (USEPA)
http://www.epa.gov/

USEPA Superfund 🏛 📖 🛠 *http://www.epa.gov/superfund/*

The USEPA administers the Superfund program through the Office of Solid Waste and Emergency Response (OSWER) in cooperation with individual states and tribal governments. Superfund locates, investigates and cleans up the nation's hazardous waste sites. The web site provides information on the technical resources, initiatives, programs, and accomplishments of the Superfund program. Resources include:

- **Rules of Thumb for Superfund Remedy Selection** 📖
  http://www.epa.gov/superfund/resources/rules/index.htm

  This guidance document outlines key principles and procedures that should be consulted during the Superfund remedy selection process.

- **Role of Cost in the Superfund Remedy Selection Process** 📖
  http://www.epa.gov/superfund/resources/cost_dir/index.htm

  This document outlines the role of costs in the Superfund remedy selection process as established in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and current EPA guidance documents.

- **A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents** 📖 *http://www.epa.gov/superfund/resources/remedy/rods/index.htm*

  This document provides recommended formats and content for Superfund remedial action decision documents, clarifies roles and responsibilities of regulatory agencies and stakeholders in the remedy selection process, and explains how to address changes made to proposed and selected remedies.

- **Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis (OSWER Directive 9355.3-20)** 🏛 📖 *http://www.epa.gov/superfund/*

  Contains USEPA policy on the use of discount rates for RI/FS cost analyses.

- **Presumptive Remedies** 🏛 📖 🛠 *http://www.epa.gov/superfund/resources/presump/index.htm*

  In an effort to streamline investigations and remedy selection, presumptive remedy guidance has been or will be developed for volatile organic compounds in soil, municipal landfills, metals in soils, wood treaters, and contaminated groundwater.

- **National Oil and Hazardous Substances Pollution Contingency Plan (NCP)** 🏛 📖
  http://www.epa.gov/docs/epacfr40/chapt-I.info/subch-J/

  Contains regulatory requirements for the RI/FS process (Title 40 Code of Federal Regulations, Part 300, Subpart E, Section 300.430).

Symbol Key: 🏛 Policy 🛠 Technical $ Cost 🖫 Software/Database 📖 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

USEPA OSWER *http://www.epa.gov/swerrims/*

The Office of Solid Waste and Emergency Response (OSWER) develops guidelines and standards for the land disposal of hazardous wastes and for underground storage tanks. OSWER furnishes technical assistance in the development, management and operation of solid waste activities and analyzes the recovery of useful energy from solid waste. In addition, OSWER has undertaken the development and implementation of a program to respond to abandoned and active hazardous waste sites and accidental release (including some oil spills) as well as the encouragement of innovative technologies for contaminated soil and groundwater. OSWER resources include:

- **Federal Facilities Restoration and Reuse** *http://www.epa.gov/swerffrr/*
- **Solid and Hazardous Waste** *http://www.epa.gov/epaoswer/osw/index.htm*
- **Brownfields** *http://www.epa.gov/swerosps/bf/*
- **Superfund** *http://www.epa.gov/superfund/index.htm*
- **Technology Innovation** *http://www.epa.gov/swertio1/index.htm*
- **Underground Storage Tanks** *http://www.epa.gov/swerust1/*

USEPA – Publications *http://www.epa.gov/epahome/publications.htm*

Provides access to USEPA technical and public information. Resources include:

- **USEPA – National Service Center for Environmental Publications (NSCEP)**
  http://www.epa.gov/ncepihom

  Formerly known as NCEPI, NSCEP is a central repository for all EPA documents with over 5,500 titles in paper and/or electronic format, available for free distribution. The web site contains the National EPA Publications Catalog where documents can be browsed and ordered online.

- **National Environmental Publications Internet Site (NEPIS)**
  http://www.epa.gov/ncepihom/nepishom

  EPA's largest electronic documents site allows you to search view and print, including full images of all original pages and full-text, from a collection of over 7,000 archival and current documents. This collection may include documents that are no longer available in print form.

USEPA SITE Program *http://www.epa.gov/ORD/SITE*

USEPA's Superfund Innovative Technology Evaluation (SITE) Program encourages the development and implementation of innovative treatment technologies for hazardous waste site monitoring and remediation. The SITE program gathers engineering and cost data to assess the performance of treatment technologies. The information provided is intended to assist in evaluating and screening potential remediation technologies and in selecting a remedial alternative.

- **SITE Reports** *http://www.epa.gov/ORD/SITE/reports*

  This page provides links to SITE Reports including general reports, demonstration program reports, and emerging technology program reports.

Symbol Key: Policy Technical $ Cost Software/Database Publication

Exhibit A-1 (cont.)
Internet Resources – Government

USEPA Office of Research and Development 🕮 🛠 *http://www.epa.gov/ORD*

The USEPA's web site for research and development provides information pertaining to environmental and human health problems. The Office of Research and Development (ORD) focuses on the advancement of scientific research and the implementation of cost-effective technologies. ORD labs include the National Risk Management Research Lab, which includes:

- **Technology Transfer** 🕮 *http://www.epa.gov/ttbnrmrl/*

  Technology Transfer contains publications including guides, handbooks, summary reports and seminars on pollution prevention, monitoring, and treatment technologies.

USEPA – Office of Underground Storage Tanks 🕮 🏛 *http://www.epa.gov/swerust1/index.htm*

EPA's Office of Underground Storage Tank's (OUST) web site. OUST's goal is to provide current information relevant to the Federal underground storage tank (UST) program. The web site offers compliance assistance, UST publications, law/regulation information, and cleanup information. Resources include:

- **USEPA – Cleanup of UST System Releases** 🕮 🛠 *http://www.epa.gov/swerust1/cat/index.htm*

  This page contains UST cleanup resources, including general information, site characterization, remediation technologies, sampling, and monitoring.

U.S. Army Corp of Engineers (USACE)
http://www.usace.army.mil/

USACE - HTRW Center of Expertise 🏛 🕮 🛠 *http://www.environmental.usace.army.mil/*

The Hazardous, Toxic, and Radioactive Waste Center of Expertise (HTRW CX) provides general information regarding numerous technical areas including environmental regulations and laws, innovative technologies, environmental risk assessments, and environmental engineering. HTRW CX also provides general assistance to U.S. Army Corp of Engineer offices involved in environmental programs. The HTRW CX homepage contains technical information and guidance for cleaning up sites contaminated with hazardous, toxic, or radioactive waste. Technical resources include innovative technologies, process engineering, and costs. Resources include:

- **The TSDF Report** 🕮 🛠 $ *http://www.environmental.usace.army.mil/library/pubs/tsdf/tsdf.html*

  The Report on Treatment, Storage & Disposal Facilities (TSDF) for Hazardous, Toxic, and Radioactive Waste is designed to provide information, including costs, regarding the disposal of RCRA Subtitle C hazardous wastes and recycling of selected solid wastes.

- **Environmental Lessons Learned Program** 🕮 🛠
  http://www.environmental.usace.army.mil/library/lessons/lessons.html

  The Lessons Learned program was created to provide a means of identifying problem areas in the HTRW program; collect ideas on solutions, new technology and better methods; and to distribute those lessons learned.

- **Environmental Guidance Documents** 🕮 🛠
  http://www.environmental.usace.army.mil/library/guide/guide.html

  This page provides a link to environmental guidance documents including engineering manuals, pamphlets, technical letters, regulations, and guidance specifications.

- **Cost Engineering Resources** 🏛 🕮 🛠
  http://www.environmental.usace.army.mil/info/technical/cost/cost.html

  This page contains information regarding cost engineering resources of the HTRW CX. Links are provided to guidance, training materials, tools and databases, etc.

Symbol Key: 🏛 Policy 🛠 Technical $ Cost 🖫 Software/Database 🕮 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

USACE – Cost Engineering Branch 🏛 📖 🛠 💾 **$** *http://www.hq.usace.army.mil/cemp/e/ec/ec_new.htm*

This is the home web site for the Cost Engineering and Programs Formulation Branch of the USACE. This branch is responsible for all aspects of cost engineering for the USACE. Links to various web sites related to cost information and other initiatives can be found on this web page. Resources include:

- **Economic Analysis for Military Construction** 🛠 💾 $
  http://www.hq.usace.army.mil/cemp/e/ec/econ/econ.htm

  This page contains links to economic analysis information including updated inflation and discount rates.
- **Regulations and Guidance Documents** 🏛 📖 🛠 *http://www.hq.usace.army.mil/cemp/e/ec/ec-regs.htm*

  This page contains links to regulation and guidance documents including:
  - Engineering and Design Cost Engineering Policy and General Requirements
  - Area Cost Factor Index
  - Military Construction Cost Index
  - Programming Cost Estimates for Military Construction
  - Economic Studies for Military Construction Design Applications

USACE – TRACES 📖 💾 🛠 **$** *http://www.hnd.usace.army.mil/traces/*

TRACES is the Tri-Services umbrella linking all automated cost engineering systems and their associated databases. Contained within this web site are links to information on various modules and other sources of cost information. Check the following sites for more specific information:

- **Micro Computer Assisted Cost Engineering System (MCACES)** 💾 🛠 $
  http://www.hnd.usace.army.mil/traces/mcaces.asp

  MCACES is a multi-user software program used for the preparation of detailed construction cost estimates for military, civil works, and HTRW programs.
- **Historical Analysis Generator (HAG)** 💾 🛠 $ *http://www.hnd.usace.army.mil/traces/hag.asp*

  The Historical Analysis Generator (HAG) is a software tool for analyzing and reporting historical cost data of past construction projects. The tool was developed by Building Systems Design, Inc. for the Tri-Service Cost Engineer Committee.
- **Life Cycle Cost (LCC)** 💾 🛠 *http://www.hnd.usace.army.mil/traces/lcc.asp*

  The Life Cycle Cost (LCC) module is a DOS-based stand-alone program that provides cost engineers with the capability of developing life cycle cost analyses.

USACE – Publications 📖 🛠 *http://www.usace.army.mil/inet/usace-docs/*

The collection of publications on this web site is the repository for all official USACE engineering regulations, circulars, manuals, and other documents originating from USACE headquarters. Many of the publications can be downloaded in electronic format. These include:

- **Engineering Instructions EI 01D010: Construction Cost Estimates**
  http://www.hnd.usace.army.mil/techinfo/ei.htm

Symbol Key: 🏛 Policy 🛠 Technical **$** Cost 💾 Software/Database 📖 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

U.S. Department of Energy (USDOE)
http://www.doe.gov/

USDOE – Environmental Management (EM) 🏛 📖 🛠 💾 *http://www.em.doe.gov*

In 1989, the Office of Environmental Restoration (ER) was created within the newly established Office of Environmental Management (EM) to consolidate, centralize and promote the cleanup of contaminated waste sites and surplus facilities within the DOE Complex. The DOE Environmental Restoration Program is involved in assessment and cleanup activities at 132 sites throughout the United States and in Puerto Rico. Check the following sites for more specific information:

- **Pollution Prevention in the Environmental Restoration Program** 📖 🛠
  http://www.em.doe.gov/p2/index.html

  This web site offers tools, resources, and guidance to assist in environmental cleanup projects.

- **Environmental Restoration Lessons Learned** 📖 🛠 *http://www.em.doe.gov/lessons/index.html*

  The EM Lessons Learned program evaluates the lessons learned relevant to environmental management business and functional areas to improve efficiencies and effectiveness, reduce risk and waste, and accelerate remediation project closure.

- **Decommissioning of Facilities** 🏛 📖 🛠 *http://www.em.doe.gov/dd/index.html*

  This page provides information on policy and guidance, a downloadable version of the Decommissioning Benchmarking Study, and links to site-specific decommissioning pages and lessons learned.

- **Cost & Performance Document** 📖 🛠 *http://www.em.doe.gov/costperf/index.html*

  The purpose of this DOE document is to facilitate the use of consistent procedures to document cost and performance information for environmental cleanup projects.

USDOE – EM – Applied Cost Engineering 📖 🛠 *http://www.em.doe.gov/aceteam/*

The Environmental Restoration (ER) Applied Cost Engineering (ACE) Team was established to promote continuous cost improvements through dissemination of cost engineering tools, methods, techniques, best practices, and lessons learned. Resources include:

- **Cost Engineering Links** 📖 🛠 *http://www.em.doe.gov/aceteam/links.html*

  This page provides links to cost engineering resources on the Internet.

USDOE – EM – Remedial Action Program Information Center (RAPIC) 🛠 💾 📖
http://www.em.doe.gov/rapic

RAPIC provides technical information support to the DOE Environmental Restoration (ER) Program. Information includes decontamination and decommissioning (D&D) and remedial action (RA) activities, technology development, and research at sites and facilities contaminated with radioactive and/or hazardous materials. Resources include:

- **Environmental Restoration Document Information System (ERDIS)** 📖
  http://www.em.doe.gov/rapic/6erdis.html

  The Environmental Restoration Document Information System (ERDIS), is an online document locator resource sponsored by the USDOE Office of Environmental Restoration.

Symbol Key: 🏛 Policy 🛠 Technical $ Cost 💾 Software/Database 📖 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

USDOE –EM – Preferred Alternatives Matrices (PAMs) 🕮 🛠 *http://www.em.doe.gov/define*

The DOE's Preferred Alternatives Matrices provide information, background and descriptions of commercially available soil and groundwater remediation technologies. PAMs evaluate the available technologies ranking them on the basis of performance, risk of technology failure, and cost. The goal of this effort is to implement "the right technology, at the right time, at the right site."

USDOE – Environmental Technology Cost-Savings Analysis Plan 🛠 🖫 $
http://www.lanl.gov/projects/etcap/home.html

This web site contains information about the Environmental Technology Cost-Savings Analysis Project (ETCAP), sponsored by Los Alamos National Laboratory (LANL). This compendium provides a representative sample of cost information for environmental remediation technologies used in the treatment of hazardous, radioactive, and mixed waste. Data was gathered from a variety of sources and summarized herein to provide actual cost summaries or engineering cost estimates, site characteristics, and comments detailing remedial projects.

USDOE – National Energy Technical Laboratory 🛠 *http://www.netl.doe.gov/*

The National Energy Technical Laboratory (NETL) performs, procures, and sponsors technical research, development, and demonstration to advance technology into the commercial marketplace, thereby benefiting the environment. Their web site contains links to information on environmental projects and innovative technologies. The NETL was formerly known as the Federal Energy Technology Center (FETC).

U.S. Department of Defense

U.S. Air Force Civil Engineer Support Agency (AFCESA) 🛠 $ 🕮 🖫 *http://www.afcesa.af.mil/*

The Air Force Civil Engineer Support Agency provides tools, practices and professional support to maximize Air Force civil engineer capabilities in base and contingency operations. AFCESA consists of four directorates: Operations Support, Technical Support, Contingency Support; and Civil Engineer Maintenance, Inspection and Repair Team - Field Support. The Civil Engineering division of the Technical Support Directorate provides expertise in cost estimating; structural, water, wastewater, drainage and pavement systems; as well as in airfield marking, arresting and barrier systems. Resources include:

- **Cost Engineering Program** 🛠 $ 🕮 🖫
  http://www.afcesa.af.mil/Directorate/CES/Civil/CostEngr/CostEngr.htm

  The AFCESA Cost Engineering Program develops and maintains methodologies, cost models, and associated databases to estimate and analyze construction, environmental, and life cycle costs of Air Force facilities. Links to automated tools and guides/handbooks are provided on the web site.

Symbol Key: Policy 🛠 Technical $ Cost 🖫 Software/Database 🕮 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

Other or Interagency

Federal Remediation Technologies Roundtable (FRTR) 🕮 🛠 🖫 $ *http://www.frtr.gov/*

The Federal Remediation Technologies Roundtable (FRTR) is an interagency working group seeking to build a more collaborative atmosphere among the federal agencies involved in hazardous waste site remediation. By providing such opportunities, the Roundtable hopes to identify and publicize more efficient, cost-effective solutions to the Federal government's hazardous waste challenges. Members include major developers and users of these technologies: Department of Defense, U.S. Army, U.S. Army Corps of Engineers, U.S. Navy, U.S. Air Force, U.S. Department of Energy, Department of the Interior, and the U.S. Environmental Protection Agency. Check the following sites for more specific information:

- **Cost and Performance Reports** 🕮 🛠 $ *http://www.frtr.gov/cost/*

  This page presents case studies and abstracts containing available cost and performance information for full-scale remediation efforts and numerous large-scale demonstration projects.

- **Environmental Cost Engineering Committee (EC2)** 🕮 🛠 $ *http://www.frtr.gov/cost/info/ec2.html*

  This page provides information on the work of the interagency EC2 group, including newsletters, listing of projects, and work products. Includes links to the Historical Cost Analysis System (HCAS) and the HTRW remedial action (RA) and operation and maintenance (O&M) work breakdown structures:

  HCAS *http://www.frtr.gov/cost/ec2/HCAS_OVERVIEW.htm*

  HTRW RA and O&M WBS *http://www.frtr.gov/cost/ec2/wbs1.html*

- **Remediation Technology Infobase** 🕮 🛠 *http://www.frtr.gov/publications/infobase98.html*

  This page contains a list of resources for information on Federal cleanup programs and remediation technologies.

- **Technology Demonstration** 🕮 🛠 *http://www.frtr.gov/demonstration.html*

  This page contains links to various technology demonstration projects.

- **Technology Development** 🕮 *http://www.frtr.gov/techdev/index.html*

  This page contains links to environmental technology resources on the Internet.

- **Remediation Screening Matrix** 🕮 🛠 $ *http://www.frtr.gov/matrix2/top_page.html*

  The Treatment Technologies Screening Matrix is a comprehensive guide intended to screen and evaluate candidate technologies for environmental cleanup projects and used to assist in selecting a remedial alternative. The guide incorporates performance and cost data allowing the user to screen for potential treatment technologies and to assign a relative probability of success. The guide can be accessed using a table of contents, screening matrix, or a search engine.

- **Sampling & Analysis Matrix** 🕮 🛠 $ *http://www.frtr.gov/site/*

  The sampling and analysis matrix assists in choosing cost-effective site characterization technologies so that the impact on human health and the environment can be properly evaluated.

- **Publications** 🕮 *http://www.frtr.gov/pubs.html*

  This page provides a list of FRTR publications.

Symbol Key: Policy 🛠 Technical $ Cost 🖫 Software/Database 🕮 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

Groundwater Remediation Technologies Analysis Center (GWRTAC) 🕮 🛠 $ *http://www.gwrtac.org*

The Groundwater Remediation Technologies Analysis Center (GWRTAC) compiles, analyzes, and disseminates information on innovative groundwater remediation technologies. The data contains information on past performance, cost, and applicability. The information provided is intended to assist in evaluating and screening potential remediation technologies and in selecting a remedial alternative. Resources include:

- **Vendor Information** 🕮 🛠 *http://www.gwrtac.org/html/vendors.html*

  This page provides vendor information for groundwater remediation technologies.

- **Technical Reports** 🕮 🛠 $ *http://www.gwrtac.org/html/techdocs.html*

  This page contains groundwater and environmental technical reports available online.

Remedial Technologies Development Forum (RTDF) 🕮 🛠 *http://www.rtdf.org*

The purpose of the RTDF is to "identify what government and industry can do together to develop and improve the environmental technologies needed to address their mutual cleanup problems in the safest, most cost-effective manner." The RTDF consists of several action teams including:

The Bioremediation Consortium
The Lasagna Partnership
INERT Soils – Metal Team
Phytoremediation of Organics Team
Permeable Reactive Barriers Team
In-Situ Flushing Team
Sediments Remediation Team

Detailed information on each of these teams can be found on this web site, including technical documents, processes, and other resources.

Global Network of Environment and Technology (GNET) 🕮 🛠 *http://www.gnet.org*

GNET provides daily news and up-to-date information on current environment and technology issues. Resources include:

- **TechKnow** 🕮 🖫 🛠 $ *http://www.techknow.org*

  TechKnow is GNET's free interactive database of innovative remediation and environmentally sustainable technologies.

Johnson Space Center - Cost Estimating Group 🕮 🛠 🖫 *http://www.jsc.nasa.gov/bu2/index.html*

This is NASA's cost estimating web site, containing resources, publications, software and tools pertaining to cost estimating.

Symbol Key: 🏛 Policy 🛠 Technical $ Cost 🖫 Software/Database 🕮 Publication

Exhibit A-1 (cont.)
Internet Resources – Government

Hazardous Waste Cleanup Information *http://www.clu-in.org/*

This web site, maintained by the USEPA Technology Innovation Office (TIO), provides information on hazardous waste innovative treatment technologies. It contains links to available products, software, remediation technology descriptions, regulatory information, vendor information, and other online resources for hazardous waste remediation. Check the following sites for more specific information:

- **Site Remediation Technologies** *http://www.clu-in.org/remed1.htm*

  This page contains technical data, publications, and resources for site remediation technologies.

- **TechDirect** *http://www.clu-in.org/techdrct/default.htm*

  TechDirect is a free information service providing information, new publications, and events of interest for site remediation and site assessment professionals.

- **Bioremediation in the Field Search System** *http://www.clu-in.org/products/moreinfo/bfss.htm*

  The Bioremediation in the Field Search System is a database of information of waste sites where bioremediation is being tested, implemented or has been completed.

- **Site Characterization** *http://www.clu-in.org/char1.htm*

  This page contains technical data, publications, and resources for site characterization techniques.

- **Regulatory Information** *http://www.clu-in.org/reg1.htm*

  This page contains technical data, publication, and resources on environmental regulatory information.

- **Vendor Support** *http://www.clu-in.org/supply1.htm*

  Vendor support contains information to direct technology vendors and developers to the appropriate funding sources and to provide technical support for all stages of development.

- **Internet and Online Resources** *http://www.clu-in.org/resourc1.htm*

  This page contains links to technical resources available on the Internet.

U.S. Office of Management and Budget (OMB) *http://www.whitehouse.gov/OMB*

OMB's predominant mission is to assist the President in overseeing the preparation of the Federal budget and to supervise its administration in Executive Branch agencies. OMB ensures that agency reports, rules, testimony, and proposed legislation are consistent with the President's budget and with Administration policies. In addition, OMB oversees and coordinates the Administration's procurement, financial management, information, and regulatory policies. Resources include:

- **OMB Circular No. A-94** *http://www.whitehouse.gov/omb/circulars/a094/a094.html*

  OMB Circular No. A-94 presents guidelines on discount rates to be used in evaluating time-distributed costs and benefits.

Symbol Key: Policy | Technical | $ Cost | Software/Database | Publication

Exhibit A-2
Internet Resources – Non-Government

Private Firms/Companies

Building Systems Design (BSD), Inc. $ 🖫 *http://www.bsdsoftlink.com/*

BSD is a firm that develops software for the architectural, engineering, and construction industry. Links and information are provided on BSD CostLink software, as well as products developed for government use such as MCACES for Windows and the Life Cycle Cost (LCC) module.

Craftsman Book Company 🕮 🖫 *http://www.craftsman-book.com/*

Craftsman Book Company publishes estimator costbooks that include: National Construction Estimator, National Repair & Remodeling Estimator, National Electrical Estimator, National Plumbing & HVAC Estimator, National Painting Cost Estimator, and National Renovation & Insurance Estimator. Information about their National Estimator software is also available.

D4Cost 2000 🕮 🖫 *http://www.d4cost.com/*

This web page provides a description, online demonstrations, and other information for the D4Cost 2001 Building Cost Modeling Tool.

Decisioneering - Crystal Ball 🕮 🖫 *http://www.decisioneering.com/crystal_ball/index.html*

This web page provides information and demonstrations of Crystal Ball, an advanced modeling tool for risk analysis.

Engineering News Record 🕮 **$** *http://www.enr.com/*

This is the online resource for the Engineering News Record periodical. This site provides various information related to engineering, costs, and a comprehensive listing of companies, affiliated with ENR, and their profiles. Check the following sites for more specific information:

- **ENR's Cost Indexes** 🕮 $ *http://www.enr.com/cost/cost1.asp*

  ENR publishes both a Construction Cost Index and Building Cost index that are used in the construction industry. This web site contains an explanation of the index methodology.

GLOBALtechs 🛠 🖫 *http://www.globaltechs.com/index.html*

GLOBALtechs is an online remediation technologies directory containing information on over 650 remediation technologies available worldwide.

National Technology Transfer Center Web Site (Environmental) 🛠 🖫
http://www.nttc.edu/environmental.html

The National Technology Transfer Center web site provides online resource for technology summaries. This web site offers links to environmental resources.

- **Envirotrade** 🛠 http://www.nttc.edu/env/

  Envirotrade provides detailed summaries for numerous environmental technologies.

Estimating Systems Inc. 🕮 🖫 *http://www.estimatingsystems.com/*

Estimating Systems Inc. manufactures Pulsar, a PC-based construction cost-estimating package. Pulsar uses R.S. Means Cost Data.

Symbol Key: Policy 🛠 Technical **$** Cost 🖫 Software/Database 🕮 Publication

Exhibit A-2 (cont.)
Internet Resources – Non-Government

G2 Estimator 🕮 🖫 *http://www.g2estimator.com/*

G2 Estimator is a Windows-based estimating software package, produced by Valli Information Systems, Inc. Information on G2 Estimator and other G2 products are found on this web site.

Independent Project Analysis, Inc. 🕮 🖫 *http://www.ipaglobal.com/*

Independent Project Analysis, Inc. (IPA) provides project evaluation and project system benchmarking services. IPA has developed detailed, carefully normalized databases of projects executed around the world. The databases cover the project life cycle from business idea through early production. IPA has used these databases to develop statistical tools that allow for performance comparisons among projects.

Marshall & Swift 🕮 🖫 **$** *http://www.marshallswift.com/*

Marshall & Swift publishes various cost books for construction, remodeling, and renovation. Information on their products can be found on their web site.

Project Time and Cost, Inc. 🛠 *http://www.ptcinc.com/*

Project Time and Cost, Inc. (PT&C) is a national cost management firm, providing services to the design and construction industry. Environmental cost management services offered by PT&C include feasibility studies, activity-based cost estimating, risk analysis, and cost engineering.

Remedial Technologies Network 🕮 🛠 🖫 **$** *http://www.enviroglobe.com/*

RTN's web site, EnviroGlobe, contains information, news, support, and databases on environmental technologies, including the RIMS2000 database. RIMS2000 is a large database of environmental technology information. The information provided is intended to assist in evaluating and screening potential remediation technologies and in selecting a remedial alternative.

R.S. Means, Inc. 🕮 🖫 **$** *http://www.rsmeans.com/*

R.S. Means offers construction cost estimating and management resources. More information and links to cost information and software is available on their web page.

Saylor Publications, Inc. 🕮 🖫 **$** *http://www.saylor.com/*

The web page includes descriptions and ordering information for Saylor's Cost Manuals and software. Additionally, a labor cost index is presented online.

Sweet's Group 🕮 🖫 *http://www.sweets.com/*

The Sweet's system consists of a variety of print and electronic products for architect, engineering and construction (AEC) professionals. Does not contain cost data, but does list specific vendors of building products that can be used to obtain quotes.

Symbol Key: Policy 🛠 Technical **$** Cost 🖫 Software/Database 🕮 Publication

Exhibit A-2 (cont.)
Internet Resources – Non-Government

Talisman Partners, Limited 🕮 🖫 *http://www.talpart.com/*

Talisman Partners, Limited is a consulting firm that provides services in the areas of facility management, construction, operations and maintenance, and environmental restoration. Products include proprietary data, tools and systems for analysis and decision making, management consulting services, and training. Check the following sites for specific information:

- **RACER Environmental Remediation Cost Estimating Software** 🖫 **$**
  http://www.talpart.com/products/racer/index.html

  Remedial Action Cost Engineering and Requirements (RACER) is a Windows-based environmental remediation cost estimating system.

- **ECHOS Environmental Remediation Cost Data Books** 🕮 🖫 **$**
  http://www.talpart.com/products/echos/index.html

  ECHOS Cost Data Books provide assemblies costs data and unit cost data for environmental remediation projects.

- **Environmental Remediation Estimating Procedures Handbook** 🕮
  http://www.talpart.com/products/handbook/index.html

  Environmental Remediation Estimating Procedures Handbook is a step by step guide for estimating environmental remediation cost.

- **Tank RACER** 🖫 **$** *http://www.talpart.com/products/tankracer/index.html*

  Tank RACER is a Windows-based cost estimating system that was developed specifically to address storage tank and petroleum-related assessment and remediation.

Tecolote Research, Inc. 🕮 🖫 *http://www.tecolote.com/*

The Tecolote Research web page contains useful links to the software and services they provide. Links to detailed information on numerous software programs, including ACEIT, COETS, IFTS, PC-DATS, and SCANS, are also included.

Thomas Register of American Manufacturers 🕮 🖫 *http://www.thomasregister.com/*

The Thomas Register is a series of manuals containing information for companies in the U.S. The Online Catalog contains detailed buying information about a company's products or services. This site requires the a membership to obtain information.

Timberline Software Corporation 🕮 🖫 *http://www.timberline.com/*

Timberline Software Corporation is an international supplier of accounting and cost estimating software for the construction and property management industries. Their web site provides information about Timberline's products, training, support and upcoming events.

TSD Central $ *http://www.tsdcentral.com/*

TSD Central is an online source of direct pricing for waste management, cleanup, and transportation services from vendors across the country.

Symbol Key: Policy Technical $ Cost 🖫 Software/Database 🕮 Publication

Exhibit A-2 (cont.)
Internet Resources – Non-Government

U.S. Cost, Inc. 🕮 🖫 *http://www.uscost.com/*

U.S. COST has developed the estimating software Success. Success is US Cost's integrate estimating and cost management program. Technical and ordering information is available on the following page:

- **Success - Integrated Estimating & Cost Management** 🖫 *http://www.uscost.com/success4.htm*

Professional Societies/Organizations

Association for the Advancement of Cost Engineering (AACE) 🏛 🕮 🖫 *http://www.aacei.org/*

The AACE International web page contains links to publications, online forums, software/data vendors, professional organizations and other information for the cost engineer.

American Society of Professional Estimators (ASPE) 🏛 🕮 🖫 ***http://www.cmpi.com/aspe/***

The American Society of Professional Estimators serves construction estimators by providing education, fellowship, and professional development opportunities. Links to more information can be found on their web site.

Environmental Technology Council (ETC) 🕮 🛠 $ ***http://www.etc.org/index.cfm***

The ETC is a trade organization of commercial environmental firms that recycle, treat and dispose of industrial and hazardous wastes; and firms involved in cleanup of contaminated sites. A compilation of low, average, and high landfill and incinerator cost data for different types of wastes, based on a survey of ETC members, can be found at:

- **Incinerator and Landfill Cost Data (January 2000) $** *http://www.etc.org/costsurvey3.cfm*

International Cost Engineering Council (ICEC) 🏛 🕮 🛠 🖫 *http://www.icoste.org/*

International Cost Engineering Council (ICEC) is a worldwide confederation of cost engineering, quantity surveying, and project management societies. The web page provides links to many international resources for cost and project management information and other technical papers.

The Society of Cost Estimating and Analysis (SCEA) 🏛 🕮 🛠 🖫 *http://www.erols.com/scea/*

SCEA is an organization dedicated to improving cost estimating and analysis in government and industry, and enhancing the professional competence and achievements of its members. The web page contains links to various cost resources.

Symbol Key: 🏛 Policy 🛠 Technical $ Cost 🖫 Software/Database 🕮 Publication

THROW THIS PAGE AWAY

Appendix B
Cost Adjustment Factors

This appendix provides information on how to calculate and apply cost adjustment factors, including those for escalation, area cost, and health and safety productivity.

Escalation

Costs that have been derived from sources that are one year old or more should be updated or escalated to the base year. This can be done using the following equation:

$$C_b = C_o (F_b / F_o)$$

where C_b is the base year or current cost, C_o is the old cost, F_b is the base year or current index factor, and F_o is the index factor for the old cost.

Escalation indexes are available from both private and public sources. Most are published on a monthly or annual basis. An example index is Engineering News Record's (ENR) building cost index, which is based on a 20-city average of labor rates for bricklayers, carpenters, and iron workers plus material costs for structural steel, portland cement, and lumber using a certain number of labor hours and material quantity. Monthly factors for this index, from January 1978 to July 2000, are shown in Exhibit B-1. The index is also available at *http://www.enr.com/cost/costbci.asp*.

Exhibit B-1
ENR Building Cost Index

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG.
1978	1609	1617	1620	1621	1652	1663	1696	1705	1720	1721	1732	1734	1674
1979	1740	1740	1750	1749	1753	1809	1829	1849	1900	1900	1901	1909	1819
1980	1895	1894	1915	1899	1888	1916	1950	1971	1976	1976	2000	2017	1941
1981	2015	2016	2014	2064	2076	2080	2106	2131	2154	2151	2181	2178	2097
1982	2184	2198	2192	2197	2199	2225	2258	2259	2263	2262	2268	2297	2234
1983	2311	2348	2352	2347	2351	2388	2414	2428	2430	2416	2419	2406	2384
1984	2402	2407	2412	2422	2419	2417	2418	2428	2430	2424	2421	2408	2417
1985	2410	2414	2406	2405	2411	2429	2448	2442	2441	2441	2446	2439	2428
1986	2440	2446	2447	2458	2479	2493	2499	2496	2504	2511	2511	2511	2483
1987	2515	2510	2518	2523	2524	2525	2538	2557	2564	2569	2564	2589	2541
1988	2574	2576	2586	2591	2592	2595	2598	2611	2612	2612	2616	2617	2598
1989	2615	2608	2612	2615	2616	2623	2627	2637	2660	2662	2665	2669	2634
1990	2664	2668	2673	2676	2691	2715	2716	2716	2730	2728	2730	2720	2702
1991	2720	2716	2715	2709	2723	2733	2757	2792	2785	2786	2791	2784	2751
1992	2784	2775	2799	2809	2828	2838	2845	2854	2857	2867	2873	2875	2834
1993	2886	2886	2915	2976	3071	3066	3038	3014	3009	3016	3029	3046	2996
1994	3071	3106	3116	3127	3125	3115	3107	3109	3116	3116	3109	3110	3111
1995	3112	3111	3109	3100	3096	3095	3114	3121	3109	3117	3131	3128	3112
1996	3127	3131	3135	3148	3161	3178	3190	3218	3246	3284	3304	3311	3203
1997	3332	3333	3323	3364	3377	3396	3392	3385	3378	3372	3350	3370	3364
1998	3363	3372	3368	3375	3374	3379	3382	3391	3414	3423	3424	3419	3391
1999	3425	3417	3411	3421	3422	3433	3460	3474	3504	3505	3498	3497	3456
2000	3503	3523	3536	3534	3558	3553	3545						

Area Cost Factors

Costs that are based on national averages or on geographic locations other than the site should be adjusted for location using area cost factors (ACFs). This can be done using the following equation:

$$C_s = C_o (F_s / F_o)$$

where C_s is the cost for the site location, C_o is the cost based on other location, F_s is the area cost factor for the site, and F_o is the area cost factor for other location.

ACFs are available from both private and public sources. Most are updated yearly for their publication. National and state averages for ACFs (current as of March 10, 2000), as maintained by the USACE for military construction use, are provided in Exhibit B-2 below, as an example. These factors are based on local construction costs of labor, material, and equipment, and other factors such as weather, climate, seismic, mobilization, overhead and profit, labor availability, and labor productivity. The most current ACFs can be downloaded through the USACE Cost Engineering Branch website at *http://www.hq.usace.army.mil/cemp/e/es/pax/321/321.pdf* .

Exhibit B-2
USACE Area Cost Factors as of March 10, 2000

Location	Area Cost Factor	Location	Area Cost Factor
Alabama	0.85	Nebraska	0.94
Alaska	1.61	Nevada	1.14
Arizona	0.98	New Hampshire	1.05
Arkansas	0.87	New Jersey	1.18
California	1.18	New Mexico	1.01
Colorado	1.03	New York	1.23
Connecticut	1.05	North Carolina	0.85
Delaware	1.02	North Dakota	1.04
Florida	0.87	Ohio	0.99
Georgia	0.85	Oklahoma	0.87
Hawaii	1.48	Oregon	1.10
Idaho	1.06	Pennsylvania	1.03
Illinois	1.15	Rhode Island	1.06
Indiana	0.99	South Carolina	0.87
Iowa	1.06	South Dakota	0.95
Kansas	0.93	Tennessee	0.87
Kentucky	0.94	Texas	0.82
Louisiana	0.89	Utah	1.03
Maine	1.06	Vermont	0.92
Maryland	0.89	Virginia	0.92
Massachusetts	1.12	Washington	1.07
Michigan	1.17	West Virginia	0.95
Minnesota	1.07	Wisconsin	1.14
Mississippi	0.87	Wyoming	0.99
Missouri	0.97	Washington, D.C.	0.95
Montana	1.13	National Average	1.00

Health and Safety Productivity

Unless effects are already accounted for, factors that reflect decreased productivity due to required health and safety levels of protection should be applied to costs for labor and construction equipment used in a crew makeup. The levels of protection, which are determined based on the hazards to workers that might be present at a hazardous waste site, are classified as follows:

- Level A: Fully encapsulating vapor-tight suit with full-facepiece, self-contained breathing apparatus (SCBA) or supplied-air respirator.
- Level B: Totally encapsulating suit, not necessarily vapor-tight, with full-facepiece SCBA or supplied-air respirator.
- Level C: Chemical protective, full body suit with full-face, canister air-purifying respirator.
- Level D: Basic work uniform (i.e., coveralls, gloves, hardhat, boots, faceshield or goggles). Modified Level D adds a chemical protective, full body suit (i.e., Level C without respirator).

Factors associated with decreased productivity due to protective equipment and clothing as described above include restricted mobility, heat stress requiring break time, and time for safety meetings, suit-up, suit-down, decontamination, and air tank changes. All of these factors reduce crew production rates.

As an example, the productivity factors used by the USACE for Hazardous, Toxic, and Radioactive Waste (HTRW) projects are shown in Exhibits B-3 and B-4, for light and heavy work, respectively, as published in *Construction Cost Estimates* (USACE 1997). The factors in these exhibits are based on a productivity study conducted in 1994 and are applied to crew production rates in the Unit Price Book (UPB), which are based on "clean" site conditions, to develop adjusted rates based on the health and safety level of protection. The decreased production rate has an impact on cost by either increasing the time required to complete the activity or prompting the cost engineer to add crews.

As an approximate method (e.g., development of cost estimate during FS), the inverse of these factors can be applied to the unadjusted cost of an element to reflect decreased productivity for that item. This can be done using the following equation:

$$C_l = C_o (1 / F_l)$$

where C_l is the cost for the assumed level of protection, C_o is the cost unadjusted for level of protection, and F_l is the productivity factor from Exhibit B-3 or B-4.

The productivity factors do not apply to material costs, treatment equipment costs, or other costs that do not include crew costs.

Exhibit B-3
HTRW Productivity Factors - Light Work

VARIABLES	U/M	LEVEL A			LEVEL B			LEVEL C			LEVEL D MODIFIED			LEVEL D		
		T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85
A. Standard Losses	Min	160	160	160	140	140	140	128	128	128	76	76	76	32	32	32
B. Scheduled / Heat Stress Breaks	Min	60	90	120	43	65	86	35	63	101	30	47	63	30	33	44
C. Dexterity Losses	Min	78	69	60	74	69	64	55	51	44	4	4	3	5	5	5
D. Total Time Lost per 8 hr MD	Min	298	319	340	257	274	290	218	242	273	110	127	142	67	70	81
E. Productive Time per 8 hr MD	Min	182	161	140	223	206	191	262	238	207	370	353	338	413	410	399
F. Productive Time on Clean Site	Min	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430
G. HTRW Productivity Factor		**0.42**	**0.37**	**0.33**	**0.52**	**0.48**	**0.44**	**0.61**	**0.55**	**0.48**	**0.86**	**0.82**	**0.79**	**0.96**	**0.95**	**0.93**

Notes: 1. Standard Losses account for all time losses independent of temperature variations. They include safety meetings, instructions, donning / doffing PPE, decontamination, switching air supply / filters, monitoring delays, and cleanup.

2. Scheduled / Heat Stress Breaks account for all paid rest periods per manday.

3. Dexterity Losses are based on subjective opinions of the percentage that PPE slows down a normal worker because of factors such as discomfort, clumsiness, weight, and restricted breathing and communication. The number of minutes actually worked is reduced by the percentage representing the average response for that particular PPE level.

4. Values for A, B, and C were derived by averaging the survey responses for each PPE level. Responses that varied greatly from the average were subject to omission at the author's discretion.

5. Total Paid Time = 480 minutes

6. 50 min delay on clean site = 10 min. safety meeting & instructions + 10 min. cleanup + 30 min. breaks

7. Calculations:
   - D = A + B + C
   - E = 480 - D
   - F = 480 - 50
   - G = E / F

   U/M = Unit of Measure
   MD = Man-Day
   Min = Minutes
   T = Temperature Farenheit

8. Level A protection is used in extreme emergency situations only. Productivity factors for Level A should be used with caution because they were extrapolated from 2 data points.

Source: Engineering Instructions (EI 01D0101) - Construction Cost Estimates (USACE 1997)

Exhibit B-4
HTRW Productivity Factors - Heavy Work

VARIABLES	U/M	LEVEL A			LEVEL B			LEVEL C			LEVEL D MODIFIED			LEVEL D		
		T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85	T < 70	70<T<85	T > 85
A. Standard Losses	Min	220	220	220	204	204	204	135	135	135	76	76	76	28	28	28
B. Scheduled / Heat Stress Breaks	Min	60	105	150	50	75	123	64	131	178	30	90	165	30	45	60
C. Dexterity Losses	Min	80	62	44	52	46	35	44	34	26	28	24	18	11	10	10
D. Total Time Lost per 8 hr MD	Min	360	387	414	306	325	362	243	300	339	134	190	259	69	83	98
E. Productive Time per 8 hr MD	Min	120	93	66	174	155	118	237	180	141	346	290	221	411	397	382
F. Productive Time on Clean Site	Min	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430
G. HTRW Productivity Factor		**0.28**	**0.22**	**0.15**	**0.40**	**0.36**	**0.27**	**0.55**	**0.42**	**0.33**	**0.80**	**0.68**	**0.51**	**0.96**	**0.92**	**0.89**

Notes: 1. Standard Losses account for all time losses independent of temperature variations. They include safety meetings, instructions, donning / doffing PPE, decontamination, switching air supply / filters, monitoring delays, and cleanup.

2. Scheduled / Heat Stress Breaks account for all paid rest periods per manday.

3. Dexterity Losses are based on subjective opinions of the percentage that PPE slows down a normal worker because of factors such as discomfort, clumsiness, weight, and restricted breathing and communication. The number of minutes actually worked is reduced by the percentage representing the average response for that particular PPE level.

4. Values for A, B, and C were derived by averaging the survey responses for each PPE level. Responses that varied greatly from the average were subject to omission at the author's discretion.

5. Total Paid Time = 480 Minutes

6. Delay on clean site = 10 min. safety meeting & instructions + 10 min. cleanup + 30 min. breaks

7. Calculations:
   D = A + B + C
   E = 480 - D
   F = 480 - 50
   G = E / F

   U/M = Unit of Measure
   MD = Man-Day
   Min = Minutes
   T = Temperature Farenheit

8. Level A protection is used in extreme emergency situations only. Productivity factors for Level A should be used with caution because they were extrapolated from 2 data points.

Source: Engineering Instructions (EI 01D0101) - Construction Cost Estimates (USACE 1997)



Appendix C
Example Cost Templates

The following pages provide example summary sheets for capital costs, annual O&M costs, periodic costs, present value analysis, and sensitivity analysis. Also provided is example cost worksheet that can be used to calculate and provide backup for cost element or sub-element unit costs used in an estimate.

Alternative:
Name:

CAPITAL COST SUMMARY

Site: _____ **Description:** _____
Location: _____ _____
Phase: _____ _____
Base Year: _____ _____
Date: _____ _____

DESCRIPTION	QUAN-TITY	UNIT	UNIT COST	TOTAL	NOTES

Alternative:
Name:

ANNUAL O&M COST SUMMARY

Site: _____ **Description:** _____
Location: _____ _____
Phase: _____ _____
Base Year: _____ _____
Date: _____ _____

DESCRIPTION	QUAN-TITY	UNIT	UNIT COST	TOTAL	NOTES

Alternative:
Name:

PERIODIC COST SUMMARY

Site: _____ **Description:** _____
Location: _____ _____
Phase: _____ _____
Base Year: _____ _____
Date: _____ _____

DESCRIPTION	QUAN-TITY	UNIT	UNIT COST	TOTAL	NOTES

Alternative:
Name:

PRESENT VALUE ANALYSIS

Site: _____ **Description:** _____
Location: _____ _____
Phase: _____ _____
Base Year: _____ _____
Date: _____ _____

YEAR	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE

Alternative:
Name:

SENSITIVITY ANALYSIS

Site: _____ **Description:** _____
Location: _____ _____
Phase: _____ _____
Base Year: _____ _____
Date: _____ _____

YEAR	PRESENT VALUE COST (Per Factor Evaluated - See Below)				
	1	2	3	4	5

Alternative:
Element:
Sub-Element:

COST WORKSHEET

Site: _____
Location: _____
Phase: _____
Base Year: _____

Prepared By: _____ **Date:** _____

Checked By: _____ **Date:** _____

Work Statement:

Cost Analysis:

Source of Cost Data:

Cost Adjustment Checklist:

	FACTOR:	NOTES:
☐	H&S Productivity (labor & equip only)	_____
☐	Escalation to Base Year	_____
☐	Area Cost Factor	_____
☐	Subcontractor Overhead and Profit	_____
☐	Prime Contractor Overhead and Profit	_____



Appendix D

Glossary

Capital Costs: Expenditures required to construct a remedial action. They are exclusive of costs required to operation or maintain the action.

Constant (Real) Dollars: Observed dollar values that are not affected by general price inflation. Typically used during FS cost estimating to compare relative prices over time.

Contingency: An amount added to a cost estimate to cover costs associated with unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the data on hand at the time the estimate is prepared. Can include both scope (design) contingency, to cover costs due to scope changes during design, and bid (construction) contingency, to cover unknown costs associated with constructing or implementing a given project scope.

Cost Element: An activity identified for a remedial alternative that is used to estimate both capital, annual O&M, or periodic costs and help define the project. Cost element categories include construction activities, O&M activities, professional/technical services, and institutional controls.

Cost Engineering: The practice of total cost management over the life cycle of a project, facility, or manufacturing operation. Components include cost estimation, cost control, project management, planning, scheduling, and profitability analysis.

Cost Estimate: An evaluation of all the costs of the elements of a project or effort as defined by an agreed-upon scope.

Discount Rate: The interest rate used in calculating the present value of expected future costs. A nominal discount rate is an interest rate that has not been adjusted for any change in the general price level (inflation). Nominal interest rates are those that usually may be observed in the market, such as the published rate on a savings account or a bond. Nominal interest rates should be used to discount costs that are in current, or nominal, dollars. A real discount rate is an interest rate that has been adjusted to account for the effect of expected or actual inflation. Real interest rates can be approximated by subtracting the expected or actual inflation rate from a nominal interest rate. Real interest rates should be used to discount costs that are in constant, or real, dollars, which is the typical situation for FS present value analyses.

Life Cycle Cost: The total cost across the life span of a project, including design, construction, operation and maintenance, and closeout activities. Includes initial capital costs plus any continuing costs of operation and maintenance. For the purposes of this guide, excludes costs prior to design, such as investigation and study costs, and excludes government or program management costs.

Nominal (Current) Dollars: Values as they are observed in the market when transactions occur. Nominal dollars are real dollars that have been escalated to reflect the effects of inflation.

O&M Costs: Post-construction costs necessary to ensure continued effectiveness of a remedial action. Includes both short-term O&M and long-term O&M costs. Most O&M costs are estimated on an annual basis.

Periodic Costs: Capital or O&M costs that occur only once every few years or only once during the entire project timeframe. Because of their periodic nature, these costs are usually considered separately in the estimating process from initial capital or annual O&M costs.

Present Value: The present value of a future investment or payment that is calculated using a particular discount or interest rate. Total present value is the amount of money, which, if invested in the current year, would be sufficient to cover all the costs over time associated with a project.

Sensitivity Analysis: A type of uncertainty analysis that measures the project impact of changing one or more input values. For remedial alternative cost estimates, sensitivity analyses are typically completed for those factors that have a relatively high degree of uncertainty and that, with only a small change in their value, could significantly affect the overall cost of the alternative.

Unit Cost: A cost per unit of measure that is usually multiplied by a quantity to estimate the cost of an element or sub-element within the cost estimate of a remedial alternative. A unit cost is typically adjusted for decreased crew productivity, escalation to base year, geographic location, contractor markups (e.g., overhead, profit), and other factors, depending on the source of cost data (e.g., quotes, cost references, historical data).

Geology and Ground-Water Resources of Outagamie County Wisconsin

By E. F. LEROUX

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CONTENTS

	Page
Abstract	1
Introduction	2
Purpose and scope	2
Method of investigation	2
Acknowledgments	3
Previous reports	3
Description of the area	3
Location and extent	3
Culture	4
Topography	4
Drainage	5
Climate	5
Geologic units and their water-bearing properties	6
Precambrian rocks	6
Paleozoic rocks	8
Cambrian system	8
Upper Cambrian series	8
Ordovician system	9
Prairie du Chien group	9
St. Peter sandstone	11
Platteville formation and Galena dolomite	12
Maquoketa shale	12
Cenozoic rocks	13
Quaternary system	13
Pleistocene deposits	13
Recent deposits	14
Bedrock structure	14
Bedrock topography	15
Geologic history	16
Ground water	17
Source and movement	17
Water levels	19
Use	24
Wells	24
Springs	38
Pumping tests	39
Seymour tests	39
Appleton test	41
Hortonville tests	41
Quality	41
Conclusions	44
Well logs	44
Literature cited	54
Index	57

ILLUSTRATIONS

[All plates in pocket]

PLATE 1. Map of Outagamie County, Wis., showing location of wells.
2. Map of the bedrock geology of Outagamie County, Wis.
3. Geologic sections of Outagamie County, Wis.
4. Bedrock-surface map of Outagamie County, Wis.
5. Map of Outagamie County, Wis., showing the piezometric surface in April 1954.
6. Hydrographs of wells at Seymour, Wis., during pumping test.
7. Logarithmic diagrams for water-analysis data, Outagamie County, Wis.

Page

FIGURE 1. Average monthly temperature and precipitation, Outagamie County, Wis ---- 6
2. Histogram (*A*) and cumulative-frequency curve (*B*) for a sandstone of Cambrian age, Outagamie County, Wis ---- 8
3. Water level in well Ou 2, Kaukauna, Wis ---- 19
4. Water levels in two wells and cumulative departure from normal precipitation during 1947–55, Outagamie County, Wis ---- 20

TABLES

TABLE 1. Description and water-bearing characteristics of geologic units in Outagamie County, Wis ---- 7
2. Specific capacity and yield factor of wells in the Upper Cambrian series ---- 10
3. Specific capacity and yield factor of wells in the St. Peter sandstone ---- 11
4. Calculated movement of water to the southeast in Outagamie County, Wis ---- 18
5. Water levels in wells in Outagamie County, Wis ---- 21
6. Records of wells in Outagamie County, Wis ---- 25
7. Distances, in feet, between pumped well and observation wells used during pumping tests at Seymour, Wis ---- 40
8. Coefficients of transmissibility and storage at Seymour, Wis., Apr. 18–22, 1949 ---- 40
9. Chemical analyses of ground water in Outagamie County, Wis ---- 42
10. Materials penetrated by wells in Outagamie County, Wis. (Interpretation by F. T. Thwaites) ---- 45
11. Materials penetrated by wells in Outagamie County, Wis. (Interpretation by the author) ---- 50

GEOLOGY AND GROUND-WATER RESOURCES OF OUTAGAMIE COUNTY, WISCONSIN

By E. F. LeRoux

ABSTRACT

Outagamie County is in east-central Wisconsin. It has no serious ground-water problem at present, but the county is important as a recharge area for the principal aquifers supplying water to Brown County and industrial Green Bay to the east.

The county is covered by glacial drift and lake deposits of the Wisconsin stage of glaciation. In the northwestern quarter of the county these deposits rest upon Precambrian crystalline rocks; throughout the remainder of the county they are underlain by sandstone, limestone, dolomite, and shale of Cambrian and Ordovician age. Where they are sufficiently thick, and where more productive formations are absent, glacial sand and gravel are an important source of ground water. The major sources, however, are the St. Peter sandstone, of Ordovician age, and the sandstones of the Upper Cambrian series. The Precambrian crystalline rocks, which underlie all the county, yield little or no water to wells.

The regional dip of the Paleozoic bedrocks is 25 to 30 feet per mile eastward and southeastward. There are no major folds, but the thickness of each geologic unit may change from place to place because of predepositional or postdepositional erosion. There is no conclusive evidence of major faulting in the area.

Ground water in Outagamie County occurs under both water-table (unconfined) and artesian (confined) conditions. The source of the ground water is precipitation which falls on the surface and percolates downward into the underlying permeable materials. Regional movement of ground water in the eastern third of the county is controlled by the bedrock structure, and the discharge is toward the east and south. Throughout the rest of the county the movement of water is controlled mainly by bedrock and surface topography, and the water moves toward the streams and bedrock valleys.

Water-level fluctuations follow definite patterns. Where the effects of pumping are at a minimum, water levels reach a high in April or May, decline through the summer months owing to natural discharge, and lack of recharge, and do not begin to recover until after the ground thaws in the spring. In areas of heavy pumping where this pattern is distorted, the lowest water levels occur in the early fall and recoveries begin in October or November after the period of heaviest pumping.

Pumpage in the county was estimated to be about 9.0 million gallons per day (mgd) in 1951 and 1952. Nearly half of this was for industrial, commercial, and public-supply use along the Fox River. Wells, most of which are drilled by the cable-tool method, range in diameter from 3 to 16 inches and in depth from 10 or 20 feet to 804 feet. In the alluvium and glacial drift 1¼- to 2½-inch driven wells are common.

Pumping tests were made to determine the hydraulic characteristics of the aquifers at Seymour, Appleton, and Hortonville. The average coefficient of transmissibility at Seymour is about 18,000 gpd per foot; at Appleton it is about 19,000 gpd per foot. The coefficients of storage are 0.00022 and 0.00015 at Seymour and Appleton, respectively. Movement of ground water out of the county, assuming an average transmissibility of 18,000 gpd per foot, was calculated to be more than 10 mgd toward the southeast.

The ground water differs greatly in chemical quality from well to well, but it is generally a very hard calcium magnesium bicarbonate water, some of it high in iron. To aid in determining the source of well waters, 22 chemical analyses were plotted on a logarithmic diagram to obtain characteristic patterns for waters from several geologic sources.

INTRODUCTION

PURPOSE AND SCOPE

The study of ground-water conditions in Outagamie County described in this report was made by the U. S. Geological Survey in cooperation with the University of Wisconsin. The report includes a discussion of the geology of the area, the occurrence of ground water, the hydrologic properties of the aquifers, and the chemical quality of the water. Hydrologically the county is important as a recharge area for the principal aquifers underlying Brown County and Green Bay to the east. The present study is, in part, supplemental to the investigation of Brown County published as U. S. Geological Survey Water-Supply Paper 1190. There is no serious ground-water problem at present in Outagamie County, and this report is presented as a compilation and summary of available data for use in conjunction with the expected expansion of agriculture and industry in the county.

METHOD OF INVESTIGATION

A canvass of wells and systematic collection of other data were begun in 1951 by W. C. Walton. The investigation was continued and expanded in 1952 and 1953 by V. T. McCauley. The geology was mapped and the fieldwork was completed by the author in 1954. The work was done under the general direction of A. N. Sayre, chief of the Ground Water Branch of the U. S. Geological Survey, and under the immediate supervision of W. J. Drescher, district engineer.

Water levels in several wells have been measured at intervals since 1947 as a part of a Statewide program, and an automatic water-level recorder has been in operation on well Ou 2 since December 1946. A continuing program of water-level measurements was begun in 1952. In April 1949 a pumping test was made at Seymour to determine the hydrologic properties of the water-bearing material at that location. This was followed by a test at Hortonville in 1953 and another in Appleton in 1954. The results of these tests were used to estimate rates of movement of ground water and to predict trends of the water levels in relation to pumping.

Reconnaissance geologic mapping of the county was done on Wisconsin Land Inventory maps at a scale of about 1 inch to the mile; most of the county has not been topographically mapped. Field mapping was based on examination of outcrops and land forms. Subsurface control is from drillers' logs and from logs based on examination of drill cuttings by F. T. Thwaites of the Wisconsin Geological Survey.

ACKNOWLEDGMENTS

The success and value of a study such as this depend in large part on the cooperation and assistance of local persons. The willing cooperation of well owners, well drillers, civil officials, and private citizens is greatly appreciated. The pumping tests would not have been possible without the cooperation of Walter Muehle, superintendent of the Seymour Water Department; Arthur Dunn, Hortonville water superintendent; Walter Schroder, president of the Fox Valley Canning Co.; and W. Segar of the Badger Consolidated Cooperative Dairy.

The author wishes especially to thank F. T. Thwaites, Wisconsin Geological Survey, for the use of his field notes and G. F. Hanson, State Geologist, for his review of the report.

Members of the Bureau of Sanitary Engineering, Wisconsin State Board of Health, contributed greatly to the report by giving access to files of well records and pumpage data. Chemical analysis of water samples, which were collected by members of the U. S. Geological Survey, was made by chemists of the Wisconsin State Laboratory of Hygiene.

PREVIOUS REPORTS

Martin (1932) presents a fairly complete list of early reports on the geology of Wisconsin. Reports by Chamberlin (1877), Weidman and Schultz (1915), and Thwaites (1943) contain much information pertinent to the geology and ground-water resources of Outagamie County. A soil survey by Whitson and others (1921) and a discussion of the geography of the Fox River valley by Whitbeck (1915) provide additional historical and geographical information.

DESCRIPTION OF THE AREA

LOCATION AND EXTENT

Outagamie County is in east-central Wisconsin, north of Lake Winnebago and southwest of Green Bay, between latitudes 44°14′ and 44°36′ N. and longitudes 88°11′ and 88°44′ W. (pl. 1). The county is rectangular, about 27 miles long, east-west, and 24 miles wide; it has an area of about 646 square miles. Appleton (1950 pop. 34,010) is the principal city and the county seat.

CULTURE

In 1950 the county's population was 81,722. About 61 percent of the population lives in the urban areas along the Fox River, about 20 percent on farms, and about 19 percent in villages.

More than 90 percent of the land was in farms in 1949. The farms are small, averaging about 109 acres as compared with 138 acres for the State. Seventy-eight percent are classed by the U. S. Census as dairy farms, and 89 percent of the farm income is from livestock and livestock products. The county ranks 7th in milk production (412,500,000 lbs. in 1953) and 13th in cheese production (15,587,000 lbs. in 1953) in the State.

Industrial growth has been due almost entirely to the abundant water and power furnished by the Fox River. The world's first hydroelectric central station started operation in Appleton in 1882, and electricity has played an important role in industrial development since that time. The principal industries are associated with food processing, and knitting, and the manufacture and processing of paper, wood products, metal products, and machinery. Closely associated with the growth and development of the area is Lawrence College, at Appleton, founded in 1847, 10 years before the city was incorporated.

TOPOGRAPHY

Only small, isolated areas in Outagamie County have been covered by adequate topographic mapping. The well altitudes and rock-outcrop altitudes used in this report were obtained with an aneroid altimeter using U. S. Coast and Geodetic Survey and U. S. Geological Survey bench marks for control. The highest altitude obtained by this method is 1,015 feet above mean sea level at the top of a drumlin along the north edge of sec. 33, T. 22 N., R. 16 E., about 3.5 miles east of Hortonville. This hill is probably the highest point in the county, although several other drumlins near Hortonville reach altitudes of more than 1,000 feet. The lowest measured well altitude (Ou 43) is 620 feet above mean sea level in Kaukauna. However, the lowest point in the county is about 600 feet where the Fox River enters Brown County, about 4.5 miles northeast of Kaukauna.

The county may conveniently be divided into three topographic units. The flat northwestern quarter, bounded on the south and east by the escarpment of the cuesta formed by rocks of the Prairie du Chien group, is covered by glacial-lake deposits and Recent flood-plain deposits. Along both sides of the Fox River is another area of relatively flat but well-drained land, formed by glacial-lake deposits. The remainder of the county is a gently rolling countryside of drumlins, moraines, and occasional small scarps and cliffs of bedrock exposed through thin glacial drift.

DRAINAGE

Essentially all of Outagamie County, except for the land drained by Duck Creek, is included within the Fox River drainage basin.

From the northern boundary of the county, near Leeman, the Wolf River flows parallel to the escarpment formed by the Prairie du Chien group southward through Shiocton to a point about 3 miles northeast of Hortonville, where it turns abruptly to the west and flows through New London. It is joined at Shiocton by the Shioc River, which drains the area north and west of Seymour, and at New London by the Embarrass River, which drains the extreme northwestern part of the county. The drainage basin of the Wolf River above New London has an area of about 2,240 square miles, about 400 square miles being in Outagamie County. The average daily discharge at New London is 1,793 cubic feet per second (cfs) (Paulsen and others, 1952). The Wolf River is a slow-moving, meandering stream as it traverses the flat, poorly drained northwestern quarter of the county. The gradient from Shawano, 47 miles upstream, to New London averages only about 0.8 foot per mile (Smith, 1908). From New London the river flows southwestward through Waupaca County and into Winnebago County, where it joins the Fox River, which flows into Lake Winnebago at Oshkosh.

The lower Fox River leaves the northwest corner of Lake Winnebago at Neenah-Menasha, about 5 river miles south of Appleton. In its 35-mile course to Green Bay it falls about 4.8 feet per mile (Smith, 1908). However, most of this fall is over rapids in the reach from Appleton to Kaukauna, where it drops nearly 10 feet per mile. At Rapide Croche Dam, about 12 miles downstream from Appleton, the average discharge is 4,242 cfs (Paulsen and others, 1952) from a drainage area of 6,150 square miles.

The remainder of the county is drained by Duck Creek, which flows generally south from Seymour, about 6.5 miles north of Little Chute, it turns abruptly to the northeast and flows between two prominent ridges out of the county and, 17 or 18 miles farther northeast, into Green Bay.

CLIMATE

The climate of Outagamie County is characterized by mild, humid summers and rather long, severe winters. The growing season averages 163 days at Appleton, 151 days at New London, and 134 days about 27 miles north of New London at Shawano. Four months of the year, December through March, have an average temperature below 32° F; the 5 months from May through September are generally free from frost (fig. 1). Average monthly temperatures range from a high of 70.9° F in July to a low of 16.2° F in January. The mean annual temperature is 43.6° F, which is 0.2° F above the annual mean for the

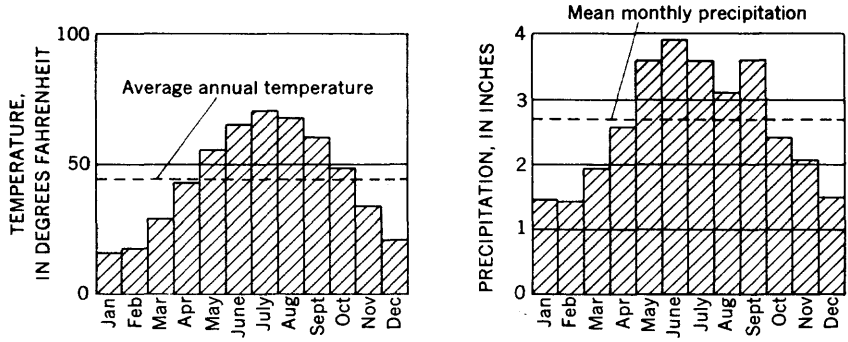

FIGURE 1.—Average monthly temperature and precipitation, Outagamie County, Wis. (Appleton, Green Bay, New London)

entire State. The average annual precipitation, including snow in the winter months, is 31.25 inches. The average ranges from 3.93 inches in June to 1.42 inches in February. Fortunately for agriculture, about 57 percent of the yearly precipitation falls during the growing season, May through September.

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

With the exception of the Precambrian granite, all the rock units discussed in the report and shown in table 1 are exposed at the surface in Outagamie County. The map showing bedrock geology (pl. 2) is based on the State geologic map (Bean, 1949). Modifications and changes were made in accordance with field observations and drillers' logs collected during the investigation.

PRECAMBRIAN ROCKS

The crystalline rocks of Precambrian age, which underlie all of Outagamie County, have been encountered in a number of wells throughout the area. They are usually reported to be pink, red, or gray coarse-grained granite or granite gneiss, which may or may not be weathered through the first several feet. Thwaites (1931) suggests that much of the weathered zone of kaolinitic clay, where present, may not be a product of subaerial weathering, but rather a product of alteration of the crystalline rocks by acidic ground water from the overlying sandstone. This theory is supported by the fact that some well drillers report a nongradational contact between the weathered zone and the overlying sandstone. No Precambrian rocks are exposed in Outagamie County. However, a prominent northwest-trending hill in Waupaca County, about 3 miles south-southwest of New London, is composed entirely of a moderate pink coarse- to medium-grained biotite granite intersected by numerous quartz veins.

TABLE 1.—*Description and water-bearing characteristics of geologic units in Outagamie County, Wis.*

System	Geologic unit	Maximum depth to top (feet)[1]	Maximum thickness (feet)[1]	Description		Water-bearing characteristics
				Drill cuttings [2]	Outcrop observations [3]	
Quaternary.	Recent river and swamp deposits.	0	?	----------	Silt, sand, and peat.	Not determined.
	Pleistocene deposits.	?	510	Glacial drift, mostly till; sand, clay, silt, gravel, boulders.	Glacial drift, mostly till, and lake clay. Moderate-red to dark-yellowish-orange silty clay; sand, gravel, silt, boulders.	Good yields where sufficiently thick. Flowing wells and seepage springs common. Only source of groundwater supply in northwest part of county.
Ordovician.	Maquoketa shale.	7	209	Shale, blue, dolomitic, calcareous; thin beds of shaly blue-gray dolomite.	Shale, light-bluish-gray, thin-bedded. Thin beds of dolomite.	Yields very small quantities of highly mineralized water to a few domestic and stock wells.
	Galena dolomite and Platteville formation, undifferentiated.	216	211	Dolomite, sandy, gray to bluish-gray. Sandstone, fine-to medium-grained, gray; usually near base of formation.	Dolomite, thin-bedded to blocky and massive. Greenish-gray to yellowish-gray; sandy, silty, oolitic in places.	Yields small amounts of water along bedding planes and from sandy zones.
	St. Peter sandstone.	424	171	Sandstone, fine- to coarse-grained, pink, gray, and white; some chert. Thin layers of sandy gray and red shale.	Sandstone, fine- to coarse-grained, well-rounded, soft, friable; banded pale-reddish-brown and grayish-orange, occasionally white.	Good yields, but limited by presence of shale and relatively small thickness of formation.
	Prairie du Chien group.	490+	235+	Dolomite, gray, pink, and red, commonly sandy and shaly; layers of chert. Sandstone, fine- to medium-grained, white. Shale, red and green.	Dolomite, usually massive, yellowish-gray; chert layers common. Occasional sandy and shaly zones.	Small quantities of water obtained from cracks and sandy zones.
Cambrian.	Upper Cambrian series.	490+	458+	Sandstone, very fine to coarse-grained; pink, white, gray, and red; occasionally shaly and dolomitic. Dolomite, soft, sandy, with red and greenish-gray dolomitic siltstone.	Sandstone, very fine to coarse-grained, well-rounded; interbedded soft, hard, and friable; pale yellowish-orange and white to medium-gray. Some pyrite.	Yields large amounts of water, especially from the lower portion which is less dolomitic.
Precambrian.		800		Granite, pink, gray, and red; weathered at the top.	Granite, coarse- to medium-grained, moderate-pink, biotitic. (Crops out in Waupaca County.)	Essentially impermeable. May yield some water from weathered and creviced zone.

[1] Based on well logs. [2] By F. T. Thwaites. [3] By E. F. LeRoux.

The crystalline rocks yield little or no water to wells. A very small amount might be obtained from cracks in the rock or from the weathered zone, but drilling usually ceases shortly after reaching granite.

PALEOZOIC ROCKS

CAMBRIAN SYSTEM

Upper Cambrian series.—Sandstones of Late Cambrian age (Dresbach sandstone, Franconia sandstone, and Trempealeau formation) are the principal source of water for industrial and public-supply wells in Outagamie County. They supply water to Seymour and Hortonville and to all the cities along the Fox River below Appleton. They are exposed in several places at the foot of the escarpment of the Prairie du Chien group (pl. 2) and in the Mosquito Hills, about 1½ miles east of New London. In outcrops the sandstones are very fine to coarse grained, ranging from pale yellowish orange to medium gray and white. Hard, well-cemented layers are interbedded with soft, friable layers. Some beds stand up well to weathering; others crumble and disintegrate rapidly. In drillers' logs (table 10) the section is reported as shaly, silty, and dolomitic in the upper part, grading into a fine- to medium-grained sandstone at the base.

A sample taken from an outcrop in the SE¼NE¼ sec. 4, T. 22 N., R. 15 E., had a remarkably symmetrical distribution of grain sizes (J. Lopez, written communication). The histogram in figure 2 shows

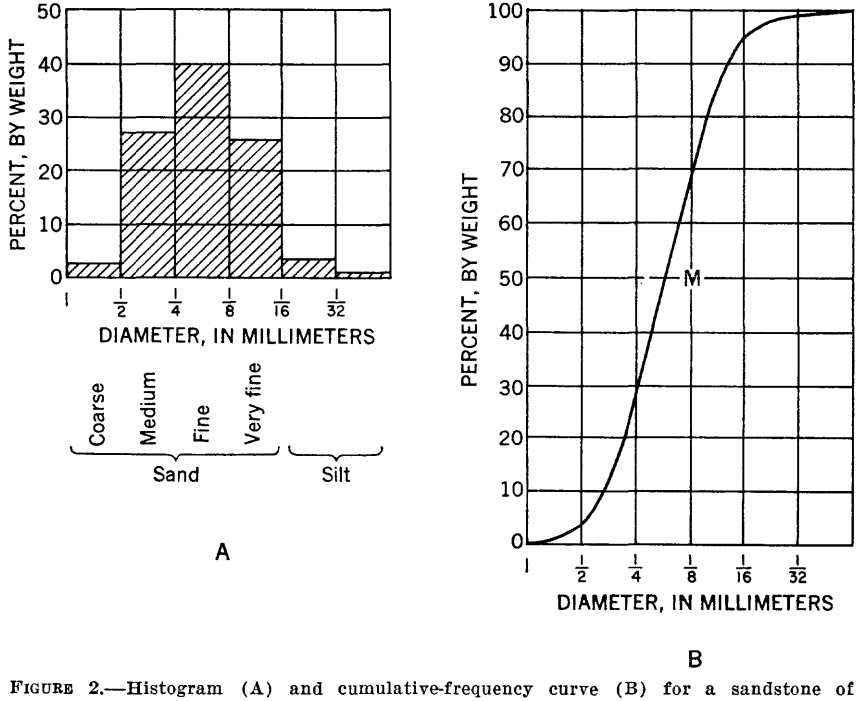

FIGURE 2.—Histogram (A) and cumulative-frequency curve (B) for a sandstone of Cambrian age, Outagamie County, Wis.

that about 40 percent of the grains were in the fine-sand range, the remainder being divided almost equally between the larger and the smaller sizes. The cumulative-frequency curve shows that the mean grain size is about $\frac{3}{16}$ mm (fine grained); it gives also a more exact picture of the gradation between grain size units in the sample.

Although the Upper Cambrian series is the most important aquifer in Outagamie County, a comparison of specific capacities and yield factors (tables 2 and 3) shows the St. Peter sandstone to have a much higher permeability. The specific capacity of a well (yield per unit of drawdown, generally expressed as gallons per minute per foot of drawdown) is an indication of both the water-yielding capacity of wells and the relative transmissibility of the water-bearing materials they penetrate. The yield factor (Poland and others) is an indication of the relative permeability of the water-bearing material. It is expressed as gallons per minute per foot of drawdown per 100 feet of aquifer penetrated. The specific capacity and yield factor of a well are representative of the water-bearing material within the area of influence of the well. In tests of short duration the area of influence is relatively small. As the well continues to pump, the area of influence expands and the specific capacity and yield factor may change, owing to changes in the character of the water-bearing material sampled by the expanding cone of influence. For this reason, comparisons between tests of equal length are the most consistent.

Table 2 summarizes the available data on specific capacity and yield factor for 16 wells. Wells Ou 19, 23, and 280 in Appleton have almost identical yield factors, as do the two wells in Seymour. The lower yield factors for the wells in Kimberly, Little Chute, and Kaukauna indicate lower permeability. Drillers' logs of these wells show that the water-bearing material is finer grained and contains more silt and siltstone than that penetrated by the wells in Appleton. The relatively high yield factors of the remaining wells may be due to their location near the outcrop area or may reflect the smaller dicharge and shorter duration of the tests.

ORDOVICIAN SYSTEM

Prairie du Chien group.—The Prairie du Chien group of Ordovician age, the Lower Magnesian of early reports, is composed of the Oneota dolomite, the New Richmond sandstone, and the Shakopee dolomite (Thwaites, 1923), but it was not subdivided in this investigation. It is best exhibited in the prominent escarpment which forms the southern and eastern boundaries of the flat northwestern quarter of Outagamie County. It is exposed also in many active quarries where rock is obtained for use as road material. An interesting feature of several of these quarries (that in the SE¼SE¼ sec. 17, T. 24 N., R. 17 E., for example) is the domelike structure that is revealed.

These domes are quite characteristic of the Prairie du Chien group. They are composed of concentric layers over a core of brecciated dolomite (Chamberlain, 1883).

TABLE 2.—*Specific capacity and yield factor of wells in the Upper Cambrian series*

Well no. Ou—	Specific capacity [a]	Yield factor [b]	Length of test (hrs)	Average discharge (gpm)	Thickness of aquifer penetrated (ft)	Location	Well diameter (in.)
1	7.4	2.7	24	421	[c] 276	Seymour	10
10	8.6	2.8	24	310	305	do	12
19	8.7	5.4		165	160	Appleton	8
23	13	5.7	18	550	229	do	10
33	15	5.4	24	310	282	Hortonville	
34	5.5	1.4	6	887	407	Kimberly	12
35	3.6	.9		524	420	do	12
37	5.0	1.3		497	382	Little Chute	12
46	5.0	1.5	30	340	123	Kaukauna	10
47	2.7	2.3		234	117	do	10
168	7.1	12	4	250	59	Black Creek (5 miles south)	8
200	1.4	13	4	7	11	Dale	4
269	12	12	4	35	97	Black Creek (3 miles south)	6
272	5.0	8.3	4	30	60	Shiocton (4 miles south)	6
273	.9	1.6	4	20	[d] 58	do	6
280	29	5.8	10	1,200	[e] 500	Appleton	15

[a] Gallons per minute per foot of drawdown.

[b] $\frac{\text{Specific capacity} \times 100}{\text{Thickness of aquifer penetrated (feet)}}$

[c] Includes 65 feet of St. Peter sandstone which contributes water to the well.

[d] Includes 40 feet of hard, non-water-bearing sandstone. If this is not included the yield factor becomes 5.0.

[e] Includes 70 feet of St. Peter sandstone which contributes water to the well.

The weathered surface of the rock is pale brown to pale yellowish brown; fresh surfaces are yellowish gray. Sandy and shaly zones and layers of chert are exposed in some outcrops. Thwaites (1923) states that the presence of oolitic chert is a reliable marker of the Prairie du Chien group, as it has never been found in adjacent dolomite formations. In drillers' logs the rock is described as gray, pink, or red dolomite that is often sandy or shaly. Lenses of fine- to medium-grained white sandstone are found throughout the section, as are thin layers of red or green shale.

The dolomite is dense, and water is transmitted through vertical fractures and along bedding planes and solution channels. The sandstone lenses also supply some water to wells, but the unit as a

whole is not as productive as the overlying and underlying sandstone units. However, many domestic and stock wells obtain a small but adequate supply from the Prairie du Chien. Well Ou 278 was pumped at 12 gallons per minute for 2 hours, the water level lowering 2 feet. In a comparable test, well Ou 15, which taps both the Platteville formation and Galena dolomite and the Prairie du Chien group, yielded 150 gallons per minute but with a drawdown of 150 feet.

St. Peter sandstone.—The St. Peter sandstone of Ordovician age crops out at the base of escarpments topped by the Platteville formation and Galena dolomite or is buried by Pleistocene and Recent deposits in low, swampy areas. It is a soft, friable sandstone that usually weathers to a pale reddish brown. Fresh surfaces show a reddish-brown and grayish-orange banding and occasional zones of pure white sand. The well-rounded grains range in size from fine to coarse and appear well sorted. The drill cuttings are described as fine- to coarse-grained pink, gray, and white sandstone with some chert. Thin layers of sandy gray and red shale are disseminated throughout the section but usually are more common near the base.

The St. Peter sandstone is an important supplier of water to stock and domestic wells but it is absent in most wells in the industrial area along the Fox River. Table 3 shows that the relatively slight importance of the St. Peter as an aquifer in Outagamie County is a reflection of the thinness of the sandstone. Yield factors of 3 of the 4 wells tapping the St. Peter are considerably higher than those of wells tapping the Upper Cambrian series (table 2), showing that, were the St. Peter sandstone as thick and extensive as the Upper Cambrian series, it would easily surpass that series as an aquifer. The short duration of the tests cited in table 3 may account, in part, for the high yield factors, but similar tests of wells in the Upper Cambrian series do not give comparably high figures.

TABLE 3.—*Specific capacity aid yield factor of wells in the St. Peter sandstone*

Well no. Ou—	Specific capacity [1]	Yield factor [2]	Length of test (hrs)	Average discharge (gpm)	Thickness of aquifer penetrated (ft)	Location	Well diameter (in.)
76	10	50	4	10	20	Seymour (2 miles east)	6
85	4.0	33	4	8	12	Appleton (4 miles northwest)	6
91	2.9	145	2	20	2	Hortonville (5 miles southeast)	6
201	6.0	9.1	1	30	66	Seymour (1 mile southwest)	5

[1] Gallons per minute per foot of drawdown.

[2] $\frac{\text{Specific capacity} \times 100}{\text{Thickness of aquifer penetrated (feet).}}$

Platteville formation and Galena dolomite.—No attempt was made to differentiate the Platteville formation and the Galena dolomite. The Decorah formation could not be recognized. The unit crops out in many small scarps and is exposed in quarries and stream beds throughout the eastern portion of the county. Many of the older quarries have been abandoned but several large ones are still supplying rock. The Fox River has cut through the overlying glacial drift to the Platteville and Galena unit throughout its reach in Outagamie County, and Duck Creek exposes the formation in several places (pl. 2).

As seen in outcrops, the weathered surface of the rock is usually grayish orange; fresh surfaces range from greenish gray to yellowish gray. Numerous sandy or silty zones weather rapidly, allowing blocks of the more crystalline rock to break off along vertical fractures and slump or fall from the scarps. Other outcrops reveal a series of thin beds with very thin shaly partings between the dolomite layers. In drill cuttings the Platteville and Galena section is recognized by its predominantly gray to bluish-gray color, and there may be as much as 20 feet of fine- to medium-grained gray sandstone (Ou 19) near the base of the unit.

The Platteville and Galena formations contribute water to many domestic and stock wells in the county. At least 2 schools (Ou 279, Ou 285) and 1 industrial plant (Ou 38) rely entirely on this unit for their water supplies. Yields are generally small, and drawdowns are excessive in most of the wells. Some domestic and stock wells that penetrate almost the full thickness of the Platteville and Galena are reported to "pump dry" after a short period of pumping. The presence of recoverable water is evidence that the formation is not an ideal confining bed and that it probably transmits some water to recharge the underlying formations where their head is below that of the Platteville and Galena. Drescher (1953) states that where the Platteville and Galena formations are overlain by the more impervious Maquoketa shale it is of little importance as an aquifer. This indicates that the water moves downward through cracks and solution openings more easily than along the nearly horizontal bedding planes.

Maquoketa shale.—The Maquoketa shale underlies the glacial drift in an area of about 1 square mile in the extreme southeastern corner of Outagamie County. It is a light bluish-gray thin-bedded shale with thin layers of dolomite. In well logs it is described as a blue calcareous or dolomitic shale with some layers of shaly blue or gray dolomite. The shale acts as an effective confining bed for the underlying formations and yields little or no water to wells. It has been reported, however, that well Ou 48 obtains its water entirely from the Maquoketa shale.

CENOZOIC ROCKS

QUATERNARY SYSTEM

Pleistocene deposits.—Glacial deposits of the Wisconsin stage, which cover Outagamie County, consist of lake deposits and glacial drift. The lake deposits are exposed at or near the surface over most of the western two-thirds of the county but are covered by ground moraine of the Valders Substage (Thwaites, 1943) in the eastern part. They consist of layers of silt and clay deposited in deep portions of Lake Oshkosh (Thwaites, 1943), zones of fine-to medium sand deposited in shallow water, and beach sand and gravel laid down around the edge of the lake. The glacial drift in Outagamie County includes both stratified and unstratified deposits. Ground moraine, terminal moraines, and drumlins are composed of unsorted and unstratified material left by the glacier and not reworked by water. Eskers formed by swiftly flowing subglacial streams and consisting of roughly stratified sand and gravel are usually somewhat distorted by slump and covered by unstratified till left by the melting ice sheet. More or less irregular bodies of sorted sand and gravel are found in places within the body of the drift.

Pleistocene deposits are the only water source for wells in the northwest quarter of the county. They furnish adequate supplies to domestic and farm wells and for several public-supply systems. New London is supplied by three wells in drift and alluvium, and the village of Black Creek is supplied by a single well (Ou 71), pumping as much as 170,000 gallons per day from 43 feet of coarse gravel and sand. The specific capacity of the well is 18 gpm per foot of drawdown and the yield factor (p. 9) is 42. In a discussion of Pleistocene deposits the term yield factor has a very limited significance because of the rapid change in character of the water-bearing material. For example, well Ou 169 has a yield factor of only 3.3, yet it penetrates 21 feet of what appears to be the same kind of sand and gravel as that tapped by Ou 71 about half a mile away.

In the southern and eastern parts of the county most of the wells obtain water from the consolidated rocks, and the unconsolidated Pleistocene deposits are cased out to prevent caving. However, many wells obtain sufficient water for domestic and farm use from small, discontinuous sand and gravel lenses, confined in the Pleistocene clay. Because of the discontinuity of the Pleistocene beds, the artesian systems developed locally are small and unrelated, each resulting from recharge on nearby high ground.

Thwaites (1943) has published a detailed study of the Pleistocene geology of part of northeastern Wisconsin. It includes all of Outagamie County except the small portion south of the Fox River.

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Recent deposits.—The Recent deposits consist mostly of silt and very fine sand deposited on the flood plains of the Wolf, Embarrass, and Shioc Rivers. They include also about 55,000 acres of peat (Whitson and others, 1921), which is continually forming in the swamps and marshes. Areas of peat are scattered throughout the county but are most extensive in the western half. The peat deposits in a given swamp are usually thickest near the center, where they sometimes extend to depths of more than 10 feet below the surface.

The thickness of the Recent river deposits in the northwestern quarter of the county is not known. Riverbanks here are low, and flooding of the adjacent lands during high water is quite common. The very fine sand and silt deposited at these times are not important as a source of ground water.

BEDROCK STRUCTURE

The regional bedrock structure is one of gentle dips to the east and southeast (pl. 3). The rocks in Brown County dip at about 30 to 35 feet per mile about S. 70° E. (Drescher, 1953). In eastern Outagamie County the dip, determined from well logs and altitudes, is 25 to 30 feet per mile S. 60° E. The few well logs available for wells in the southwestern quarter of the county indicate that the direction of dip there may be nearly S. 45° E.

Because of the nature of their deposition and subsequent erosion, there is a great range in the thickness of most of the geologic units. The Precambrian floor is an uneven surface that slopes generally 20 to 30 feet per mile toward the east and south. Lying unconformably upon this crystalline floor, the Upper Cambrian series fills in the depressions and covers the areas of low relief, producing a relatively flat inclined plane. The base of the Prairie du Chien group is relatively flat, but its upper surface is described by Chamberlin (1877) as being highly undulating and billowy. The origin of the undulations or domes is uncertain. They have been attributed to Cryptozoön reefs, tectonic deformation, subaerial erosion, and compaction of sediments. The presence of brecciated material within the domes, however, indicates that they were formed after deposition of the original sediments.

The St. Peter sandstone was deposited on the undulating surface of the Prairie du Chien group. It fills in the low areas and generally covers the domes, again producing a relatively even surface. However, where the relief of the Prairie du Chien is unusually great, the sandstone is missing from the high areas and the Platteville and Galena formations rest directly upon the dolomite of the Prairie du Chien group (geologic sections *A–A′* and *D–D′*). This may be the situation in the areas 6 miles west of Freedom and about 6 miles

west of Appleton where the boundaries of the St. Peter sandstone are shown as dashed lines on the geologic map (pl. 2). Field observations in these areas indicate that the formation is absent, and it is not encountered in wells immediately to the east. Except where they have been acted upon by glacial and preglacial erosion, the Platteville and Galena formations have a more uniform thickness than any of the other geologic units. The unit has an even upper surface and rests upon a similar surface formed by the St. Peter sandstone and the Prairie du Chien group.

A west-trending fault along the Wolf River and Bear Creek has been reported by Chamberlin (1877) and others. The only evidence of a fault observed during this investigation is the peculiar right-angle turn in the Wolf River northeast of Hortonville and the straight-line effect caused by Bear Creek coming in from the east. Such a straight-line effect, however, is often the only surface expression of a fault and is sufficient reason for further investigation. The fault is not evident in geologic section D–D′ (pl. 3), which shows only a flattening of the apparent dip probably caused by a change in trend of the line of section (see geologic map, pl. 2). The movement of ground water in the area does not appear to be controlled by a fault (pl. 5), and there is no definite indication of a fault on the bedrock-surface map (pl. 4).

No other major faults or anomalies in structure have been found. The odd bedrock pattern in the vicinity of Seymour (pl. 2) is due not to structure but rather to the preglacial valley that heads in that area.

BEDROCK TOPOGRAPHY

In an area where the glacial drift is an important aquifier, it is necessary to define the buried surface of the consolidated rocks. A map showing contours on the bedrock surface may reveal preglacial valleys and depressions that have no surface expression. These valleys and depressions have been filled with glacial debris which may constitute an additional source of ground water.

The bedrock-contour map (pl. 4) was constructed from data obtained in drillers' logs and from field observations of quarries and other outcrops and surface topography. The altitudes are from aneroid-altimeter traverses using U. S. Coast and Geodetic Survey and U. S. Geological Survey bench marks as control. The lack of sufficient surface and subsurface control, the irregularity of the bedrock surface, and the variable thickness of the drift all tend to limit the accuracy of a map of this type. However, the general character and the dominant features of the buried surface are probably as shown on the map.

The outstanding feature of the preglacial landscape is the large buried valley which may be traced from near Seymour to Shiocton.

It is quite narrow and reaches a depth of 512 feet below the land surface at Black Creek. Although the valley may have been deepened and modified by ice advances, it was probably formed by a pre-Pleistocene stream flowing southwestward and emptying into the ancestral Wolf River at Shiocton. Two smaller valleys to the north also seem to terminate along the course of the present Wolf River, which flows southward to a point about 3 miles northeast of Hortonville where it is joined by a deep, narrow valley from the east. The straight-line effect caused by this confluence has been discussed in the section on bedrock structure. The fact that the present-day streams conform so well to the preglacial drainage pattern is due to the thinness of the drift in much of the county. Although the old channels are buried beneath hundreds of feet of sediments, the streams are still controlled by the same bedrock configurations etched out by their ancestors.

Other prominent features of the old surface are the Mosquito Hills about 1½ miles east of New London. They are preglacial erosional remnants of the Upper Cambrian series which were modified by the advancing ice. A cut-and-fill terrace, which may be an early stream terrace or a wave-cut bench from the time of Lake Oshkosh (Thwaites, 1943), was observed on the west side of the mounds.

The bedrock-topography map used in conjunction with land-surface altitudes shows that the glacial drift is thickest in the buried valleys and in the general area north and west of the Prairie du Chien escarpment. The bedrock surface in the remainder of the county is relatively flat, with no evidence of any great thickness of drift except in drumlins and eskers.

GEOLOGIC HISTORY

The Precambrian rocks that underlie all of Outagamie County were formed during the earliest geologic era. In Wisconsin these rocks consist of igneous rocks, as well as of sedimentary rocks that have been altered by heat and pressure. The Precambrian landscape was rugged and mountainous; even after long periods of exposure to the elements it was still dominated by many hills and ridges.

After the close of the Precambrian the area was covered by a sea into which layer after layer of sediment was deposited. The sea was not stationary, and alternating layers of sandstone, limestone, and shale were deposited as the water advanced and retreated. At times the sea retreated entirely, leaving the deposits exposed to subaerial erosion and continental deposition. From the time of final retreat of the sea until the advent of the Pleistocene glaciers, the rocks were subjected to weathering and erosion. It was during this interval that the bedrock valleys (pl. 4) were cut by the ancestral Wolf River and its tributaries.

Modification of the land surface during Pleistocene glaciation was accomplished more by deposition than by erosion. The valleys were filled, moraines were built up, and new drainage patterns were formed. As the ice front withdrew from its last major advance, much of Outagamie County was again covered by fresh water, of a glacial lake (Thwaites, 1943). Lake sediments were deposited, and then the water withdrew, leaving the land surface much as it appears today. Little erosion has taken place, and deposition has been restricted to flood-plain deposits of silt and sand along the streams and to organic deposits in lakes and swamps.

GROUND WATER

SOURCE AND MOVEMENT

The piezometric surface of a water-bearing formation, or aquifer, may be defined as that surface represented by the water level in wells or other large openings. If the water is not confined by impermeable material, the piezometric surface is called the water table. Under artesian conditions the water is confined under pressure by relatively impermeable material, and the piezometric surface is above the top of the aquifer. Ground water occurs under both artesian and water-table conditions in Outagamie County. Water-table conditions prevail locally in bodies of clean sand or gravel, and in limestone and dolomite where the water moves freely through cracks and solution openings that are connected with the atmosphere. Artesian water occurs locally, confined by layers of silt or clay, in the glacial drift and is the source of many springs and flowing wells. It occurs also throughout the bedrock aquifers wherever it is confined by relatively impermeable dolomite and shale. The confining material is not totally impermeable, and there is much slow leakage through the beds, so that over a long period of time the water may be considered as a single water body rather than several water bodies.

The direction of movement of ground water is illustrated by the piezometric map (pl. 5), which was constructed from water-level measurements made in 91 wells during April 1954. The wells do not represent any one aquifer, as most wells are cased only through the drift, and the leaky-artesian conditions that prevail in much of the county make it impossible to assign a water level to a specific aquifer without a driller's log and casing record of the well. The contour lines represent points of equal altitude on the piezometric surface. Because water flows down the hydraulic gradient, the direction of movement at any given point can be determined. Natural movement is controlled by discharge, recharge, topography, and geologic structure. It is altered by local pumping and by recharge from man-made reservoirs. In the eastern third of Outagamie County the water flows

southeastward. The direction of flow is the result of natural discharge into the Fox River, of recharge from the large area to the west, of municipal and industrial pumping along the Fox River from Lake Winnebago to Green Bay, and of the eastward dip of the bedrock. Industrial and municipal pumping has increased the gradient and hence the volume of water moving toward the areas of discharge, but it has not greatly changed the direction of ground-water movement. An increase in gradient at any given place may also be due to a decrease in permeability of the water-bearing material or to a local increase in recharge.

The quantity of water moving out of the county to the southeast was computed by applying Darcy's law to the area between the 780- and 700-foot contours running northeast from Appleton. From Darcy's law it follows that the quantity of water discharged in a unit of time (Q) is equal to the product of the average permeability of the material (P), the hydraulic gradient (I), and the cross-sectional area through which the water moves (A). It may be written in the form $Q=TIL$, where T is the transmissibility and L is the length of the section perpendicular to the direction of flow. An approximate T of 18,000 gpd per foot was obtained from pumping tests at Seymour and Appleton. L is the average length of the contours between the limiting flow lines A–B and C–D (pl. 5). The gradient, I, is averaged as the quotient of the area between the contours divided by the average length of the contours. Table 4 summarizes the data and results of the computations.

TABLE 4.—*Calculated movement of water to the southeast in Outagamie County, Wis.*

Contour interval (feet)	T (gpd per foot)	I (foot per foot)	L (miles)	Q (mgd)
780–740	18,000	0.0036	29.6	10.1
740–700	18,000	.0040	27.7	10.5

The amount of water moving southeastward is more than 10 mgd. Of this, about 4.5 mgd is pumped from wells along the Fox River from Appleton to Kaukauna. A large quantity is discharged naturally into the river, and the remainder flows downvalley toward the city of Green Bay, where the pumpage is estimated to average about 12.5 mgd.

Throughout the remainder of Outagamie County ground-water movement is controlled mainly by surface and bedrock topography. The water flows outward from the high areas toward lower ground, where it may come to the surface through seeps and springs. The large bedrock valley near Seymour influences ground-water move-

ment in the central part of the county. Water moves toward the valley from both sides and then westward toward the Wolf River. The number and distribution of control wells in the northwestern part of the county did not justify the drawing of piezometric contours in this area. The water here is in glacial drift, and, except in a few places where it is confined by impermeable layers, it exists under water-table conditions. The gradient appears to be quite flat, the water moving toward the Wolf and Embarrass Rivers.

The source of the ground water is precipitation. Recharge to the Paleozoic rocks takes place by percolation through the glacial drift into the subjacent sandstones or dolomites and thence downward into the deeper lying formations. The best opportunities for recharge are in areas where the sandstones crop out or are covered only by permeable glacial deposits. The piezometric map shows that where a stream influences ground-water movement the flow is usually toward the stream, indicating that water is entering rather than leaving the stream.

In areas of local recharge, the seasonal distribution of rainfall and seasonal changes in temperature have a pronounced effect on water levels. Rainfall on a recharge area may add water to the ground-water body; it also reduces the demand for ground water, thus tending to maintain natural conditions. High temperatures create a greater demand for water and a consequent lowering of water levels. High temperatures also increase the rates of evaporation and transpiration, thus reducing the amount of water available for recharge.

WATER LEVELS

Periodic water-level measurements (table 5, figs. 3 and 4) were made in 27 wells during the investigation. In addition, a continuous water-

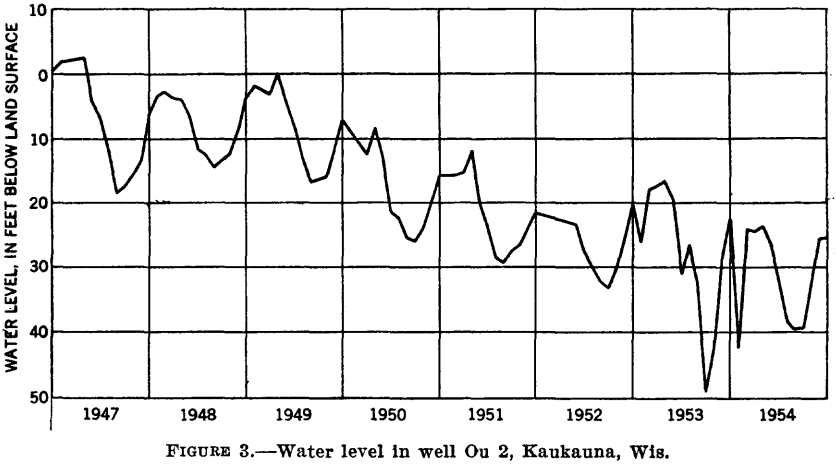

FIGURE 3.—Water level in well Ou 2, Kaukauna, Wis.

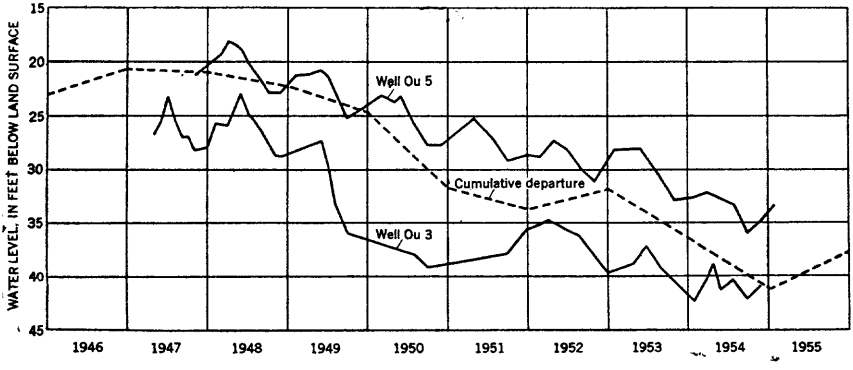

FIGURE 4.—Water levels in two wells and cumulative departure from normal precipitation since 1947–55, Outagamie County, Wis.

level recorder has been in operation on well Ou 2 since December 1946. More than 90 wells were measured in April 1954 for use in construction of the piezometric map (pl. 5).

Fluctuations caused by pumping from a water-table aquifer represent actual removal of water from the aquifer and usually are relatively small. In an artesian aquifer the fluctuations caused by pumping are relatively rapid and large, as they represent mostly changes in pressure within the system. Evaporation of water directly from the ground-water body and evaporation from plants (transpiration) are effective when the ground-water body is at or near the land surface. Barometric and other pressure effects on water levels are most pronounced in wells tapping confined water. Atmospheric pressure is transmitted through the well to the elastic artesian aquifer, and the well acts as a water barometer.

Fluctuations in water level may be grouped into three categories: short-term (ranging from a few seconds or minutes to several days); seasonal; and long-term. Nearly instantaneous fluctuations may be the result of loading of the aquifer by railroad trains, of earthquakes, of pumping from wells, etc. Diurnal or semidiurnal fluctuations may be caused by pumping, diurnal barometric changes, earth tides, or evaporation and transportation. Weekly fluctuations may occur as a result of a decrease in industrial and municipal pumping on weekends.

TABLE 5.—*Water levels in wells in Outagamie County, Wis.*

[Measurements in feet below land-surface datum]

Well Ou 19

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 19, 1951	38.00	Dec. 4, 1952	29.00	May 5, 1954	33.98
Aug. 21	39.00	Jan. 29, 1953	28.31	July 8	38.32
Dec. 6	34.00	Apr. 9	27.98	Sept. 10	40.02
Feb. 8, 1952	30.00	June 5	30.73	Nov. 18	34.32
Apr. 11	30.00	Aug. 7	41.03	Mar. 16, 1955	29.35
June 13	34.00	Oct. 16	37.65		
Aug. 14	42.00	Jan. 8, 1954	30.41		
Oct. 10	35.00	Mar. 4	30.35		

Well Ou 24

July 25, 1951	77.95	Oct. 10, 1952	74.64	Mar. 4, 1954	70.25
Sept. 21	77.03	Dec. 5	68.76	May 5	72.06
Dec. 6	72.98	Jan. 29, 1953	67.55	Sept. 10	79.44
Feb. 8, 1952	68.69	Apr. 9	66.58	Mar. 16, 1955	70.74
Apr. 10	67.93	Oct. 16	77.54		
Aug. 14	75.59	Jan. 8, 1954	68.75		

Well Ou 29

July 27, 1951	56.96	Dec. 5, 1952	57.18	Mar. 4, 1954	58.61
Sept. 21	57.36	Jan. 29, 1953	57.43	May 5	57.78
Feb. 8, 1952	56.16	Apr. 9	56.20	July 8	57.50
Apr. 17	59.64	June 5	54.88	Sept. 10	58.04
June 13	55.83	Aug. 7	56.81	Nov. 18	55.69
Aug. 14	55.33	Oct. 16	58.30	Mar. 16, 1955	57.10
Oct. 10	57.31	Jan. 8, 1954	58.14		

Well Ou 41

June 25, 1952	71.76	Sept. 4, 1953	77.14	July 30, 1954	75.40
Dec. 9	71.89	Jan. 7, 1954	72.83	Sept. 22	76.03
Mar. 23, 1953	72.20	Mar. 3	72.88		
May 26	72.02	Apr. 26	74.05		

Well Ou 59

Aug. 6, 1952	71.80	Aug. 13, 1953	73.12	July 30, 1954	69.31
Dec. 9	71.89	Jan. 7, 1954	72.81	Sept. 22	70.76
Mar. 23, 1953	71.91	Mar. 3	73.07	Nov. 18	72.82
May 26	72.79	Apr. 28	73.18		

Well Ou 65

Aug. 27, 1952	32.10	Aug. 2, 1953	32.97	July 29, 1954	34.04
Dec. 9	33.48	Jan. 7, 1954	34.51	Sept. 22	35.03
Mar. 23, 1953	33.80	Mar. 4	34.77	Nov. 17	35.08
May 26	32.91	Apr. 28	35.01		

Well Ou 70

Aug. 28, 1952	81.22	May 26, 1953	80.21	July 30, 1954	83.53
Dec. 9	82.38	Aug. 13	81.67	Sept. 22	84.01
Mar. 23, 1953	82.65	Jan. 7, 1954	83.59	Nov. 17	81.84

Well Ou 74

Sept. 9, 1952	0.41	July 16, 1953	[a] 1.96	Nov. 18, 1954	Flowing.
Dec. 10	[a] 1.48	July 30, 1954	0.21		
Mar. 24, 1953	[a] 1.61	Sept. 21	0.37		

[a] Feet above land-surface datum.

TABLE 5.—*Water levels in wells in Outagamie County, Wis.*—Continued

Well Ou 82

Date	Depth to water	Date	Depth to water	Date	Depth to water
Sept. 11, 1952	43.89	May 26, 1953	40.65	Apr. 27, 1954	44.31
Dec. 10	44.39	Aug. 13	43.74		
Mar. 24, 1953	42.32	Mar. 4, 1954	46.34		

Well Ou 87

Oct. 2, 1952	7.97	Aug. 13, 1953	8.63	July 30, 1954	11.93
Dec. 9	11.53	Jan. 7, 1954	14.95	Sept. 21	12.20
Mar. 23, 1953	3.86	Mar. 4	12.54	Nov. 27	6.88
May 26	5.55	Apr. 27	9.86		

Well Ou 95

Nov. 6, 1952	8.23	Aug. 13, 1953	9.24	July 30, 1954	8.76
Dec. 10	7.05	Jan. 8, 1954	10.24	Sept. 21	9.05
Mar. 24, 1953	6.46	Mar. 4	8.11	Nov. 17	7.50
May 26	7.00	Apr. 27	9.38		

Well Ou 105

May 28, 1953	2.31	Mar. 4, 1954	6.28	Sept. 21, 1954	6.51
Aug. 13	4.73	Apr. 27	5.12	Nov. 17	3.15
Jan. 8, 1954	6.38	July 29	5.88		

Well Ou 121

June 25, 1953	24.85	Mar. 4, 1954	24.54	Sept. 22, 1954	24.55
Aug. 2	22.93	Apr. 28	24.54	Nov. 17	21.71
Jan. 7, 1954	24.22	July 29	24.95		

Well Ou 125

June 25, 1953	32.41	Mar. 4, 1954	34.12	Sept. 22, 1954	35.50
Aug. 2	32.42	Apr. 28	33.38	Nov. 17	33.08
Jan. 7, 1954	34.54	July 29	33.82		

Well Ou 136

June 26, 1953	12.69	Mar. 4, 1954	13.34	Apr. 28, 1954	11.68

Well Ou 152

July 1, 1953	7.26	Mar. 4, 1954	11.14	Sept. 22, 1954	9.35
Aug. 13	7.79	Apr. 29	10.50	Nov. 17	7.02
Jan. 7, 1954	10.19	July 29	8.82		

Well Ou 155

July 1, 1953	1.44	Mar. 4, 1954	3.17	Nov. 17, 1954	1.03
Aug. 13	1.74	July 29	2.10		
Jan. 7, 1954	3.02	Sept. 21	1.84		

Well Ou 169

July 13, 1953	12.29	Mar. 4, 1954	13.78	Sept. 21, 1954	13.50
Aug. 13	11.88	Apr. 29	13.74	Nov. 17	10.59
Jan. 7, 1954	13.04	July 29	12.91		

Well Ou 170

July 13, 1953	6.72	Mar. 4, 1954	9.82	Nov. 17, 1954	5.94
Aug. 13	7.43	July 29	7.38		
Jan. 8, 1954	8.76	Sept. 21	7.90		

TABLE 5.—*Water levels in wells in Outagamie County, Wis.*—Continued

Well Ou 179

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 14, 1953	8.01	Mar. 4, 1954	9.35	Nov. 17, 1954	7.86
Sept. 4	8.27	July 29	8.58		
Jan. 8, 1954	9.16	Sept. 21	8.84		

Well Ou 203

July 22, 1953	58.09	Mar. 4, 1954	58.37	Sept. 22, 1954	57.49
Jan. 7, 1954	58.26	July 29	45.34	Nov. 17	34.77

Well Ou 217

July 23, 1953	7.89	Mar. 4, 1954	6.00	Nov. 17, 1954	5.98
Sept. 4	7.94	July 29	7.22		
Jan. 8, 1954	6.30	Sept. 21	7.29		

Well Ou 238

Sept. 1, 1953	8.42	Apr. 27, 1954	6.37	Nov. 17, 1954	5.43
Jan. 8, 1954	6.74	July 30	6.44		
Mar. 4	7.11	Sept. 21	6.68		

Well Ou 246

Sept. 3, 1953	4.47	July 29, 1954	4.63	Nov. 17, 1954	2.51
Jan. 8, 1954	4.60	Sept. 21	4.01		

Well Ou 258

Oct. 14, 1953	7.15	Apr. 27, 1954	4.80	Nov. 17, 1954	2.93
Jan. 8, 1954	8.41	July 30	4.89		
Mar. 4	6.89	Sept. 21	5.64		

Seasonal fluctuations are due to seasonal variations in pumping, evaporation and transpiration, and recharge. Normally, water levels decline through the summer as a result of reduced recharge (due to increased evaporation and transpiration) and of drainage into streams. The decline continues through the winter months when the ground is frozen and recharge is at a minimum. Recharge is greatest in the spring, owing to snow melt and spring rains. In southeastern Outagamie County the pattern is distorted by pumping along the Fox River. Hydrographs (figs. 3 and 4) show that the lowest water levels occur in the early fall at the end of the period of heaviest industrial and municipal pumping. Recovery is rapid, and a nearly stable condition is reached early the following year. The water level in well Ou 3, which of the three wells illustrated is that least affected by pumping, follows more closely the natural influences of recharge and discharge. It continues to decline during the winter and reaches its maximum recovery in April or May.

Long-term trends in water levels are the result of precipitation and temperature cycles or of pumping trends. About 8 years of records are available for wells Ou 2, 3, and 5 (figs. 3 and 4). All three

wells are affected by increased pumping at Green Bay and along the Fox River, and all three hydrographs show a downward trend during the period of record. However, the cumulative-departure curve for precipitation in Outagamie County also shows a downward trend during this period. The curve follows quite closely the trend of the hydrographs, indicating that the precipitation cycle has a definite influence on water levels. The effects of precipitation and temperature cycles on water levels are accentuated by corresponding pumping cycles; for example, high temperatures and lack of precipitation, which reduce recharge and cause water levels to decline, usually result in increased pumping, which has a similar effect. Wells Ou 2 and 5 are deep wells near the area of maximum withdrawal and relatively far from the recharge area. Here the effect of pumping is at a maximum and the effect of fluctuations in precipitation are minimized. Well Ou 3 is a shallow well located near the outcrop area, where water levels are influenced by precipitation cycles. This influence is shown by the trend of the hydrograph, which follows very closely the cumulative-departure curve for precipitation. The well is west of the recharge boundary, determined by Drescher (1953), for the Green Bay area and should not be greatly affected by withdrawals at Green Bay.

USE

Withdrawal of ground water in Outagamie County in 1951 and 1952 is estimated to have averaged about 9.0 mgd. Industrial, commercial, and public-supply pumping along the Fox River accounts for 48 percent of the total. The city of Appleton and the paper mills use Fox River water, but pumping by other industries and businesses in the Appleton area amounts to about 1.7 mgd. The cities of Kaukauna, Little Chute, Kimberly, and Combined Locks use ground water at the rate of 2.6 mgd for all purposes. Pumpage in the remainder of the county, estimated to be about 4.6 mgd, is predominantly for domestic and general farm use. The estimate is based on pumpage figures supplied by the villages and on an estimated average consumption of 40 gallons per day (gpd) per person for rural areas, 35 gpd per cow for milk cows and associated dairy servicing, 12 gpd for cattle and horses, and smaller amounts for other animals.

WELLS

The locations of the 287 wells visited during the investigation are shown on plate 1. The data assembled for each well are listed in table 6. Wells are numbered consecutively in the order visited and prefixed by the letters Ou to show that they are in Outagamie County.

TABLE 6.—*Records of wells in Outagamie County, Wis.*

[Qa, Recent alluvium and Pleistocene deposits; Om, Maquoketa shale; Ogp, Galena dolomite, and Platteville formation; Osp, St. Peter sandstone; Opc, Prairie du Chien group; Cs, Upper Cambrian series; AC, Air conditioning; Des, Destroyed; Dom, Domestic; Ind, Industrial; PS, Public supply; RR, Railroad; S, Stock; Un, Unused]

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
1	NW¼SW¼ sec. 28, T. 24 N., R. 18 E.	City of Seymour	1934	788	406	202	12-10	Cs	195	211			PS.
2	NE¼SW¼ sec. 24, T. 21 N., R. 18 E.	City of Kaukauna	1909	645	798	208	12	Cs	368	410	+1.84	Dec. 4, 1946	Un.
3	SE¼NE¼ sec. 2, T. 23 N., R. 18 E.	William Vanden Huefel	1942	790	110	35	5	Osp	55	50	26.67	Apr. 16, 1947	S.
4	SE¼NW¼ sec. 5, T. 21 N., R. 18 E.	Marvin Murphy			400±		8				32.25	May 14, 1947	Un.
5	SW¼SE¼ sec. 4, T. 21 N., R. 19 E.	Kaukauna Water and Electric.	1929	660	408	69	6	Osp	237	171	21.19	Oct. 30, 1947	Dom.
6	NW¼NW¼ sec. 16, T. 24 N., R. 19 E.	Wisconsin State Reformatory.		776	192	82	6	Osp	178	14			PS.
7	NE¼NW¼ sec. 33, T. 24 N., R. 18 E.	Seymour Canning Co	1910	796	235		6				32.80	December 1952.	Un.
8	NE¼NW¼ sec. 33, T. 24 N., R. 18 E.	do	1929	796	350	193	12	Cs	220	130			Ind.
9	NW¼NW¼ sec. 33, T. 24 N., R. 18 E.	Green Bay and Western Railroad Co.		791									Un.
10	NE¼NE¼ sec. 32, T. 24 N., R. 18 E.	City of Seymour	1947	788	500	270	10	Cs	195	305			PS.
11	NE¼SE¼ sec. 29, T. 24 N., R. 18 E.	Outagamie County		790	140		5				18.23	Apr. 18, 1949	PS.
12	NE¼SW¼ sec. 35, T. 24 N., R. 18 E.	John Vander Zanden					4				41.23	Oct. 5, 1949	Un.
13	SW¼SE¼ sec. 26, T. 21 N., R. 17 E.	Fox River Paper Corp	1900?		250±		6						Un.
14	NW¼SE¼ sec. 26, T. 21 N., R. 17 E.	do	1900?		250±		6						Un.
15	NW¼NE¼ sec. 36, T. 21 N., R. 17 E.	Institute of Paper Chemistry.	1942	765	249	71	10	Ogp, Opc	68	181	129	July 18 1951	AC.
16	NW¼NE¼ sec. 35, T. 21 N., R. 17 E.	Appleton Machine Co	1900?		100±		4						Ind.
17	SW¼SW¼ sec. 26, T. 21 N., R. 17 E.	Geo. Walters Brewery	1900?										Ind.
18	SW¼SW¼ sec. 26, T. 21 N., R. 17 E.	do	1948	790	520		8-6				96	July 19, 1951	Ind.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
19	SE¼SW¼ sec. 35, T. 21 N., R. 17 E.	Wisconsin-Michigan Power Co.	1946	728	450	54	8	Cs	290	160	38	July 19, 1951	Un.
20	NW¼NW¼ sec. 23, T. 21 N., R. 17 E.	North Star Locker Plant	1947	830	410	100	6	Cs	345	65			Ind.
21	SW¼SW¼ sec. 26, T. 21 N., R. 17 E.	Outagamie County	1941	777	433	215	8	Cs	340	93	96.67	July 20, 1951	AC.
22	NW¼NW¼ sec. 34, T. 21 N., R. 17 E.	Consolidated Badger Coop Dairy.	1946	806	528	128	10	Cs	315	213			Ind.
23	NW¼NW¼ sec. 34, T. 21 N., R. 17 E.	do	1949	806	538	130	10	Cs	309	229			Ind.
24	NW¼NW¼ sec. 25, T. 21 N., R. 17 E.	Appleton Coated Paper Co	1928	763	501	244	12	Cs	344	157	77.95	July 25, 1951	Un.
25	NW¼NE¼ sec. 29, T. 21 N., R. 17 E.	Valley Locker Co	1947	781	312	65	6	Cs	205	107			Ind.
26	SE¼SE¼ sec. 20, T. 21 N., R. 17 E.	Outagamie County Hospital	1950	754	662	158	10	Cs	225	437	43.47	July 26, 1950	PS.
27	SE¼SE¼ sec. 20, T. 21 N., R. 17 E.	do	1890		700±								PS.
28	SW¼NE¼ sec. 26, T. 21 N., R. 17 E.	Tuttle Paper Press Co			250±	103	5						PS.
29	NE¼SE¼ sec. 15, T. 21 N., R. 17 E.	Highland Memorial Park	1935	839	300±						56.96	July 27, 1951	
30	SE¼SE¼ sec. 22, T. 21 N., R. 17 E.	Fox River Valley Knitting Co.	1902		360		5						Ind.
31	SE¼SW¼ sec. 23, T. 21 N., R. 17 E.	G. M. Hahn	1948	798	368		6	Osp	350	18			AC.
32	NW¼SE¼ sec. 26, T. 21 N., R. 17 E.	Conway Hotel			700±		6	Cs					PS.
33	NW¼SE¼ sec. 35, T. 22 N., R. 15 E.	City of Hortonville	1946	772	340			Cs	58	282	17.5	June 23, 1952	PS.
34	NW¼SW¼ sec. 21, T. 21 N., R. 18 E.	Village of Kimberly	1924	717	661	119	12	Cs	350	407			PS.
35	NE¼NW¼ sec. 28, T. 21 N., R. 18 E.	do	1939	731	804	148	12	Cs	380	420			PS.
36	SW¼SW¼ sec. 22, T. 21 N., R. 18 E.	Village of Little Chute	1923	679	734	102	12	Cs	345	385	41.1	June 24, 1952	PS.
37	NW¼NE¼ sec. 21, T. 21 N., R. 18 E.	do	1948	731	772	153	12	Cs	390	382			PS.

38	NE¼NW¼ sec. 21, T. 21 N., R. 18 E.	Little Chute Bottling Co	1950		68	58	8	Ogp	58	10				Ind.
39	NW¼SW¼ sec. 21, T. 21 N., R. 18 E.	Kimberly-Clark Paper Co			711	29	8	Cs	349	415				Ind.
40	NW¼NW¼ sec. 27, T. 21 N., R. 18 E.	Combined Locks Paper Co	1925	665	227	65	6	Ogp	65	146				PS.
41	SW¼NW¼ sec. 31, T. 21 N., R. 19 E.	Peter Loderbauer	1927	735	581	141	6	Cs	466	115	71.76	June 25, 1952		Dom, S.
42	SW¼NE¼ sec. 24, T. 21 N., R. 18 E.	Thilmany Pulp & Paper Co	1934	660	714		16–14	Cs	356	358				Ind.
43	SE¼NE¼ sec. 24, T. 21 N., R. 18 E.	do	1941	620	332	101	10	Osp	170	90				Ind.
44	NE¼SW¼ sec. 24, T. 21 N., R. 18 E.	City of Kaukauna	1921	648	726	34	15½	Cs	340	386				PS.
45	SW¼SW¼ sec. 24, T. 21 N., R. 18 E.	do	1935	642	733	121	16	Cs	370	363				PS.
46	SE¼SE¼ sec. 23, T. 21 N., R. 18 E.	do	1945	720	570	159	10	Cs	445	125				PS.
47	NW¼NW¼ sec. 25, T. 21 N., R. 18 E.	do	1945	704	557	135	10	Cs	440	117				PS.
48	SE¼NE¼ sec. 28, T. 21 N., R. 19 E.	Leo Schmidt	1949	784	91	28	6	Om	28	63	9.67	Aug. 5, 1952		Dom, S.
49	SE¼SE¼ sec. 21, T. 21 N., R. 19 E.	R. Vanderloop	1950	704	370	130	6				73.33	Aug. 5, 1952		S.
50	NE¼NE¼ sec. 32, T. 21 N., R. 19 E.	Louis Mischler	1921	729	152	100	6				76.72	Aug. 6, 1952		Dom, S.
51	SW¼NW¼ sec. 21, T. 21 N., R. 19 E.	Frank Nytes	1900?	693	102		4				44.95	Aug. 6, 1952		Dom, S.
52	NE¼SE¼ sec. 9, T. 21 N., R. 19 E.	Peter Feldkamp		658			3				58.08	Aug. 6, 1952		Dom, S.
53	NE¼NE¼ sec. 12, T. 21 N., R. 17 E.	Robert Van Handel	1950	770			6				27.54	Aug. 7, 1952		Dom.
54	NE¼NW¼ sec. 16, T. 21 N., R. 18 E.	William Van Grall	1948	728	171	100	8–6				55.01	Aug. 7, 1952		Dom, S.
55	SW¼NW¼ sec. 3, T. 21 N., R. 18 E.	Alois Jansen		729			4				29.02	Aug. 8, 1952		Dom, S.
56	NE¼NE¼ sec. 3, T. 21 N., R. 16 E.	St. Mary's Congregation	1938	915	659	29	6	Cs	201	458				Un.
57	NE¼SE¼ sec. 3, T. 21 N., R. 16 E.	Henry Griesbach		890							52.37	Aug. 7, 1952		Dom, S.
58	SE¼SE¼ sec. 35, T. 22 N., R. 17 E.	Delmar Schmeichel	1951	841	174	40±	6				59.47	Nov. 6, 1952		Dom.
59	NW¼NE¼ sec. 17, T. 21 N., R. 19 E.	Richard Lamers		673	96±		4				71.80	Aug. 6, 1952		Dom, S.
60	NE¼NE¼ sec. 28, T. 22 N., R. 18 E.	George Diedrick	1941	737	120		4	Ogp	90	30	26.05	Aug. 8, 1952		Dom, S.
61	NW¼NW¼ sec. 13, T. 21 N., R. 18 E.	Lester Besaw	1947	715			6				53.69	Aug. 26, 1952		Dom, S.
62	SW¼NW¼ sec. 13, T. 21 N., R. 18 E.	Ben Pahl		723			6				60.31	Aug. 26, 1952		Dom.
63	SE¼SW¼ sec. 25, T. 22 N., R. 18 E.	William Walsh		171	90		6				35.69	Aug. 26, 1952		Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
64	NW¼NW¼ sec. 14, T. 22 N., R. 18 E.	Herbert Van Wychen		759			6				24.68	Aug. 27, 1952	Dom.
65	SW¼NW¼ sec. 18, T. 22 N., R. 19 E.	Mark Kerkhoff	1950	735	52	32±	6				32.10	Aug. 27, 1952	Dom, S.
66	NW¼NW¼ sec. 16, T. 22 N., R. 19 E.	Pete Kieffer		700			6				41.05	Aug. 27, 1952	Dom, S.
67	SE¼NE¼ sec. 29, T. 22 N., R. 19 E.	Joe Mennen		697	320		6				52.52	Aug. 27, 1952	Dom, S.
68	NW¼NW¼ sec. 5, T. 21 N., R. 19 E.	Robert Van Delou		710	96?		4				79.38	Aug. 27, 1952	Dom, S.
69	SE¼SE¼ sec. 2, T. 21 N., R. 18 E.	Austin Diedrich		711	72		4	Ogp			28.82	Aug. 27, 1952	Dom, S.
70	SW¼NW¼ sec. 18, T. 22 N., R. 18 E.	Orville Krabbe		856	136		4				81.22	Aug. 28, 1952	Dom, S.
71	SE¼SW¼ sec. 9, T. 23 N., R. 17 E.	Village of Black Creek	1941	789	158	130	10	Qa	115	40	21	Sept. 8, 1952	PS.
72	SE¼SW¼ sec. 7, T. 22 N., R. 15 E.	New London Utilities					4						PS.
73	SE¼SW¼ sec. 7, T. 22 N., R. 15 E.	do			76	46	24						PS.
74	SW¼NE¼ sec. 29, T. 23 N., R. 16 E.	Shiocton Produce Co	1947	766	411		6				.41	Sept. 9, 1952	Ind.
75	SW¼NE¼ sec. 29, T. 23 N., R. 16 E.	Shiocton Kraut Co	1929?	765	295		6				5.31	Sept. 9, 1952	Ind.
76	NW¼NE¼ sec. 35, T. 24 N., R. 18 E.	John Vander Zanden	1952	796	89	38	8-6	Osp	69	20	15.12	Sept. 10, 1952	Dom, S.
77	NE¼NE¼ sec. 21, T. 23 N., R. 18 E.	N. Van Handel		802	68		4				39.98	Sept. 10, 1952	Dom, S.
78	SW¼SW¼ sec. 9, T. 22 N., R. 18 E.	Jerry Geenen		820	160	5	6				22.48	Sept. 10, 1952	Dom.
79	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Fox Valley Canning Co		794	335±		10	Cs	60	275			Ind.
80	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	do		793	210±		6	Cs			3.64	Dec. 10, 1952	Ind.
81	SE¼SE¼ sec. 35, T. 22 N., R. 15 E.	R. E. Schweb		801	108		6	Cs					Ind.
82	SE¼SE¼ sec. 2, T. 21 N., R. 15 E.	American Telephone & Telegraph.	1930	845	134	83	4½	Cs	80	54	43.89	Sept. 11, 1952	Ind.

83	NW¼NE¼ sec. 29, T. 22 N., R. 15 E.	Fox Valley Canning Co		748			2½						Un.
84	NW¼NE¼ sec. 32, T. 21 N., R. 17 E.	Fred Yelg	1951	773	102	43	6	Osp	90	12	20.71	Oct. 1, 1952	Dom.
85	SE¼NE¼ sec. 18, T. 21 N., R. 17 E.	Charles Milbauer	1951	825	112	41	6	Osp	100	12	24.16	Oct. 1, 1952	Dom, S.
86	NW¼SE¼ sec. 26, T. 21 N., R. 17 E.	Rio Theater	1931	769	514	95		Cs	350	164			AC.
87	NW¼NE¼ sec. 19, T. 22 N., R. 17 E.	Peter Williamson	1951	796	96	30	6	Cs	80	16	7.97	Oct. 2, 1952	Dom, S.
88	NE¼NE¼ sec. 5, T. 21 N., R. 15 E.	Franklin Gruetzmacher	1950	896	159	67	6	Cs	110	49	56.43	Nov. 5, 1952	Dom, S.
89	SE¼NW¼ sec. 15, T. 21 N., R. 15 E.	Don Sell		874	104+		4				38.90	Nov. 5, 1952	Dom, S.
90	NE¼NW¼ sec. 25, T. 21 N., R. 15 E.	Emil Tullock	1948	826	116		6				28.01	Nov. 5, 1952	Dom.
91	SW¼SW¼ sec. 14, T. 21 N., R. 16 E.	Virginia Findley	1952	826	91	73	6	Cs	89	3	18.04	Nov. 6, 1952	Dom.
92	NW¼NW¼ sec. 5, T. 21 N., R. 17 E.	H. F. McCarthy		848			4				77.19	Nov. 6, 1952	Dom, S.
93	SW¼NE¼ sec. 33, T. 22 N., R. 17 E.	Landwehr & Hackel Gravel Co.	1951	813	124	40	8				19.43	Dec. 11, 1952	Ind.
94	SW¼SE¼ sec. 31, T. 22 N., R. 16 E.	Elmer Collar		885	135	66	6	Cs	120	15	43.2	Nov. 6, 1952	Dom.
95	NE¼NW¼ sec. 20, T. 22 N., R. 16 E.	John Ross	1952	777	112	111	6	Qa	100	12	8.23	Nov. 6, 1952	Un.
96	SW¼NW¼ sec. 27, T. 22 N., R. 16 E.	Vernon Kern		863	100±		4				49.12	Nov. 6, 1952	Dom, S.
97	SE¼SE¼ sec. 8, T. 23 N., R. 17 E.	Borden Condensed Milk Co.	1918	788	484			Qa	2	510			Un.
98	SW¼NW¼ sec. 33, T. 21 N., R. 19 E.	Mike Weiss	1926	796	490	10	8-6	Osp	424	66			Dom.
99	NW¼SW¼ sec. 6, T. 21 N., R. 19 E.	George Lambie	1927	709	311½	90	6	Ogp, Opc	90	222			Dom.
100	NE¼NW¼ sec. 33, T. 21 N., R. 19 E.	Henry Mischler	1924	790	486	49	6	Osp	415	71	31.08	May 26, 1953	Dom.
101	SE¼NE¼ sec. 31, T. 23 N., R. 17 E.	Outagamie County	1925	827	305		10	Cs	91	214			Des.
102	NW¼SW¼ sec. 23, T. 21 N., R. 18 E.	Riverview Sanatorium	1935	667	302	100	8	Ogp	25	190			PS.
103	SW¼NW¼ sec. 29, T. 21 N., R. 19 E.	Eleanor Hansen	1952	742	370		6				83.02	May 26, 1953	Dom.
104	NW¼SW¼ sec. 32, T. 21 N., R. 17 E.	William Martin	1949	767	49	33½	4	Osp	42	7			Dom.
105	NE¼SW¼ sec. 29, T. 21 N., R. 16 E.	Serto Balliet		776	142		6	Cs	128	14	2.81	May 28, 1953	Dom.
106	NW¼NW¼ sec. 36, T. 21 N., R. 15 E.	E. J. Winkler	1951	838	138		6	Cs	126	12	64.50	May 28, 1953	Dom, S.
107	NW¼NW¼ sec. 33, T. 22 N., R. 16 E.			963	180	65	6	Cs	165	15			Dom, S.
108	NW¼NW¼ sec. 26, T. 21 N., R. 16 E.	V. Leppla	1943	900±	265	148	4						Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
109	NE¼NW¼ sec. 25, T. 21 N., R. 15 E	E. L. Lippert	1950	829			6	Cs			39.66	May 29, 1953	Dom.
110	NE¼SE¼ sec. 34, T. 21 N., R. 16 E.	Elmer H. Schroeder		918	98		6				76.76	May 29, 1953	Dom, S.
111	NE¼NE¼ sec. 32, T. 22 N., R. 18 E.	Richard Van Schyndel	1951	752	305	35	6	Osp	240	10	32.90	May 13, 1953	Dom, S.
112	NE¼NE¼ sec. 13, T. 21 N., R. 17 E.	Jacob Behle	1953	756	120	59	6				36.16	June 23, 1953	
113	NE¼SE¼ sec. 27, T. 21 N., R. 16 E.	Clem Gitter		905	200+		4				64.82	June 23, 1953	Dom, S.
114	SW¼NW¼ sec. 25, T. 22 N., R. 16 E.	Evangelical Lutheran Church.	1944	884	134	30	6–5	Cs	60	74	84.37	June 23, 1953	Dom, PS.
115	SW¼SW¼ sec. 30, T. 22 N., R. 18 E.	George Bohl	1949	854	304	96	6	Ogp, Opc	96	208			Dom, S.
116	SE¼NE¼ sec. 36, T. 22 N., R. 17 E.	Harry Brockmann		880	8	8	60				3.34	June 24, 1953	Dom, S.
117	SE¼SE¼ sec. 6, T. 22 N., R. 18 E.	Roy M. Riessenweber	1942	794	130	63	5	Osp	96	34			Dom.
118	NW¼SE¼ sec. 21, T. 23 N., R. 17 E.	Arron Riehl	1942	841	80	57	5	Opc	57	23			Dom, S.
119	SE¼SE¼ sec. 18, T. 24 N., R. 17 E.	Lawrence Dudek	1942	777	137	137	4½	Qa	137				Dom, S.
120	NE¼NW¼ sec. 12, T. 22 N., R. 16 E.	Mrs. Geo. Laird	1945	824	99	99	4	Qa	88	11			Dom.
121	NW¼NW¼ sec. 14, T. 22 N., R. 18 E.	Arnold Hooyman and Joe Heckel.	1942	756	83	53	5	Osp	53	30	24.85	June 25, 1953	Dom.
122	NW¼SE¼ sec. 6, T. 22 N., R. 19 E.	Marvin Murphy	1944	727	67	47	5	Ogp	47	20	3.60	June 25, 1953	S.
123	NW¼NE¼ sec. 1, T. 22 N., R. 18 E.	Norman Austin	1948	767	113	96	6	Osp	100	13	60.76	June 25, 1953	Dom, S.
124	SW¼NW¼ sec. 29, T. 23 N., R. 19 E.	Melvin Van Den Berg		725	120	58	6	Osp	107	13			Dom.
125	SE¼NE¼ sec. 30, T. 23 N., R. 19 E.	Immaculate Conception Mission.	1953	729	122	65½	6				32.41	June 25, 1953	PS.
126	SE¼NW¼ sec. 20, T. 23 N., R. 19 E.	Chester Smith		733	92	92	6	Qa	90	2	48.12	June 25, 1953	Dom, S.
127	SE¼NE¼ sec. 7, T. 23 N., R. 19 E.	John Van Boxtle	1945	762	144	48	6	Osp	100	44	41.51	June 25, 1953	Dom, S.

128	NW¼NW¼ sec. 7, T. 23 N., R. 19 E.	Bernard Van de Vort	1945	766	73	28	6	Ogp	28	45			Dom, S.
129	NE¼SE¼ sec. 12, T. 23 N., R. 18 E.	Wm. and John Van Boxtle	1949	767	141	30	6	Osp	115	26			Dom
130	SE¼SE¼ sec. 33, T. 24 N., R. 18 E.	Claud Schamberg	1945	825	104	58	6	Osp	58	46			Dom, S.
131	NE¼NE¼ sec. 5, T. 23 N., R. 18 E.	Robert Schultz	1943	839	64	64	8–5	Osp	28	36			Ind.
132	SW¼SE¼ sec. 9, T. 23 N., R. 18 E.	Winfred Cleereman	1945	819	82	34	6	Osp	48	34			Dom, S.
133	SW¼SW¼ sec. 5, T. 23 N., R. 18 E.	Lawrence Barclay	1944	853	80	14½	6	Osp	46	34			Dom, S.
134	SE¼SW¼ sec. 30, T. 24 N., R. 18 E.	Evert McBain	1944	777	119	119	6	Qa	44	75			Dom, S.
135	SE¼SW¼ sec. 20, T. 24 N., R. 18 E.	Earl Court	1944	830	153	21	5	Opc	17	136			Dom, S.
136	NW¼SW¼ sec. 20, T. 24 N., R. 18 E.	Hugo Baehler	1944	861	41	19	6	Opc	29	12	12.69	June 26, 1953	Dom, S.
137	NW¼NW¼ sec. 21, T. 24 N., R. 18 E.	Fenton Gardner	1945	848	130	14	6	Osp	35	75			Dom, S.
138	SW¼NW¼ sec. 21, T. 24 N., R. 18 E.	Roger Gardner	1945	807	140	110	6	Opc	110	30			Dom, S.
139	SE¼SE¼ sec. 1, T. 23 N., R. 17 E.	Frank Kirzek	1952		8	8	48	Qa	6	2			Dom, S.
140	SE¼SE¼ sec. 1, T. 23 N., R. 17 E.	do	1944	796	41	34½	6	Osp	32	9	.82	June 26, 1953	Un.
141	SE¼NE¼ sec. 23, T. 24 N., R. 18 E.	George Lindsley	1944	803	168	75	6	Ogp	75	93			Dom, S.
142	NW¼SW¼ sec. 30, T. 24 N., R. 19 E.	Andrew Schmidt	1946	791	105	21	6	Osp	76	29			S.
143	NW¼SW¼ sec. 30, T. 24 N., R. 19 E.	do	1915±	791	20	20	48				8.10	June 30, 1953	Dom.
144	NW¼NE¼ sec. 13, T. 24 N., R. 18 E.	Elmer Ashman	1945	803	102	35	6	Ogp	35	67	13.54	June 30, 1953	Dom.
145	SE¼SE¼ sec. 6, T. 24 N., R. 19 E.	Harlin Schmidt	1943	777	66	33	6	Ogp	33	33	11.50	June 30, 1953	Dom, S.
146	NE¼NE¼ sec. 15, T. 24 N., R. 18 E.	Kranzusch Bros	1953	829	212	62	6	Ogp, Opc	62	150	76.88	June 30, 1953	Un.
147	NE¼NE¼ sec. 15, T. 24 N., R. 18 E.	do	1931		20		42	Qa					Dom, S.
148	SE¼SE¼ sec. 8, T. 24 N., R. 18 E.	Herbert Krahn	1946	884	102	16	6	Osp	80	22			Dom, S.
149	SE¼SE¼ sec. 7, T. 24 N., R. 18 E.	Leonard Montie	1944	891	90	18	6	Osp	53	37			Dom, S.
150	SE¼SW¼ sec. 15, T. 24 N., R. 17 E.	Chester Gritt	1945	838	47	45	5	Opc	45	2			Dom, S.
151	SE¼NE¼ sec. 20, T. 24 N., R. 18 E.	Ray Elsen	1945	812	36	36	6	Qa	35				Dom.
152	SW¼SE¼ sec. 12, T. 23 N., R. 17 E.	Corbin Graunke	1943	793	85½	85	5				7.26	July 1, 1953	Un.
153	NE¼SW¼ sec. 2, T. 23 N., R. 17 E.	Lambert Sanderfoot		783	18½	18	48				9.70	July 1, 1953	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
154	SW¼NW¼ sec. 30, T. 24 N., R. 17 E.	George Van Eperen	1945	775	113	113	5	Qa	113				Dom, S.
155	NE¼NE¼ sec. 7, T. 23 N., R. 17 E.	Albert Theobald	1925±	769	43	43	2	Qa	43		1.44	July 1, 1953	Un.
156	SE¼NE¼ sec. 31, T. 23 N., R. 17 E.	Hollis Reineck		827	40		4				13.44	July 1, 1953	Ind.
157	NE¼NW¼ sec. 10, T. 22 N., R. 17 E.	Clarence A. Pennings		803	36	20±	5	Opc	20	16	16.11	July 1, 1953	Dom, S.
158	SW¼SW¼ sec. 14, T. 22 N., R. 17 E.	Walter H. Wieckert	1890	864	198		4				102.50	July 1, 1953	Dom, S.
159	NW¼NE¼ sec. 20, T. 21 N., R. 16 E.	Clarence, Harvey, and Stanley Jameson.	1940	806	102	96±	6	Qa			13.96	July 2, 1953	Dom, S.
160	SW¼SW¼ sec. 13, T. 21 N., R. 15 E.	Richard Blunenberg		860	30	30	36	Qa			18.21	July 2, 1953	Dom, S.
161	SW¼SW¼ sec. 13, T. 21 N., R. 15 E.	do		848	12		12	Qa			10.44	July 2, 1953	S.
162	SW¼SW¼ sec. 18, T. 21 N., R. 15 E.	Wilson Grunwald		873	98		4				37.53	July 2, 1953	Dom, S.
163	SW¼SW¼ sec. 6, T. 23 N., R. 18 E.	Ed. Wendt	1944	820	54	19½	6	Osp	10	44			Dom, S.
164	SE¼SW¼ sec. 18, T. 24 N., R. 17 E.	Byron Scott											Dom, S.
165	NE¼SW¼ sec. 10, T. 21 N., R. 17 E.	Clifford Weber	1953	795	39	39	6	Ogp	25	14			Dom.
166	SW¼SW¼ sec. 26, T. 22 N., R. 17 E.	Leroy Giger		820	95	70	6	Ogp	70	25			Dom.
167	SE¼SE¼ sec. 5, T. 22 N., R. 17 E.	Center Valley Coop	1936	819	225	73	6	Cs	125	100			Ind.
168	NE¼NE¼ sec. 8, T. 22 N., R. 17 E.	do	1936	824	196	68	8	Cs	137	59			Ind.
169	SE¼SE¼ sec. 8, T. 23 N., R. 17 E.	Outagamie Producer's Coop.	1942	781	163	143	8	Qa	142	21	12.29	July 13, 1953	Un.
170	NE¼SW¼ sec. 8, T. 24 N., R. 17 E.	Nichols Paper Products		798	131	78	6	Cs	78	53	6.72	July 13, 1953	Un.
171	NE¼SW¼ sec. 18, T. 24 N., R. 17 E.	Lloyd Scott	1949	784	71	54	6	Cs	54	17			Dom.
172	NE¼SW¼ sec. 8, T. 24 N., R. 17 E.	Claude Hansche	1950	798	131	78	6	Cs	78	53			PS.

173	NW¼NE¼ sec. 3, T. 24 N., R. 18 E.	Leonard Colling	1949	867	85	40	6	Ogp					Dom.
174	SE¼NE¼ sec. 4, T. 24 N., R. 18 E	Robert Thies	1951	861	230		6	Ogp	90	140	76.25	Apr. 28, 1954	Dom, S.
175	NW¼NE¼ sec. 5, T. 24 N., R. 17 E.	Ed Kemp	1941	795	151		6	Qa	141	10			Dom, S.
176	NE¼NW¼ sec. 5, T. 24 N., R. 17 E.	J. Ciesielczyk	1951	804	242	236	6	Cs	235	7			Dom, S.
177	NW¼NE¼ sec. 9, T. 24 N., R. 16 E.	Leeman School	1952	797	102	70	6	Cs	68	34			PS.
178	SW¼NE¼ sec. 9, T. 24 N., R. 16 E.	Lewis Reese		799	67		4				11.42	July 14, 1953	Dom, S.
179	SW¼NE¼ sec. 9, T. 24 N., R. 16 E.	Richard Reese		797	140		6				8.01	July 14, 1953	Un.
180	NW¼SW¼ sec. 22, T. 24 N., R. 16 E.	Oakland School	1930	772	137	137	4½	Qa					PS.
181	SE¼SE¼ sec. 7, T. 23 N., R. 17 E.	A. E. Gritt	1938	796	246	246	4½	Qa	246		19.36	July 14, 1953	Un.
182	SE¼SE¼ sec. 7, T. 23 N., R. 17 E.	do	1938	796	72	72	4	Qa	72		30.10	July 14, 1953	Dom, S.
183	NE¼NE¼ sec. 25, T. 24 N., R. 17 E.	Elmer Winters	1942	791	97	97	4½	Qa	40	57	.91	July 15, 1953	S.
184	SW¼NE¼ sec. 27, T. 24 N., R. 17 E.	Robert Mielke		817	143	42	5	Cs	60	83			Dom.
185	NE¼NE¼ sec. 34, T. 24 N., R. 17 E.	Clarence Hurkman		777	739		8				4.00	July 15, 1953	Ind.
186	NW¼SW¼ sec. 28, T. 24 N., R. 17 E.	Carl Mauthe		780	285		10	Cs			12.98	July 15, 1953	Dom.
187	NW¼SW¼ sec. 1, T. 23 N., R. 16 E.	Joe Weber		770	181	171	6	Cs	169	12	1.52	July 15, 1953	Dom, S.
188	SE¼SW¼ sec. 24, T. 24 N., R. 16 E.	John Tiekler	1941	779	103	103	4½	Qa	103		2.25	July 15, 1953	Dom, S.
189	SE¼NE¼ sec. 14, T. 24 N., R. 17 E.	Elmer Mueller		834	51		6				10.95	July 15, 1953	Dom, S.
190	SW¼NW¼ sec. 16, T. 23 N., R. 17 E.	Leo Gauss	1943	811	337	270	6	Qa					
191	SE¼NE¼ sec. 17, T. 23 N., R. 17 E.	Linder Peterson	1943		57	57	6	Qa			12.01	July 16, 1953	Dom, S.
192	SW¼SE¼ sec. 15, T. 23 N., R. 17 E.	Herman Seitz	1915	810	84	60	4	Opc	60	60	17.31	July 16, 1953	Dom, S.
193	SW¼NW¼ sec. 15, T. 23 N., R. 17 E.	Henry Dieterrich	1941	812	154	100?	5	Qa	150	4			Dom, S.
194	NE¼NW¼ sec. 10, T. 22 N., R. 16 E.	Clifford Schlintz	1950	816	80	80	5	Qa			22.80	July 16, 1953	Dom, S.
195	NW¼NE¼ sec. 9, T. 22 N., R. 16 E.	Ellington School	1952	841	175		4	Cs	122	53	38.48	July 16, 1953	PS
196	SW¼NE¼ sec. 4, T. 22 N., R. 16 E.	Carlton Schlintz	1949	913	148	10	6	Cs	61	87	69.77	July 16, 1953	Dom, S.
197	NW¼NW¼ sec. 35, T. 23 N., R. 16 E.	Joe Conrad	1941	796	100	90	4½	Cs	88	12			S.
198	NW¼NW¼ sec. 22, T. 23 N., R. 16 E.	Clinton Mack	1914	767	190		4	Qa			2.46	July 16, 1953	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
199	NE¼NW¼ sec. 18, T. 23 N., R. 17 E.	W. G. Bishoff	1953	783	68	68	6	Qa	63	5	16.58	July 16, 1953	Dom, S.
200	NW¼NW¼ sec. 27, T. 21 N., R. 15 E.	Milo Hauk	1937	785	66	22	4	Cs	55	11			Dom.
201	NE¼NE¼ sec. 6, T. 23 N., R. 18 E.	Joe Hein	1941	855	105	14	5	Osp	39	66			Dom, S.
202	NW¼NE¼ sec. 12, T. 23 N., R. 17 E.	Mrs. Rheinhold Miller	1944	785	114	114	6	Osp	96	18			Dom, S.
203	NW¼NW¼ sec. 8, T. 23 N., R. 18 E.	Mrs. Warren Barclay	1900±	864	95	15±	4	Osp			58.09	July 22, 1953	Un.
204	SW¼SW¼ sec. 17, T. 23 N., R. 18 E.	Charles Baumgartner	1949	811	127	89	6	Osp			15.14	July 22, 1953	Dom, S.
205	SW¼SW¼ sec. 28, T. 23 N., R. 18 E.	Golden Rule School		805	45		6				7.62	July 22, 1953	PS.
206	NE¼NE¼ sec. 32, T. 23 N., R. 18 E.	Carlton Sievert		808	40		4	Ogp	13	27	11.76	July 22, 1953	Un.
207	NE¼NW¼ sec. 32, T. 23, N., R. 18 E.	do	1952	824	200	31½	6	Osp			53.17	July 22, 1953	Dom, S.
208	SE¼SW¼ sec. 29, T. 23 N., R. 18 E.	Harvey Thomas	1952	805	81	20	6	Osp	42	39			
209	SW¼NW¼ sec. 35, T. 23 N., R. 18 E.	Louis Planert		758	156		6				17.99	July 22, 1953	Un.
210	SE¼NE¼ sec. 14, T. 23 N., R. 18 E.	Heitpas		774			6				17.87	July 22, 1953	S.
211	NE¼SE¼ sec. 8, T. 24 N., R. 18 E.	Tesch Bros		903	130		6	Ogp	90	40	48.04	July 23, 1953	Un.
212	NE¼NE¼ sec. 6, T. 24 N., R. 18 E.	Lawrence Grochowski		886	55		4				16.69	July 23, 1953	Un.
213	NW¼NE¼ sec. 6, T. 24 N., R. 18 E.	do		875	90		4				22.45	July 23, 1953	Dom, S.
214	NE¼NE¼ sec. 4, T. 24 N., R. 17 E.	Benny Banker		872			4	Opc			30.90	July 22, 1953	Dom, S.
215	NW¼NW¼ sec. 12, T. 24 N., R. 16 E.	Alvin Carpenter		792	78	78					6.20	July 23, 1953	Dom, S.
216	SW¼SW¼ sec. 23, T. 24 N., R. 16 E.	Louis Planert	1951	790			4				12.07	July 23, 1953	Dom, S.
217	SW¼SW¼ sec. 27, T. 24 N., R. 16 E.	George Gomm		775	45		3				7.89	July 23, 1953	Un.

218	SE¼NW¼ sec. 10, T. 23 N., R. 16 E.	Ralph E. Gehring	1951	771	254		4						
219	NW¼NW¼ sec. 35, T. 24 N., R. 17 E.	William Grunwaldt	1949	775	197	197	6	Qa					Dom.
220	NW¼SE¼ sec. 25, T. 24 N., R. 17 E.	Ernest Ossmann	1953	769	60	60	6	Qa			17.34	July 27, 1953	Un.
221	NE¼NE¼ sec. 4, T. 23 N., R. 19 E.	Sacred Heart Seminary		740							52	July 1953	PS.
222	SE¼SW¼ sec. 27, T. 24 N., R. 16 E.	Jack Newland		770	268			Cs	238	30			
223	NE¼NE¼ sec. 9, T. 24 N., R. 19 E.	L'Onnaye School		760±									PS.
224	SE¼NW¼ sec. 18, T. 23 N., R. 17 E.	W. C. Bishoff	1953		37	32	6	Qa	32	5			
225	SW¼SW¼ sec. 17, T. 24 N., R. 16 E.	Michael McHugh		786	246	246	5	Qa	246		5.78	July 29, 1953	Dom, S.
226	SW¼NE¼ sec. 30, T. 24 N., R. 15 E.	Flanagan Bros. Inc	1936±										Ind.
227	NW¼NW¼ sec. 30, T. 24 N., R. 15 E.	Paul L. Downs	1948	857	106	101	4	Qa	90	16			Dom.
228	NE¼NW¼ sec. 30, T. 24 N., R. 15 E.	Bear Creek High School	1953	862	137	137	6	Qa					PS.
229	NE¼NW¼ sec. 30, T. 24 N., R. 15 E.	St. Mary's Congregation	1951	862	180	175	6	Qa	175	5	62.98	July 20, 1953	PS.
230	SW¼SW¼ sec. 28, T. 24 N., R. 15 E.	Herbert Poppe	1938	795	159	159	4	Qa	151	8			Dom.
231	SE¼SE¼ sec. 29, T. 24 N., R. 15 E.	do		789	100±						4.62	July 29, 1953	
232	NW¼SW¼ sec. 7, T. 23 N., R. 15 E.	Richard Thurk	1949	827	100	100	2	Qa	80	20			Dom, PS.
233	NE¼NE¼ sec. 4, T. 23 N., R. 15 E.	Edward Voss	1949	782	81	77	6	Qa	65	16			Dom, S.
234	SW¼NW¼ sec. 1, T. 23 N., R. 15 E.	Riverbend School		773	7½		36				4.82	July 30, 1953	PS.
235	NW¼SW¼ sec. 19, T. 22 N., R. 15 E.	Jess Lathrop	1895		195	195	4	Qa	189	8			Dom, S
236	SW¼SE¼ sec. 19, T. 22 N., R. 15 E.	Herbert Lathrop		784	45	45	2				1.01	Sept. 1, 1953	Un.
237	SW¼NE¼ sec. 17, T. 22 N., R. 15 E.	Franklin Runge		773	33+		2½				4.69	Sept. 1, 1953	Dom.
238	SW¼NW¼ sec. 13, T. 22 N., R. 15 E.	Rankin		776	35+		4				8.42	Sept. 1, 1953	Un.
239	SW¼SE¼ sec. 6, T. 23 N., R. 15 E.	Clover Blossom School	1953	809	111	111	2½	Qa					PS.
240	SW¼SE¼ sec. 6, T. 23 N., R. 15 E.	do		808	81½	81½	2½	Qa			10.53	Sept. 2, 1953	Un.
241	SW¼SE¼ sec. 29, T. 23 N., R. 15 E.	Pribbernow Bros		809	45+		6				30.27	Sept. 3, 1953	S.
242	NW¼NE¼ sec. 29, T. 23 N., R. 15 E.	Stanley Ziemer		802	25	25	2	Qa			11.41	Sept. 3, 1953	Un.
243	SW¼SE¼ sec. 16, T. 23 N., R. 15 E.	Anthony Young		769							5.31	Sept. 3, 1953	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
244	NW¼SE¼ sec. 17, T. 24 N., R. 15 E.	W. T. Nielson		795	16		24	Qa			12.35	Sept. 3, 1953	Un.
245	SW¼NW¼ sec. 9, T. 24 N., R. 15 E.	Owen Nielson		789	14		36	Qa			8.07	Sept. 3, 1953	Dom, S.
246	SE¼SE¼ sec. 6, T. 24 N., R. 15 E.	E. Meidam	1908	798	50		4				4.47	Sept. 3, 1953	Dom. S.
247	NE¼SE¼ sec. 18, T. 24 N., R. 15 E.	L. Meidam		793			4				3.80	Sept. 3, 1953	Dom, S.
248	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Fox Valley Canning Co		789	82		6				16.1	July 21, 1953	Ind.
249	NW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Dr. F. W. Cousineau		778	61		4						Dom.
250	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Fox Valley Canning Co		789	180						8.87	July 21, 1953	Un.
251	SE¼SW¼ sec. 35, T. 22 N., R. 15 E.	Claire Poole		820	58		4				31	Oct. 19, 1953	Un.
252	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Melvin Buesing		790	56		4				2.24	July 23, 1953	Un.
253	SW¼SW¼ sec. 27, T. 21 N., R. 17 E.	Stokely-Van Camp	1934	802	480	141	12	€s	307	173			Ind.
254	NE¼NW¼ sec. 34, T. 21 N., R. 17 E.	Appleton Wood Products Co.	1917	803	147		4				67.99	Sept. 30, 1953	Un.
255	NE¼NW¼ sec. 34, T. 21 N., R. 17 E.	Wisconsin Distributing Co.		802	300						78.55	Sept. 30, 1953	Ind.
256	SW¼SW¼ sec. 27, T. 21 N., R. 17 E.	City of Appleton	1900	803	96						78.88	Sept. 30, 1953	Un
257	SE¼NE¼ sec. 8, T. 24 N., R. 15 E.	Harvey Borg	1949	794	103	98	5				8.82	Oct. 8, 1953	Dom, S.
258	NW¼NW¼ sec. 32, T. 21 N., R. 16 E.			770	17		4				7.15	Oct. 14, 1953	Un.
259	NE¼NW¼ sec. 10, T. 22 N., R. 17 E.	Clarence Pennings	1954	813	135	36	6	Opc	34	101	20.69	Apr. 23, 1954	Dom, S.
260	NW¼NW¼ sec. 8, T. 23 N., R. 17 E.	Albert Stephani		769	20	20	2	Qa					Un.
261	SW¼SE¼ sec. 29, T. 24 N., R. 15 E.	Clover Lawn School District 1.		791				Qa			6.29	July 29, 1954	PS.
262	SE¼SW¼ sec. 29, T. 23 N., R. 15 E.	Golden Hill School Joint District 2.		813			4				38.66	July 28, 1954	PS.

263	SW¼NW¼ sec. 24, T. 22 N., R. 16 E.	Carl Timm	1953	776	342	172	6	Cs	180	162			Dom.
264	NE¼NE¼ sec. 5, T. 22 N., R. 16 E.	Harold Conradt		803									Dom.
265	SW¼SE¼ sec. 32, T. 23 N., R. 16 E.	do		770			4				Flowing	Sept. 1, 1954	Un.
266	NW¼SW¼ sec. 17, T. 22 N., R. 16 E.			768			2				Flowing	Sept. 1, 1954	S.
267	NW¼SW¼ sec. 13, T. 22 N., R. 16 E.	Edw. Halloran	1953	800	100	100	6	Qa	96	4			S.
268	SW¼SW¼ sec. 29, T. 23 N., R. 17 E.	Black Creek School District 4.	1942	827	56	30	4½						Un.
269	SW¼SW¼ sec. 29, T. 23 N., R. 17 E.	Black Creek School District 4.	1953	827	43	43	6	Cs	61	97			PS.
270	SE¼NW¼ sec. 9, T. 21 N., R. 15 E.	Unused School		839			4				17.17	Sept. 2, 1954	Un.
271	SE¼NW¼ sec. 13, T. 22 N., R. 16 E.	John McCandless	1938	799	84	37	4½	Cs	37	47	9.01	Oct. 7, 1954	Dom.
272	SE¼NW¼ sec. 17, T. 22 N., R. 16 E.	Wm. Cummings	1954	806	125	65	6	Cs	65	60	34.31	Oct. 7, 1954	Dom, S.
273	SW¼NE¼, sec. 17, T. 22 N., R. 16 E.	Peter Wied	1954	834	85	43	6	Cs	27	58			Dom.
274	SW¼SW¼ sec. 27, T. 24 N., R. 18 E.	Seymour Creamery	1947±	802	235	96		Ogp, Opc	96	139			Ind.
275	SW¼SW¼ sec. 8, T. 22 N., R. 16 E.	T. L. Knapstein	1952±	760±	205	140	3	Qa	140	65	Flowing	Oct. 8, 1954	Dom.
276	SE¼SW¼ sec. 20, T. 24 N., R. 17 E.	Wm. Marcks	1954	780	150±		6	Cs	130	20			Dom.
277	NW¼SW¼ sec. 28, T. 24 N., R. 17 E.			780	91			Cs	280	220			Oil test.
278	SE¼NE¼ sec. 11, T. 24 N., R. 17 E.	School District	1941	862	91	38	4½	Opc	427	64			PS.
279	NE¼NE¼ sec. 1, T. 24 N., R. 18 E.	County Line School	1946	804	63	40	6	Ogp	38	25			PS.
280	SW¼SW¼ sec. 27, T. 21 N., R. 17 E.	Stokely-Van Camp	1954	804	745	152	16	Cs	315	428			Ind.
281	NE¼NE¼ sec. 31, T. 24 N., R. 18 E.	Crystal Spring School		776	80		4½	Qa					PS.
282	NW¼NE¼ sec. 31, T. 24 N., R. 18 E.	K. Kollath		776	130	80	4½	Qa					Dom, S.
283	SW¼NW¼ sec. 24, T. 22 N., R. 17 E.	A. Techlin	1942	861	355	168	5	Cs	258	97			Dom, S.
284	SW¼SW¼ sec. 8, T. 24 N., R. 19 E.			771	70±		6				12.39	Nov. 18, 1954	S.
285	NE¼NW¼ sec. 7, T. 21 N., R. 17 E.	School District 9	1954	852	154	42	6	Ogp	42	112			PS.
286	SW¼NE¼ sec. 33, T. 23 N., R. 16 E.	W. Williams	1902	820	102	77	4	Cs	77	25			
287	SW¼NW¼ sec. 3, T. 23 N., R. 15 E.			783	200±			Qa	40	160+			

Drilled wells range in diameter from 3 to 16 inches, depending upon the size and type of pump to be used and the yield required. Those ending in consolidated rock are usually cased only through the drift; those penetrating just the drift use perforated casing or screen to keep the hole open and to allow water to enter the well. Some wells ending in coarse sand or gravel are cased with unperforated pipe, and water enters through the open bottom of the casing.

When a relatively small quantity of water is needed for stock or domestic use, a well may be driven into sandy deposits of the glacial drift or lake sediments. Such wells are usually 1¼ to 2½ inches in diameter and have a well point or a length of slotted pipe near the bottom. The driven well is best suited to the sandy areas in the northwestern quarter of the county.

A few dug wells are still in use for domestic and stock supplies, but most of them have been replaced by drilled or driven wells. The dug wells are 3 to 5 feet in diameter and as much as 30 feet deep. They have been dug by hand or by power shovel and are lined with stone to prevent caving. The material penetrated must be firm and must stand without caving, so the wells are usually dug through clay to the top of a more permeable underlying bed.

Twenty-four of the wells visited exceed 500 feet in depth. Of these, 20 are industrial or municipal wells along the Fox River. The deepest well visited is Ou 35, drilled for the Village of Kimberly and ending in granite at 804 feet. The average depth of the 257 wells whose depth is known is 195 feet, the median depth of the same wells is 127 feet—that is, 128 wells are less than and 128 wells are more than 127 feet deep.

SPRINGS

A spring is the discharge of ground water, under hydrostatic pressure, at the land surface or into lakes and streams. There are many different types of springs, but the two most common in Outagamie County may be classed as seepage and contact springs. Seepage springs represent an outcrop of the water table and may disappear during periods of water-table decline. They are most numerous in the low, marshy areas along the Wolf and Embarrass Rivers, where there is a considerable amount of effluent seepage. Although most marshy areas are the result of effluent ground-water seepage, in most places the seepage is not concentrated enough to be classed as a spring.

Contact springs occur when the contact between a permeable and an impermeable formation is exposed at the surface. Along the Fox River, ground water percolates downward through the glacial drift to the top of the less permeable Platteville formation, where some of the water moves laterally toward the river and issues as springs along the sides of the valley. At the base of the escarpment of Prairie du

Chien rocks between Hortonville and New London the process is reversed. Here artesian water rising in the permeable sandstone of Cambrian age is partly retarded by the overlying dolomite of the Prairie du Chien group and flows to the surface along the contact near the base of the scarp.

Weidman and Schultz report that springs were a common source of water supply in the county at the time of their report (1915), but now few are in use.

PUMPING TESTS

Determination of the hydraulic characteristics of an aquifer is essential in predicting the effects of withdrawal of water from it. The term coefficient of transmissibility is used to designate the amount of water, in gallons, that will pass in 1 day across a vertical strip of the aquifer, 1 foot wide and extending the full thickness of the aquifer, under a unit hydraulic gradient. The coefficient of storage of an aquifer is the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface.

The most reliable short-term method of determining the hydraulic characteristics of an aquifer is to apply the nonequilibrium formula of Theis (1935) to observations of the amount and rate of change in the piezometric surface at or near a discharging well.

The nonequilibrium formula is:

$$s = \frac{114.6\,Q}{T}\,W(u)$$

where $$W(u) = \int_u^\infty \frac{e^{-u}du}{u} = -0.577216 - \log_e u + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} \cdots$$

and $$u = \frac{1.87r^2S}{Tt}$$

where s = drawdown, in feet, at observation well
Q = discharge, in gallons per minute
T = coefficient of transmissibility, in gpd/ft
r = distance, in feet, from observation well to pumped well
S = coefficient of storage
t = time, in days, since pumping started

To develop the formula it was assumed that the aquifer is infinite in extent and confined between impermeable beds, that it transmits water equally in all directions and releases water from storage instantaneously with a decline in artesian head, and that its hydraulic characteristics do not change. It is recognized that these are ideal conditions which are never completely satisfied in nature, but in many areas they are substantially satisfied.

SEYMOUR TESTS

The pumping tests at Seymour in April 1949 consisted of pumping wells that tap sandstone of Cambrian age and observing the effects produced on the piezometric surface. Water-level measurements were

made with a steel tape in wells Ou 10 and 11 and with an air line in well Ou 1. Well Ou 7 was equipped with a water-stage recorder which made a continuous record of the water level in the well. The hydrographs (pl. 6) show the decline and recovery of water levels in three observation wells and the drawdown and recovery in the pumped well. Distances between wells are given in table 7, and computed values of the coefficients of transmissibility and storage are listed in table 8.

TABLE 7.—*Distances, in feet, between pumped well and observation wells used during pumping tests at Seymour, Wis.*

Pumped well	Observation well		
	Ou 7	Ou 10	Ou 11
Ou 1	2,890	1,595	368
Ou 10	2,390		1,875

TABLE 8.—*Coefficients of transmissibility and storage at Seymour, Wis., Apr. 18–22, 1949*

Pumped well Ou—	Observation well Ou—	Coefficient of transmissibility (gpd/ft)	Coefficient of storage	Duration of test (hours)
1 on		24,000		17½
	7	18,000	0.0002	17
	10	17,000	.0002	17
	11	[a] 15,000	[a] .0027	17
1 off		15,000		26
	7	19,000	.0002	19
	10	16,000	.0002	19
	11	[a] 21,000	[a] .0022	19
10 on		17,000		21½
	1	17,000	.0003	21½
	7	16,000	.0002	21½
	11	[a] 24,000	[a] .0010	21½
10 off		16,000		14
	1	18,000	.0003	12
	7	18,000	.0002	10½
	11	[a] 53,000	[a] .0014	12
Average		18,000	.0002	

[a] Not figured in average because well is shallow and penetrates a zone separated from principal aquifer by a shaly horizon.

Wells Ou 1 and 10 are deep wells which penetrate more than 200 feet of the sandstone. Well Ou 7 is drilled about 15 feet into the sandstone, and well Ou 11 is a shallow well which may be separated from the sandstone by several feet of shale. The shallow penetration of wells Ou 7 and 11 is reflected in their hydrographs, which show a relatively narrow range of fluctuations during the tests. For example, the water level in well Ou 11 was lowered less than 8 feet when well Ou 1 was pumped, whereas the water level in well Ou 10, at a much greater distance from the pumping well, was lowered nearly 6 feet during the same period. The small irregularities in the hydrograph of well Ou 7 were caused by the pumping of a shallow well nearby.

APPLETON TEST

In March 1954 a test was made in Appleton, using well Ou 22 as the pumped well and well Ou 253 as an observation well. The wells are 1,115 feet apart and both are open in the St. Peter sandstone, the dolomite of the Prairie du Chien group, and the underlying sandstone of Cambrian age. The average coefficient of transmissibility obtained from the drawdown and recovery tests is about 19,000 gpd per foot. The average coefficient of storage for the two tests is about 0.00015. The coefficients are based on measurements in only one observation well and may not be representative. However, they are in close agreement with values obtained in the Seymour tests, and the specific capacities of the wells are similar to those of other wells in the Appleton area.

HORTONVILLE TESTS

In Hortonville, pumping tests were made in October 1953 using wells Ou 33 and 80 as pumped wells and Ou 81 and 248–252 as observation wells. The pumped wells tap sandstone of Cambrian age which lies immediately below the glacial drift in this area.

Values obtained for the coefficient of transmissibility (T) range from about 27,000 to about 75,000 gpd per foot and average about 43,000 gpd. Values of the coefficient of storage (S) range from about 0.00006 to about 0.0009 and average about 0.0004. The wide range in T and S values, which is attributed to local recharge and the fact that some of the observation wells may terminate in the glacial drift, make it impossible to apply the values to a prediction of interference or water-level trends.

QUALITY

Chemical analyses of 37 samples of ground water from Outagamie County are listed in table 9. The chemical quality of the water differs greatly from well to well. For example, the mean hardness is about 385 ppm (median 300 ppm), but the range in hardness is from 1,200 ppm to 58 ppm. Although the water generally is very hard, the dissolved-solids content averages about 540 ppm (median about 350 ppm); a limit of 500 ppm is recommended by the U. S. Public Health Service (1946) for drinking and culinary water. The sulfate concentration ranges from 815 ppm to less than 1 ppm and averages about 169 ppm (median 30 ppm). The limit suggested by the Public Health Service for sulfate is 250 ppm. High iron content is a problem in many wells. A concentration of 27 ppm is reported in well Ou 56. However, in 34 analyses listed in table 9 the range is from 4.0 ppm to 0.0 ppm and the average is about 0.8 ppm (median 0.4 ppm). The median is 0.1 ppm above the limit set by the Public Health Service for iron, or iron and manganese together.

TABLE 9.—*Chemical analyses of ground water in Outagamie County, Wis.*

[Results in parts per million except pH; analyses by Wisconsin State Board of Health]

Well No. Ou—	Date of collection	Dissolved solids	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Hardness as $CaCO_3$	pH
1	1935	221	1.4			193	8	5		150	
2	[a] 1911	1,350		272	21		604	12		765	
	1935	1,460	.4			209	815	15		970	
10	Aug. 7, 1946	328	1.2	69	30	373	20	2.5	0.2	285	7.4
17	(a)	647		158	31		296	7.1		522	
26	1946	310	.8	70	27	331	30	3.5	.5	265	7.4
33	Mar. 11, 1949	346	.0	73	34	423	3.0	2.0	.1	320	7.4
34	1935	480	.3			376	122	10		450	
36	do	475	.5			293	152	8.0		380	
44	do	960				224	481	10		620	
	Mar. 6, 1946	1,040	.3	261	16	212	560	11	2.0	585	7.3
45	do	1,220	.4	312	16	222	660	14	2.0	670	7.3
46	Sept. 30, 1946	590	.2	135	20	257	245	12	1.9	385	7.4
47	do	548	.2	125	16	245	210	12	2.0	300	7.4
48	Apr. 8, 1954	1,670	1.8	362	68	456	725	28	1.0	1,200	7.1
54	do	354	.1	65	19	183	108	5.5	1.9	244	7.8
65	Apr. 23, 1954	1,020	.5	171	64	449	330	8.0	1.2	732	7.3
71	Feb. 16, 1950	180	.0	20	17	190	11	4.0	.2	120	7.7
72	1935	246	.2			268	22	8		260	
73	do	279	.4			309	16	3		250	
74	Apr. 23, 1954	302	.2	31	26	232	16	2.0	.2	176	8.1
85	Mar. 25, 1954	368	1.2	58	43	381	24	14	.1	341	7.6
87	do	370	.0	68	36	327	24	6.0	<.1	322	7.6
91	do	300	.6	34	40	320	12	3.5	.2	270	7.9
103	Apr. 8, 1954	1,010	.4	142	29	78	500	41	1.4	475	7.7
105	Mar. 25, 1954	290	4.0	56	34	356	2.5	2.0	.2	288	7.8
111	Apr. 8, 1954	298	.4	41	30	307	13	5.5	.7	235	7.7
114	do	520	1.6	87	44	417	49	44	<.1	403	7.4
125	Apr. 23, 1954	218	.1	31	20	217	22	2.0	.9	164	7.8
133	do	352	4.0	68	30	325	33	1.5	.1	299	7.3
138	do	288	1.6	56	29	320	7.0	1.5	.4	262	7.7
159	Apr. 8, 1954	258	.3	29	36	278	21	3.0	.2	236	8.0
165	Mar. 25, 1954	362	.6	53	39	412	2.0	2.5	.4	330	7.8
187	Apr. 23, 1954	196	.0	16	4.8	120	47	10	.6	58	8.3
196	do	630	1.2	98	50	400	73	35	<.1	472	7.4
259	do	296	1.0	26	41	354	.0	3.0	.3	268	7.7
260	do	238	.1	29	25	264	.5	2.0	.4	181	8.0

[a] Weidman, Samuel, and Schultz, A. R., 1915, p. 493.

Information on the chemical character of ground water is important to all users of this valuable resource. It is also an important tool for use by the hydrologist interested in the source and movement of water. A table of analyses, such as table 9, presents the available data but the form is not readily adaptable for interpretive work. In the past, several illustrative methods have been used to show the similarity or dissimilarity of various waters. These methods include the bar graph, the pie diagram, the trilinear plot, and others, each of which has advantages and disadvantages. R. C. Vorhis of the U. S. Geological Survey has suggested for interpretive work the use of a logarithmic diagram (Schoeller, 1935) adopted by the French hydrogeologists in Tunisia, Algeria, and French Morocco. The diagram consists of vertical logarithmic scales for constituents and properties, and the graph is a series of straight-line segments connecting the values plotted for each analysis (pl. 7). The similarity or difference of two analyses is readily apparent from a comparison of their graphs.

Logarithmic graphs for 22 analyses are shown on plate 7. They are grouped by geologic source to show that the source is the predominant factor in determining the pattern of the graph. The form of the graphs in diagram *A* is distinctive and is characteristic for wells that tap all the Paleozoic formations below the Maquoketa shale. Water from the Maquoketa shale is similar to, but more highly mineralized than, water from the Platteville and Galena formations (diagram *B*). Water from rocks of the Upper Cambrian series (diagram *C*) is generally characterized by a low chloride and sulfate content. Well Ou 10, which does not fit this pattern, is an old well cased through the Prairie du Chien. However, the graph for Ou 10 closely resembles those of diagram *D*, indicating that water from the Prairie du Chien must be entering the well through a defective casing, raising the sulfate content of the water sampled. The patterns of diagrams *D* and *E* are noticeably alike. They represent water from similar material but of a different age.

The graphs for well Ou 114 (diagram *C*), Ou 196 (diagram *D*), and Ou 85 (diagram *E*) are anomalous because of an abnormally high chloride content. This is attributed to their location near poorly drained, marshy areas where the chloride concentration of the water is increased by surface evaporation of the stagnant water. The pattern of diagram *F*, representing water from Pleistocene deposits, is somewhat similar to that of diagrams *D* and *E*, except for the nearly straight line formed by the calcium-magnesium-hardness plot.

The logarithmic diagram has been useful in the study of the geology and ground water of Outagamie County. Although a limited number of analyses were made and plotted, a definite tendency toward characteristic patterns for the various sources of water was

evident. Where other evidence was inconclusive, comparisons of water-analysis graphs helped in determining the source and movement of water and in establishing geologic boundaries.

CONCLUSIONS

More than three-fourths of Outagamie County is underlain by thick beds of sandstone of Cambrian age which supply most of the water to industrial and public-supply wells along the Fox River. Consolidated rocks of the St. Peter sandstone, Platteville formation and Galena dolonite, and Prairie du Chien group and unconsolidated deposits of Pleistocene age are tapped by many domestic and farm wells and probably could be developed to a much greater extent. An especially promising reservoir is the buried preglacial valley that heads near Seymour.

Recharge occurs throughout most of the county but is greatest in areas where the sandstones are at or near the surface. Practically all recharge is from local precipitation. Ground-water discharge occurs naturally by flow from contact and seepage springs; by diffused seepage into swamps, from which it is evaporated and transpired, and into streams; and by underflow to the south and east.

Ground-water pumpage along the Fox River in Outagamie County was about 4.3 mgd in 1952. There is no evidence of overdraft at present, but additional pumping tests should be made to determine the acquifer characteristics in localities other than the few already tested, to enable prediction of water-level trends and interference that would result from additional development.

WELL LOGS

Tables 10 and 11 contain selected logs of wells drilled in Outagamie County. The descriptions and stratigraphic correlations in table 10 are by F. T. Thwaites of the Wisconsin Geological Survey from his examination of drill cuttings from each well. In table 11, descriptions of the material penetrated are those of the driller and stratigraphic correlations are by the author.

Logs of 337 wells were collected from several sources during the investigation. Of these, 161 were located in the field, 49 logs were used in construction of the geologic sections, and 45 logs are published in tables 10 and 11. Essentially all drilling in the county is by the cable-tool method. This method, when used by experienced drillers facilities accurate logging of wells.

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*

[Interpretation by F. T. Thwaites, Wisconsin Geological Survey, on basis of examination of drill cuttings]

	Thickness (feet)	Depth (feet)
Well Ou 2, NE¼SW¼ sec. 24, T. 21 N., R. 18 E.		
Galena Dolomite and Platteville formation:		
Limestone	170	170
St. Peter sandstone:		
Dolomite, light-gray	3	173
Sandstone, medium- to fine-grained, gray, dolomitic	13	186
Sandstone, fine-grained; pebbles, pink; chert, white	14	200
Prairie du Chien group:		
Dolomite, light-gray; some shale, green	42	242
Sandstone, medium-grained, white; chert, white; shale, green	11	253
Dolomite, light-gray; some chert, white	115	368
Upper Cambrian series:		
Sandstone, fine-grained, light-gray; shale, red, dolomitic	12	380
Dolomite, dark-red	23	403
Sandstone, medium-gray; some pink and red, dolomitic	105	508
Sandstone, medium-grained, white	177	685
Sandstone, medium-grained, white, some red, dolomitic	15	700
Sandstone, medium- to fine-grained, white	78	778
Precambrian:		
Granite, red and gray	20½	798½
Well Ou 5, SW¼SE¼ sec. 4, T. 21 N., R. 19 E.		
Glacial drift:		
No samples	66	66
Galena dolomite and Platteville formation:		
Dolomite, gray	29	95
Dolomite, gray; some bluish-gray	15	110
Dolomite, light bluish-gray	5	115
Dolomite, gray and blue	24	139
Dolomite, blue; some gray	6	145
Dolomite, light and dark-gray	20	165
Dolomite, light-gray	5	170
Dolomite, dark-blue; some gray	17	187
Dolomite, gray	45	232
Dolomite, gray, very sandy	5	237
St. Peter sandstone:		
Sandstone, coarse- to medium-grained, gray	11	248
Sandstone, medium-grained, white	58	295
Sandstone, medium-grained, white and pink	17	312
Sandstone, medium-grained, white	21	333
Sandstone, medium- to fine-grained, very light gray	50	383
Sandstone, medium-grained, coarse, white	5	388
Sandstone, medium-grained, white	20	408
Well Ou 19, NE¼NW¼ sec. 35, T. 21 N., R. 17 E.		
Glacial drift:		
No samples	24	24
Galena dolomite and Platteville formation:		
Dolomite, blue-gray and gray	16	40
Dolomite, light-gray; chert, white	10	50
Dolomite, light-gray	30	80
Sandstone, fine- to medium-grained, light-gray, dolomitic; dolomite, very light gray	20	100
Prairie du Chien group:		
Dolomite, light-gray, sandy	10	110
Dolomite, light-gray	30	140
Dolomite, light-gray; sandstone, medium-to fine-grained, light-gray	5	145
Dolomite, light-gray	15	160
Dolomite, light-gray; chert, white	55	215
Dolomite, light-gray	60	275
Sandstone, fine- to medium-grained, light-gray, pink, dolomitic; chert	15	290
Upper Cambrian series:		
Sandstone, fine-grained, pink, dolomitic	10	300
Dolomite, sandy, red, gray, glauconitic	15	315
Sandstone, fine-grained, gray, red, dolomitic, glauconitic	10	325
Sandstone, medium- to fine-grained, light-gray, dolomitic; shale, red	45	370
Sandstone, medium- to fine-grained, light-gray, dolomitic	20	390
Sandstone, very fine to medium-grained, light-gray, dolomitic	15	405
Sandstone, coarse- to fine-grained, light-gray, dolomitic	15	420
Sandstone, fine- to medium-coarse-grained, light-gray	30	450

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 23, NW¼NW¼ sec. 34, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Till, red	18	18
Clay, red, dolomitic	30	48
Clay, red, sandy, dolomitic	6	54
No sample	5	59
Till, stony, gray	20	79
Gravel, fine, very stony	10	89
Sand and gravel	5	94
Gravel, stony	5	99
Galena dolomite and Platteville formation:		
Dolomite, light-gray, broken	10	109
Dolomite, light blue-gray; some light gray	10	119
Sandstone, medium-grained, light-gray, very dolomitic	5	124
No sample	5	129
Prairie du Chien group:		
Dolomite, sandy, light-gray	10	139
Dolomite, light-gray	75	214
No sample	5	219
Dolomite, light-gray; chert, white	20	239
Dolomite, light-gray	35	274
Dolomite, light-gray; shale, red	15	289
Dolomite, light-gray, gray, pink	10	299
Dolomite, gray; chert, gray, oolitic	5	304
No sample	5	309
Upper Cambrian series:		
Dolomite, sandy, light-gray, pink, glauconitic	15	324
Dolomite, sandy, dark-red	15	339
Sandstone, fine-grained, pink	21	360
Sandstone, fine- to medium-grained, light-gray, dolomitic, glauconitic	15	375
Sandstone, medium- to fine-grained, light-gray, dolomitic	35	410
Sandstone, fine-grained, light-gray, dolomitic	35	445
Siltstone, gray to light-gray, dolomitic	10	455
Sandstone, fine- to coarse-grained, light-gray, dolomitic	15	470
Sandstone, medium- to fine-grained, white, slightly dolomitic	68	538

Well Ou 24, NW¼NW¼ sec. 25, T. 21 N., R. 17 E.

Glacial drift:		
No samples	111	111
Galena dolomite and Platteville formation:		
Dolomite, gray	11	122
Dolomite, gray; blue spots	21	143
Dolomite, very light gray, sandy, pyritic	5	148
Prairie du Chien group:		
Dolomite, gray, blue spots, pyritic	5	153
Dolomite, gray, blue spots, sandy	10	163
Dolomite, very light gray and gray, sandy	15	178
Dolomite, light-gray	46	224
Dolomite, gray, greenish-gray, sandy, cherty	12	236
Dolomite, light-gray; some white chert	19	255
Dolomite, light-gray	53	308
Dolomite, light-gray, greenish-gray, red	5	313
Dolomite, light-gray	21	334
Dolomite, red, sandy; chert, pink, oolitic	10	344
Upper Cambrian series:		
Sandstone, medium-grained, pinkish-gray, dolomitic	10	354
Sandstone, medium-grained, light-gray, dolomitic	8	362
Sandstone, very fine grained, red, very dolomitic	15	377
Sandstone, fine-grained, gray, very dolomitic, glauconitic	28	405
Sandstone, medium- to coarse-grained, gray, dolomitic	36	441
Sandstone, medium-grained, white, slightly dolomitic	20	461
Sandstone, medium- to fine-grained, light-gray, dolomitic	17	478
Shale, gray, very sandy, dolomitic	16	494
Sandstone, medium- to coarse-grained, gray, dolomitic	7	501

Well Ou 26, SE¼SE¼ sec. 20, T. 21 N., R. 17 E.

Glacial drift:		
Clay	25	25
Till, gray, dolomitic	10	35
Gravel, fine; much silt	10	45
Galena dolomite and Platteville formation:		
Dolomite, gray, light-gray; some blue specks	20	65
Dolomite as above; sandstone, medium- to fine-grained, light-gray, dolomitic	10	75

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 26, SE¼SE¼ sec. 20, T. 21 N., R. 17 E.—Continued

	Thickness (feet)	Depth (feet)
Prairie du Chien group:		
Dolomite, light-gray	30	105
Dolomite, light-gray; chert, white, oolitic	15	120
Dolomite, light-gray, sandy; chert, white	10	130
Dolomite, light-gray	20	150
Dolomite, light-gray; some chert, white	15	165
Dolomite, light-gray	45	210
Dolomite, light-gray; some sand	10	220
Dolomite, pink, light-gray; chert, gray, oolitic	5	225
Upper Cambrian series:		
Sandstone, fine-grained, silty, purple, very dolomitic	20	245
Sandstone, fine-grained, red, dolomitic	10	255
Sandstone, fine-grained, silty, pink, green-gray, dolomitic, glauconitic	25	280
Sandstone, fine- to medium-grained, light-gray to pink, dolomitic	40	320
Sandstone, medium- to fine-grained, light-gray	5	325
Sandstone, fine- to medium-grained, light-gray, dolomitic	20	345
Siltstone, light-gray, dolomitic	5	350
Sandstone, fine-grained, silty, light-gray, dolomitic	15	365
Sandstone, fine-grained, gray, dolomitic, glauconitic	10	375
Sandstone, coarse- to fine-grained, light-gray, dolomitic	10	385
Sandstone, medium- to fine-grained, light-gray	175	560
Sandstone, fine- to medium-grained, light-pink; some light gray, dolomitic	50	610
Sandstone, medium- to fine-grained, light-gray	15	625
Sandstone, fine- to medium-grained, light-gray, part dolomitic	37	662

Well Ou 33, NW¼SE¼ sec. 35, T. 22 N., R. 15 E.

Glacial drift:		
Soil, black, on gray silt	7	7
Till, pink, dolomitic	8	15
Till, gray, dolomitic	4	19
Clay, red, dolomitic	17	36
Sand, medium, silty, gray, dolomitic; flow	1	37
Gravel and red clay mixed	3	40
Gravel, coarse, stony	14	54
Gravel; pebbles; siltstone, red, gray, dolomitic	4	58
Upper Cambrian series:		
Siltstone, red, gray, dolomitic, glauconitic	11	69
Sandstone, fine- to medium-grained, red, dolomitic, glauconitic	21	90
Sandstone, fine- to medium-grained, pink, dolomitic	8	98
Sandstone, medium- to fine-grained, light-gray	6	104
Sandstone, medium- to coarse-grained, light-gray	30	134
Sandstone, medium- to fine-grained, light-gray	38	172
Sandstone, fine- to coarse-grained, pink, dolomitic	18	190
Sandstone, medium- to fine-grained; some coarse, white	150	340

Well Ou 36, SW¼SW¼ sec. 22, T. 21 N., R. 18 E.

Glacial drift:		
Clay	5	5
Galena dolomite and Platteville formation:		
Dolomite, light brown-gray	5	10
Dolomite, brown-gray, blue specks	5	15
Dolomite, gray, blue specks	50	65
Dolomite, gray, some blue-gray	25	90
Dolomite, blue, mottled blue and gray	11	101
Dolomite, light-gray	7	108
Dolomite, light and dark-gray	6	114
Dolomite, light, dark-gray; some chert, white	25	139
Dolomite, blue, gray	12	151
Prairie du Chien group:		
Sandstone, medium- to coarse-grained, gray, very dolomitic; chert, white; shale, green	13	164
Sandstone, medium-fine-grained, gray, very dolomitic, hard	25	189
Dolomite, gray, sandy, pyritic; chert, white	11	200
Dolomite, light-gray, pyritic; shale, dark-gray	15	215
Dolomite, light-gray, sandy; chert, oolitic	14	229
Sandstone, fine-grained, white, dolomitic; chert, white	8	237
Dolomite, gray; sandstone, fine-grained, gray; chert, oolitic	5	242
Dolomite, gray; chert, white	25	267
Dolomite, gray	36	303
Dolomite, gray; chert, white	5	308
Dolomite, gray	11	319
Dolomite, banded purple-gray, sandy, glauconitic	10	329
Sandstone, very fine grained, gray, very dolomitic	6	335
Dolomite, gray, pink, sandy	10	345

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 36, SW¼SW¼ sec. 22, T. 21 N., R. 18 E.—Continued

	Thickness (feet)	Depth (feet)
Upper Cambrian series:		
Sandstone, very fine grained, pink, dolomitic; dolomite, gray	14	359
Sandstone, fine-grained, light-gray, dolomitic	10	369
Sandstone, medium- to very fine grained, pink, dolomitic	5	374
Sandstone, fine-grained, dark pink, dolomitic, glauconitic	8	382
Sandstone, fine-grained, dark-gray, dolomitic, glauconitic	5	387
Sandstone, fine-grained, silty, green, dolomitic	27	414
Sandstone, medium- to fine-grained, gray, white	7	421
Sandstone, very fine to fine-graine , dark-gray, dolomitic	29	450
Sandstone, fine-grained, gray, dolomitic	15	465
Sandstone, fine- to medium-grained, gray, dolomitic	20	485
Sandstone, medium- to fine-grained, gray, silty	5	490
Sandstone, fine- to medium-grained, silty, light-gray	15	505
Sandstone, medium- to fine-grained, silty, gray	25	530
Sandstone, fine- to medium-grained, light-gray	10	540
Sandstone, very fine to fine-grained, light-gray	15	555
Sandstone, fine- to medium-grained, light-gray	65	620
Sandstone, medium- to fine-grained, light-gray	10	630
Sandstone, fine- to medium-grained, light-gray	20	650
Sandstone, medium- to fine-grained, light-pink-gray	10	660
Sandstone, fine-grained, silty, pink	15	675
Sandstone, fine-grained, light-gray	20	695
Sandstone, medium- to fine-grained, light-gray	30	725
Sandstone, fine- to medium-grained, light-gray	5	730
Precambrian:		
Granite, light-pink	4	734

Well Ou 71, SE¼SW¼ sec. 9, T. 23 N., R. 17 E.

Glacial drift:		
Clay, red, dolomitic	80	80
Clay, gray, dolomitic	35	115
Gravel, coarse, pebbles to over ½-inch, stony	40	155
Sand, coarse, gray	3	158

Well Ou 82, SE¼NE¼ sec. 2, T. 21 N., R. 15 E.

Glacial drift:		
Till, red, dolomitic	8	8
Till, light pinkish-gray, dolomitic	72	80
Upper Cambrian series:		
Dolomite, very sandy, pink, red; shale, red	14	94
Sandstone, medium-grained, light-gray, pink, dolomitic, glauconitic	6	100
Sandstone, medium-grained, white	20	120
Sandstone, medium-grained, white; some yellow gray, dolomitic	14	134

Well Ou 97, SE¼SE¼ sec. 8, T. 23 N., R. 17 E.

Glacial drift:		
Surface soil	2	2
Clay, red	50	52
"Pack sand" and "quicksand"	38	90
"Sand-pan" and "quicksand"	20	110
"Gumbo" clay, red	20	130
"Gumbo" clay, black	38	168
"Hardpan"	100	268
"Pack sand"	2	270
Sand, coarse	8	278
"Hardpan"	25	303
"Hardpan" and "bedrock"	28	331
Sand	2	333
"Bedrock"	12	345
Sand, coarse; some water: "pack sand"	5	350
Gravel, very coarse; "hardpan"	5	355
Sand, very coarse; some water	10	365
"Hardpan," blue and gray	5	370
Gravel, coarse, and "hardpan," gray	10	380
"Bedrock" and gravel	5	385
Sand, rock and gravel; layers of mud	10	395
Gravel and rock, streaks of clay, dry, red; gravel and sand	23	418
Gravel and sand, clay, dry, red and streaks of shale rock mixed	28	446
Rock	3	449
"Shale hardpan"	24	473
Streaks of rock and shale	11	484
No record	28	512
Precambrian:		
Granite, pink, gneissic	58	570

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 101, SE¼NE¼ sec. 31, T. 23 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Gravel and sand	8½	8½
Prairie du Chien group:		
Dolomite, gray	5½	14
Dolomite, brownish-gray, sandy, pyritic	5	19
Dolomite, gray	31	50
Dolomite, pink and gray	30	80
Dolomite, gray, green, and pink; chert, white, oolitic	11	91
Upper Cambrian series:		
Sandstone, medium-grained, gray, dolomitic	8	99
Sandstone, very fine grained, pink, red and gray, dolomitic	19	118
Sandstone, very fine grained, red and gray, very dolomitic, hard	6	124
Dolomite, sandy, red, glauconitic	6	130
Sandstone, very fine grained, dark red, dolomitic, glauconitic	5	135
Sandstone, medium-grained, gray and pink, dolomitic	75	210
Sandstone, very fine grained, gray, dolomitic, some glauconite	5	215
Sandstone, medium-fine-grained, white, dolomitic, glauconitic	15	230
Sandstone, medium-to fine-grained, light-gray, dolomitic, hard	10	240
Sandstone, like above with streaks of gray dolomite	10	250
Sandstone, medium-to-fine-grained, white	25	275
Sandstone, medium-to-fine-grained, white, streaks of pink dolomite	20	295
Sandstone, fine-to-coarse-grained, white	10	305

Well Ou 102, NW¼SW¼ sec. 23, T. 21 N., R. 18 E.

Glacial drift:		
Till, red, dolomitic	10	10
Clay, gray, dolomitic	10	20
Till, gray, dolomitic	5	25
Galena dolomite and Platteville formation:		
Dolomite, gray	30	55
Dolomite, light-gray	30	85
Dolomite, light-gray and gray	20	105
Dolomite, blue-gray	20	125
No samples	20	145
Dolomite, light-gray	10	155
Dolomite, gray and light-gray	40	195
Dolomite, light-gray; much sand	20	215
Prairie du Chien group:		
Dolomite, light-gray, green spots	20	235
Dolomite, light-gray	10	245
Dolomite, light-gray; chert, dense and oolitic, red and gray; sandstone, fine-grained, white, very dolomitic	40	285
Dolomite, light-gray	17	302

Well Ou 280, NW¼NW¼ sec. 34, T. 21 N., R. 17 E.

Glacial drift:		
Sand, fine, gray-pink, weathered	5	5
Till, pink, dolomitic	80	85
Gravel, fine, stony	5	90
Till, light yellow-gray	5	95
Galena dolomite and Platteville formation:		
Dolomite, light-gray; some light blue-gray	10	105
Sandstone, medium-to fine-grained, light-gray, dolomitic	10	115
St. Peter sandstone:		
Sandstone, fine-to medium-grained, very light gray	20	135
Chert, gray, pink-gray	5	140
Shale, red; chert, green-gray, pink	5	145
Chert, gray, yellow-gray, pink-gray; quartzite, fine-grained, light-gray	40	185
Prairie du Chien group:		
Dolomite, very light gray	30	215
Dolomite, light-gray to very light gray	20	235
Dolomite, light-gray	40	275
Dolomite, light-gray, pink, some sand	5	280
Dolomite, very light gray, light-gray	30	310
Dolomite, very light gray, sandy; chert, gray, oolitic	5	315
Upper Cambrian series:		
Sandstone, very fine-grained, very light gray, dolomitic	10	325
Sandstone, very fine grained to silty, orange-pink, dolomitic	5	330
Siltstone, red-brown, red, red-orange, green-gray, glauconitic, dolomitic; shale, gray-green	25	355
Sandstone, fine-grained, pale-red, dolomitic, glauconitic	5	360
Sandstone, fine-grained, light pink-gray, dolomitic, glauconitic	10	370
Sandstone, fine- to medium-grained, light-gray, dolomitic, some glauconite	65	435
Sandstone, fine-grained, light-gray, some glauconite	15	450
Siltstone, light medium-grained, gray, dolomitic, hard	5	455
Sandstone, fine- to coarse-grained, light-gray, dolomitic	10	465

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 280, NW¼NW¼ sec. 34, T. 21 N., R. 17 E.—Continued

	Thickness (feet)	Depth (feet)
Upper Cambrian series—Continued		
Sandstone, fine- to medium-grained, very light gray	45	510
Sandstone, medium- to fine-grained, very light gray	5	515
Sandstone, fine- to medium-grained, very light gray	110	625
Sandstone, medium- to fine-grained, very light gray	5	630
Sandstone, fine- to medium-grained, very light gray	25	655
Sandstone, medium- to fine-grained, very light gray	5	660
Sandstone, very fine to medium-grained, very light gray	20	680
Sandstone, fine- to medium-grained, very light gray	10	690
Sandstone, very fine to medium-grained, very light gray	10	700
Sandstone, medium- to fine-grained, very light gray	5	705
Sandstone, fine- to medium-grained, very light gray	10	715
Sandstone, medium- to fine-grained, very light gray	5	720
Sandstone, fine- to medium-grained, very light gray	25	745

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*

Interpretation, by the author, of drillers' logs from the files of the Wisconsin State Board of Health]

Well Ou 104, NW¼SE¼ sec. 32, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	10	10
Gravel	23½	33½
Galena dolomite and Platteville formation:		
Lime rock	8½	42
St. Peter sandstone:		
Sandstone	7	49

Well Ou 105, NE¼SW¼ sec. 29, T. 21 N., R. 16 E.

Alluvium and drift:		
Gravel and sand	30	30
Sand and clay	12	42
Prairie du Chien group:		
Limestone	86	128
Upper Cambrian series:		
Sandstone	14	142

Well Ou 106, NW¼SW¼ sec. 36, T. 21 N., R. 15 E.

Alluvium and drift:		
Sand and gravel	40	40
Prairie du Chien group:		
Limestone	86	126
Upper Cambrian series:		
Sandstone	12	138

Well Ou 107, NW¼NW¼ sec. 33, T. 22 N., R. 16 E.

Alluvium and drift:		
Clay	10	10
Clay and sand	40	50
Sand	10	60
Hardpan	5	65
Prairie du Chien group:		
Limestone	100	165
Upper Cambrian series:		
Sandstone, red	15	180

Well Ou 111, NE¼NE¼ sec. 32, T. 22 N., R. 18 E.

Alluvium and drift:		
Clay	34	34
Galena dolomite, Platteville formation, and Prairie du Chien group:		
Limestone	206	240
Sandstone	10	250
Limestone	55	305

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 115, SW¼SW¼ sec. 30, T. 22 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	15	15
Sand and gravel	45	60
Hardpan and stones	30	90
Galena dolomite, Platteville formation, and Prairie du Chien group:		
Shell limestone	6	96
Limestone	208	304

Well Ou 117, SE¼SE¼ sec. 6, T. 22 N., R. 18 E.

Alluvium and drift:		
Clay	40	40
Sand	17	57
Hardpan	16	73
Galena dolomite and Platteville formation:		
Hard rock	23	96
St. Peter sandstone:		
Sandstone	34	130

Well Ou 119, SE¼SE¼ sec. 18, T. 24 N., R. 17 E.

Alluvium and drift:		
Soil and clay	28	28
Quicksand	40	68
Clay	49	117
Hardpan	20	137
Gravel		

Well Ou 124, SE¼NE¼ sec. 30, T. 23 N., R. 19 E.

Alluvium and drift:		
Sand	20	20
Clay	6	26
Hardpan	16	42
Clay	16	58
Galena dolomite and Platteville formation:		
Limestone	42	100
St. Peter sandstone:		
Shale	2	102
Limestone	1	103
Shale	4	107
Sandstone	13	120

Well Ou 126, NW¼SW¼ sec. 20, T. 23 N., R. 19 E.

Alluvium and drift:		
Sand	46	46
Clay	11	67
Hardpan	11	78
Clay	12	90
Gravel	2	92

Well Ou 152, SE¼SW¼ sec. 12, T. 23 N., R. 17 E.

Alluvium and drift:		
Clay	42	42
Hardpan	4	46
Clay	10	56
Hardpan	29½	85½

Well Ou 154, SE¼NW¼ sec. 30, T. 24 N., R. 17 E.

Alluvium and drift:		
Soil and sand	6	6
Clay	20	26
Quicksand	15	51
Clay	53	103
Hardpan	10	113
Sand and gravel		

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 163, SW¼SW¼ sec. 6, T. 23 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand	10	10
St. Peter sandstone:		
Sandstone	44	54

Well Ou 167, SE¼SE¼ sec. 5, T. 22 N., R. 17 E.

Alluvium and drift:		
Soil and clay, red	50	50
Hardpan and gravel	23	73
Prairie du Chien group:		
Limestone	52	125
Upper Cambrian series:		
Sandstone	100	225

Well Ou 175, NW¼NE¼ sec. 5, T. 24 N., R. 17 E.

Alluvium and drift:		
Sand	15	15
Clay	25	40
Quicksand	30	70
Clay	60	130
Hardpan	11	141
Sand, coarse	10	151

Well Ou 177, NW¼NE¼ sec. 9, T. 24 N., R. 16 E.

Alluvium and drift:		
Overburden	68	68
Upper Cambrian series:		
Sandstone	34	102

Well Ou 188, SE¼SW¼ sec. 24, T. 24 N., R. 16 E.

Alluvium and drift:		
Soil, sandy	12	12
Clay, hard	65	77
Hardpan	26	103
Sand		

Well Ou 193, SW¼NW¼ sec. 15, T. 23 N., R. 17 E.

Alluvium and drift:		
Clay	80	80
Sand	20	100
Hardpan	50	150
Gravel	4	154

Well Ou 197, NW¼NW¼ sec. 35, T. 23 N., R. 16 E.

Alluvium and drift:		
Soil	40	40
Hardpan	48	88
Upper Cambrian series:		
Sandstone	12	100

Well Ou 200, NW¼NW¼ sec. 26, T. 21 N., R. 15 E.

Alluvium and drift:		
Soil and clay	7	7
Prairie du Chien group:		
Shell rock	6	13
Limestone	42	55
Upper Cambrian series:		
Sandstone	11	66

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 206, NE¼NE¼ sec. 32, T. 23 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Soil	13	13
Galena dolomite and Platteville formation:		
Limestone	27	40

Well Ou 227, NW¼NW¼ sec. 30, T. 24 N., R. 15 E.

Alluvium and drift:		
Clay	22	22
Sand and clay	68	90
Sand, fine	11	101
Sand, medium	5	106

Well Ou 230, SW¼SW¼ sec. 28, T. 24 N., R. 15 E.

Alluvium and drift:		
Soil and clay, red	25	25
Quicksand	10	35
Clay, blue and stones	40	75
Sand	3	78
Clay, red; sand, stones	50	128
Clay, blue	23	151
Gravel	8	159

Well Ou 232, NW¼SW¼ sec. 7, T. 23 N., R. 15 E.

Alluvium and drift:		
Sand	25	25
Clay	55	80
Sand and gravel	20	100

Well Ou 235, NW¼SW¼ sec. 19, T. 22 N., R. 15 E.

Alluvium and drift:		
Sand	106	106
Clay	67	173
No record	7	180
Sand	9	189
Gravel	8	197

Well Ou 263, SW¼NW¼ sec. 24, T. 22 N., R. 16 E.

Alluvium and drift:		
Clay	10	10
Sand and clay	20	30
Sand	60	90
Hardpan	20	110
Sand	62	172
Rock	8	180
Upper Cambrian series: Sandstone	162	342

Well Ou 272, SE¼NW¼ sec. 17, T. 22 N., R. 16 E.

Alluvium and drift:		
Clay and stones	43	43
Sand	22	65
Upper Cambrian series:		
Sand rock	60	125

Well Ou 275, SW¼SW¼ sec. 8, T. 22 N., R. 16 E.

Alluvium and drift:		
Clay, sand, gravel, and hardpan	205	205
Rock (could not drill farther)		205

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

	Thickness (feet)	Depth (feet)
Well Ou 279, NW¼NW¼ sec. 1, T. 24 N., R. 18 E.		
Alluvium and drift:		
Clay	16	16
Hardpan	14	30
Clay	8	38
Galena dolomite and Platteville formation:		
Limestone	25	63
Well Ou 283, SW¼NW¼ sec. 24, T. 22 N., R. 17 E.		
Alluvium and drift:		
Clay	35	35
Sand	60	95
Clay	28	123
Sand	60	183
Hardpan	5	188
Galena dolomite, Platteville formation, and Prairie du Chien group:		
Lime rock	70	258
Upper Cambrian series:		
Sandstone	97	355
Well Ou 285, NE¼NW¼ sec. 7, T. 21 N., R. 17 E.		
Alluvium and drift:		
Soil	5	5
Clay	25	30
Hardpan	12	42
Galena dolomite and Platteville formation:		
Limestone, hard	88	130
Limestone, porous	24	154

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INDEX

	Page
Abstract	1
Acknowledgments	3
Appleton, Wis	3, 4, 5, 9, 18, 41
Aquifers	11, 17, 39
Artesian water	13, 17, 39
Bear Creek	15
Bedrock structure	14–15
Bedrock topography	15–16
Black Creek, Wis	13, 16
Cenozoic rocks	13–14
Chert, oolitic	10
Climate	5–6
Combined Locks, Wis	24
Conclusions	44
Culture	4
Darcy's law	18
Deposition	17
Domes	9, 14
Drainage	5
Dresbach sandstone	8
Drilling	38, 44
Drumlins	4, 13, 16
Duck Creek, Wis	5, 12
Embarrass River	5, 14, 38
Erosion	16, 17
Eskers	13, 16
Extent of area	3
Farms	4
Faults	15
Fox River	4, 5, 8, 11, 12, 18, 23, 24, 38, 44
Fox River drainage basin	5
Franconia sandstone	8
Galena dolomite (*See* Platteville formation)	7, 12, 44
Geologic units	6–14; pl. 2
Glacial stage, Wisconsin	13
Graphs, logarithmic, for water analyses	43; pl. 7
Green Bay, Wis	3, 18
Ground water	17–44
levels	19–24
movement	17–19
quality	41–44
source	8, 17–19
use	24
Hortonville, Wis	8, 15, 16, 41
Hydrographs	23, 40
Industrial growth, Outagamie County	4
Introduction	2
Kaukauna, Wis	18, 19, 24
Kimberly, Wis	24, 38
Lawrence College	4
Literature cited	54–55
Little Chute, Wis	24
Location of area	3
Mapping, geologic reconnaissance	3
Maquoketa shale	7, 12, 43
Method of investigation	2–3
Moraines, glacial	13, 17
Mosquito Hills	8, 16
New London, Wis	5, 13
New Richmond sandstone	9
Nonequilibrium formula	39
Oneota dolomite	9
Oshkosh, Lake	13, 16
Paleozoic rocks	8–12
Cambrian system	8–9
Ordovician system	9–12
Peat	14
Piezometric map	17, 19, 20; pl. 5
Piezometric surface, definition	17
Platteville formation and Galena dolomite	7, 12, 44
Pleistocene deposits	7, 13
Population, Outagamie County 1950	4
Prairie du Chien group	4, 7, 9–11, 14, 15, 44
Precambrian rocks	6–8
Precipitation	6, 19, 23, 24
Previous reports	3
Public Health Service, water quality standards	41
Pumping tests	39–41
Purpose of investigation	2
Quarries	9, 12
Quaternary system	13–14
Rapide Croche Dam	5
Recent deposits	14
Recharge	17, 18, 19, 23, 44
St. Peter sandstone	7, 9, 11, 14, 15, 41, 44
Scope of investigation	2
Seymour, Wis	5, 8, 15, 18
Shakopee dolomite	9
Shioc River	5, 14
Shiocton, Wis	5
Specific capacity	9–11, 13
Springs	38–39
Storage coefficient	39
at Appleton	41
at Hortonville	41
at Seymour	40
Temperature	5, 6, 19
Till	13
Topography	4
Transmissibility coefficient	39
at Appleton	41
at Hortonville	41
at Seymour	40
Trempealeau formation	8
University of Wisconsin	2
Upper Cambrian series	7–9, 14, 16
Water-bearing properties of geologic units	6–14
Well logs	44–54
Wells	24–38; pl. 6
records	25–37
Winnebago, Lake	5, 18
Wisconsin State Board of Health	3
Wisconsin State Laboratory of Hygiene	3
Wolf River	5, 14, 15, 16, 19, 38
Yield factor	9–11, 13

Pre-CERCLA Screening Checklist/Decision Form

This form is used in conjunction with a site map and any additional information required by the EPA Region to document completion of a Pre-CERCLA Screening (PCS). The form includes a decision on whether a site should be added to the Superfund program's active site inventory for further investigation. This checklist replaces Attachment A in the December 2016 PCS Guidance document. A current version of the PCS checklist and additional information is available at: https://www.epa.gov/superfund/pre-cercla-screening.

Region: 5 **State/Territory:** WI **Tribe:** _____ EPA ID No. (If Available): _____

Site Name: USACE Parcel J

Other Site Name(s): Kaukauna Power Canal

Site Location: RIVERS EDGE AT APARTMENTS ON BICENTENNIAL COURT (Street)

8 (Congressional District) | Kaukauna (City) | WI (State/Terr.) | OUTAGAMIE (County) | 54130 (Zip+4) | ☑ (No Zip Available)

If no street address is available: T21N R18E (Township-Range) 23 (Section)

Checklist Preparer:

BJ LeRoy (Name / Title) 04/16/2019 (Date)

Wisconsin Department of Natural Resources (Organization) (920) 662-5164 (Phone)

2984 Shawano Avenue (Street) BJ.LeRoy@Wisconsin.gov (e-Mail)

Green Bay (City) | WI (State/Terr.) | BROWN (County) | 54313-6727 (Zip+4)

Site Contact Info/Mailing Address: BJ LeRoy
2984 Shawano Avenue, Green Bay, 54313-6727

CERCLA 105d Petition for Preliminary Assessment? No **If Yes, Petition Date (mm/dd/yyyy):** _____

RCRA Subtitle C Site Status: Is site in RCRA Info? No **If Yes, RCRA Info Handler ID #:** _____

Ownership Type: Brownfields/Public **Additional RCRA Info ID #(s):** _____

Site Type: Other **State ID #(s):** 02-45-548419

Site Sub-Type: Other - Open field/riverbank **Other ID #(s):** _____

Federal Facility? Yes **Federal Facility Owner:** Army Corps of Engineers

Formerly Used Defense Site (FUDS)? No

Federal Facility Docket? No **If Yes, FF Docket Listing Date (mm/dd/yyyy):** _____

Federal Facility Docket Reporting Mechanism: (Make selection)

Native American Interest? No **If Yes, list Tribe:** _____

Additional Tribe (s): (Make Selection)

Additional Tribe (s): (Make Selection)

Site Description

Use this section to briefly describe site background and conditions if known or (easily) available, such as: operational history; physical setting and land use; site surface description, soils, geology and hydrogeology; source and waste characteristics; hazardous substances/contaminants of concern; historical releases, previous investigations and cleanup activities; previous regulatory actions, including permitting and enforcement actions; institutional controls; and community interest.

Parcel J is a strip of river bank no more than 46 feet wide, immediately upstream (west) of the Kaukauna City Dam and Power Canal, on the south side of the river. The property has more than a century of activity, dating back to 1885 with the Kaukauna Water Power Company, and likely before. As of 1910, a railroad spur and associated buildings existed on and adjacent to the property. The USACE took over supervision of river traffic in the late 1800s, and the property transferred to federal ownership in the early 1900s.

Photographs from the 1950s show a mostly wooded lot and existence of a small pond. Also according to aerial photographs, filling activities took place beginning in the 1960s, and an unimproved road existed until at least 1992. Since approximately 2000, residential apartment complexes neighbor the riverbank. The riverbank exists as partially-wooded grass yard as of 2019.

Geospatial Information

Latitude: +44.281215 **Longitude:** -88.276265

Decimal Degree North (e.g., 38.859156) Decimal Degree West (e.g., 77.036783)

Provide 4 significant digits at a minimum, more if your collection method generates them.

Except for certain territories in the Pacific Ocean, all sites in U.S. states and territories are located within the northern and western hemispheres and will have a positive latitude sign and negative longitude sign. Coordinate signs displayed above are based on the State/Territory entry on page A-1. Geospatial data tips from the PCS Guidance document are available **here**.

Point Description: Select the option below that best represents the site point for future reference and to distinguish it from any nearby sites. See additional information **here**.

- ☐ Geocoded (address-matched) Site Address
- ☐ Site Entrance (approximate center of curb-cut)
- ☒ Approximate Center of Site
- ☐ Other Distinguishing Site Feature (briefly describe):

Point Collection Method: Check the method used to collect the coordinates above and enter the date of collection. See additional information **here**.

- ☒ Online Map Interpolation
- ☐ GPS (handheld, smartphone, other device or technology with accuracy range < 25 meters)
- ☐ GPS Other (accuracy range is ≥ 25 meters or unspecified)
- ☐ Address Matching: Urban
- ☐ Address Matching: Rural
- ☐ Other Method (briefly describe below):

Collection Date (mm/dd/yyyy): 04/15/2019

POINT-SELECTION CONSIDERATIONS

- Often the best point is a feature associated with the environmental release or that identifies the site visually.
- Use the curb cut of the entrance to the site if there is a clear primary entrance and it is a good identifier for the overall location.
- The approximate center of the site (a guess at the centroid) is useful for large-area sites or where there are no appropriate distinguishing features.
- Use the geocoded address if that is the only or best option available, but if possible use something more representative for sites larger than 50 acres.

Complete this checklist to help determine if a site should be added to the Superfund Active site inventory. See Section 3.6 of the PCS guidance for additional information.	YES	NO	Unknown
1. An initial search for the site in EPA's Superfund active, archive and non-site inventories should be performed prior to starting a PCS. Is this a new site that does not already exist in these site inventories?	☒	☐	☐
2. Is there evidence of an actual release or a potential to release?	☒	☐	☐
3. Are there possible targets that could be impacted by a release of contamination at the site?	☒	☐	☐
4. Is there documentation indicating that a target has been exposed to a hazardous substance released from the site?	☒	☐	☐
5. Is the release of a naturally occurring substance in its unaltered form, or is it altered solely through naturally occurring processes or phenomena, from a location where it is naturally found?	☒	☐	☐
6. Is the release from products which are part of the structure of, and result in exposure within, residential buildings or business or community structures?	☐	☒	☐
7. If there has been a release into a public or private drinking water supply, is it due to deterioration of the system through ordinary use?	☐	☒	☐
8. Are the hazardous substances possibly released at the site, or is the release itself, excluded from being addressed under CERCLA?	☐	☒	☐
9. Is the site being addressed under RCRA corrective action or by the Nuclear Regulatory Commission?	☐	☒	☐
10. Is another federal, state, tribe or local government environmental cleanup program other than site assessment actively involved with the site (e.g., state voluntary cleanup program)?	☐	☒	☐
11. Is there sufficient documentation or evidence that demonstrates there is no likelihood of a significant release that could cause adverse environmental or human health impacts?	☐	☒	☐
12. Are there other site-specific situations or factors that warrant further CERCLA remedial/integrated assessment or response?	☐	☐	☒

Preparer's Recommendation: ☒ **Add** site to the Superfund Active site inventory.

☐ **Do not add** site to the Superfund Active site inventory.

Please explain recommendation below:

PCS Summary and Decision Rationale

Use this section to summarize PCS findings and support the decision to add or not add the site to the Superfund active site inventory for further investigation. Information does not need to be specific but, where known, can include key factors such as source and waste characteristics (e.g., drums, contaminated soil); evidence of release or potential release; threatened targets (e.g., drinking water wells); key sampling results (if available); CERCLA eligibility; involvement of other cleanup programs; and other supporting factors. Attach additional pages as necessary.

The Parcel J property contains lead in shallow soil above the state non-industrial direct contact limit. Limited site investigations showed that the top 2-4 feet of soil are contaminated. No groundwater contamination existed as of 2006; however TCLP and SPLP samples at the time showed the potential to leach lead into groundwater at concentrations 15 times higher than the enforcement standard. Due to a dispute over the lead source, the USACE (current owner) plans no further site investigation or remediation. Site work halted in 2006, and the nature/extent of lead contamination remain unknown. Potential receptors include residents by direct contact, drinking water, and the ecological food chain through plant and/or surface water uptake.

BJ LeRoy	State staff/State contractor	04/16/2019
Checklist Preparer Name	Checklist Preparer Organization	Date

EPA Regional Review and Pre-CERCLA Screening Decision

Add site to the Superfund active site inventory for completion of a:

- ☒ Standard/full preliminary assessment (PA)
- ☐ Abbreviated preliminary assessment (APA)
- ☐ Combined preliminary assessment/site inspection (PA/SI)
- ☐ Inegrated removal assessment and preliminary assessment
- ☐ Integrated removal assessment and combined PA/SI
- ☐ Other: _____

Do not add site to the Superfund active site inventory. Site is:

- ☐ Not a valid site or incident
- ☐ Being addressed by EPA's removal program
- ☐ Being addressed by a state cleanup program
- ☐ Being addressed by a tribal cleanup program
- ☐ Being addressed under the Resource Conservation and Recovery Act
- ☐ Being addressed by the Nuclear Regulatory Commission
- ☐ Other: _____

Optional - Print name of EPA Site Assessor making this decision: David Brauner

EPA Regional Approval: (Enter Date and then click this box to initiate digital signature stamp)

DAVID BRAUNER

Digitally signed by DAVID BRAUNER
Date: 2019.05.23 08:57:22 -05'00'

Date 05/23/2019

Site Description

(All text as entered on page A-2)

Parcel J is a strip of river bank no more than 46 feet wide, immediately upstream (west) of the Kaukauna City Dam and Power Canal, on the south side of the river. The property has more than a century of activity, dating back to 1885 with the Kaukauna Water Power Company, and likely before. As of 1910, a railroad spur and associated buildings existed on and adjacent to the property. The USACE took over supervision of river traffic in the late 1800s, and the property transferred to federal ownership in the early 1900s.

Photographs from the 1950s show a mostly wooded lot and existence of a small pond. Also according to aerial photographs, filling activities took place beginning in the 1960s, and an unimproved road existed until at least 1992. Since approximately 2000, residential apartment complexes neighbor the riverbank. The riverbank exists as partially-wooded grass yard as of 2019.

In the early 2000s, the USACE began transferring a series of properties along the Fox River to the State of Wisconsin, in order to upgrade and preserve historic locks once used for shipping commerce. At that time, several limited site investigations at Parcel J identified elevated levels of lead in soil from an unknown source. The property transaction (and site cleanup) stalled when the state required site remediation prior to taking ownership from the USACE. The last active site work ended in 2006.

The site investigations between 2003 and 2006 showed that lead existed (at the time) in shallow soil between 290 and 11,000 mg/kg, which is above Wisconsin's non-industrial direct contact standard of 250 mg/kg. Site soil is a mix of poorly-correlating unconsolidated river sediment, including sand, gravel, silt and clay in medium to very thick beds. Generally the site investigations extended to a depth of 10 feet or less, with lead concentrated in the top 2 to 4 feet.

The lead concentration in sediment is unknown for Parcel J; however, extensive sampling from the Fox River PCB dredging may exist in site investigations from other parcels.

Shallow groundwater samples contained lead below state enforcement standards of 15 ppb. However, SPLP and TCLP analysis showed the ability to leach lead to groundwater at concentrations above 150 ppb (15 times the enforcement standard). No groundwater wells exist at the site as of 2019.

The lead source is unknown. Potential sources may include the rail spur, lead paint removal, paint shop buildings and even a blacksmith shop that formerly existed on or near the property. The USACE maintains that they are not the causer, and despite ownership, have not completed lead delineation and cleanup.

Potential receptors include residents by direct contact, drinking water sources and the ecological food chain by uptake or leaching to surface water.

PCS Summary and Decision Rationale

(All text as entered on page A-4)

The Parcel J property contains lead in shallow soil above the state non-industrial direct contact limit. Limited site investigations showed that the top 2-4 feet of soil are contaminated. No groundwater contamination existed as of 2006; however TCLP and SPLP samples at the time showed the potential to leach lead into groundwater at concentrations 15 times higher than the enforcement standard. Due to a dispute over the lead source, the USACE (current owner) plans no further site investigation or remediation. Site work halted in 2006, and the nature/extent of lead contamination remain unknown. Potential receptors include residents by direct contact, drinking water, and the ecological food chain through plant and/or surface water uptake.

FIGURE 1: SITE LOCATION MAPS

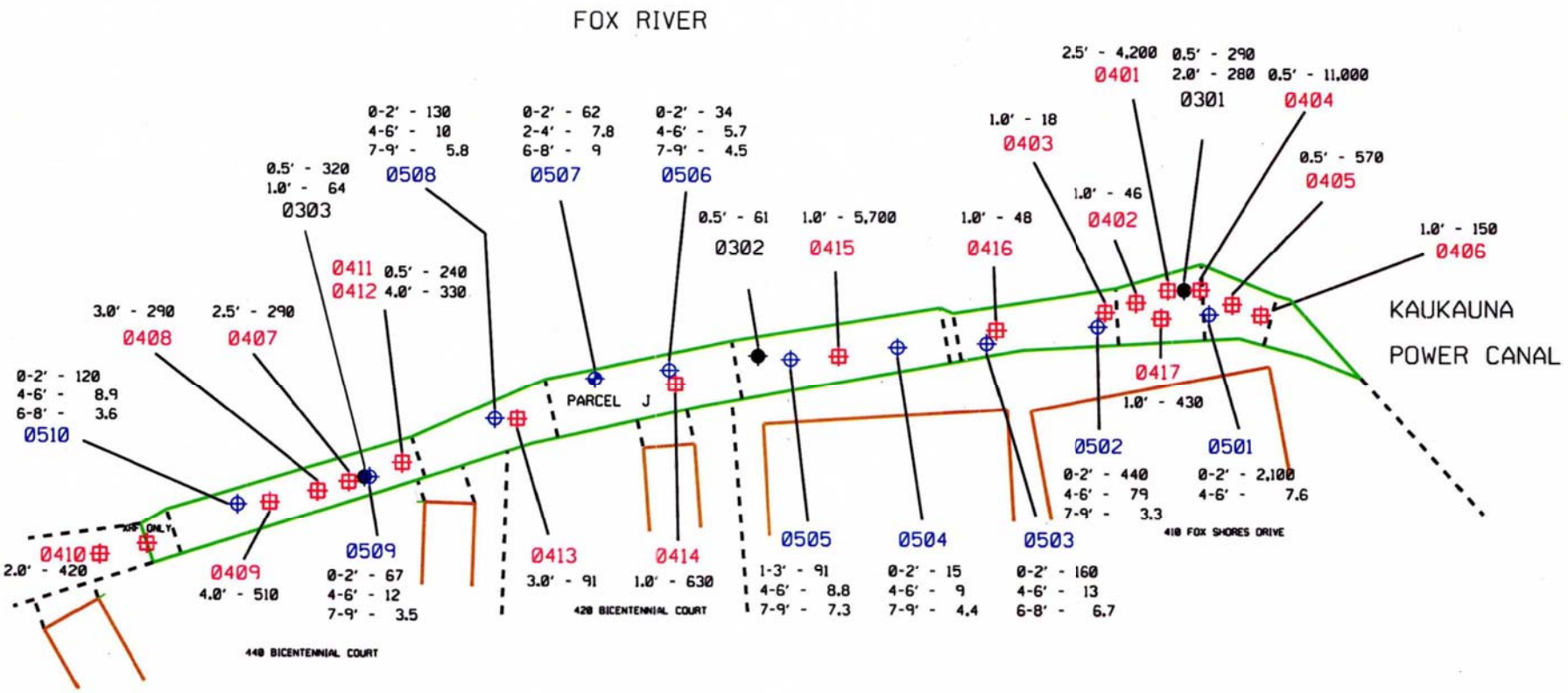




FIGURE 3: 1992 AERIAL PHOTOGRAPH



FOX RIVER KAUKAUNA POWER CANAL PARCEL "J" SAMPLING LOCATION



LEGEND

- PROPERTY BOUNDRY
- BUILDING OUTLINE
- SOIL BORING/SOIL SAMPLE FROM 2003 KCP03/KPC03
- SOIL BORING/SOIL SAMPLE FROM 2004 KCP04
- SOIL BORING/SOIL SAMPLE FROM 2005 KCP0905
- SOIL BORING/SOIL AND GROUNDWATER SAMPLE FROM 2005 KCP0905
- 0409 BORING IDENTIFICATION NUMBER
- 4.0' - 510 DEPTH, feet - LEAD ANALYTICAL RESULTS, mg/kg

NOTE:

1. ALL BORING LOCATIONS ARE ESTIMATED.
2. INFORMATION FOR FIGURE FROM DRAWINGS PROVIDED BY ACOE AND BY OUTAGAMIE COUNTY.

N

SCALE 1" = 100'

0 40 80 120 160 200

1	10-NOV-05	ADD TCLP AND SPLP DATA	MH	
REVISION	DATE	DESCRIPTION	BY	CHKD
DRAWN BY: MH	ALTECH ENVIRONMENTAL SERVICES SOUTHFIELD, MICHIGAN			
DESIGNED BY: MH	KAUKAUNA POWER CANAL PARCEL J KAUKAUNA, WISCONSIN			
DATE: 08-NOV-05	SOIL BORING LOCATION MAP SOIL LEAD LEVELS			
SCALE: 1" = 100'	FIGURE 5			
DRAWING NUM: 5				

...\Parcel J\Parcel J.dgn 7/25/2006 4:53:40 PM

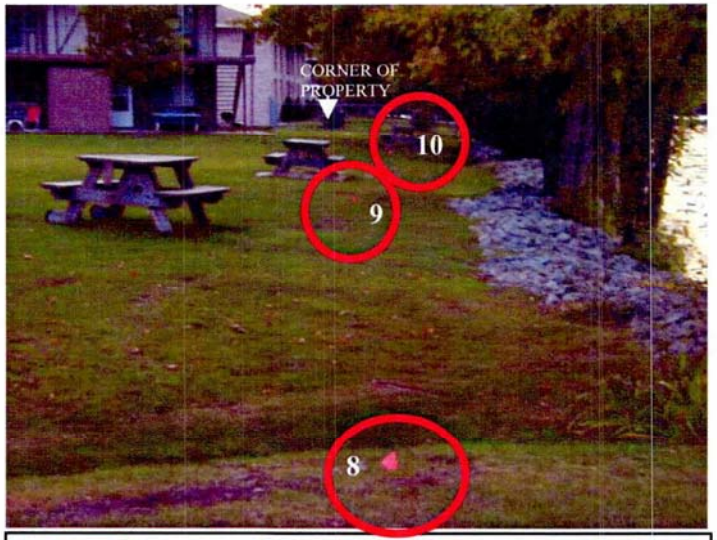


Photo 1. View of boring –08 looking southwest. Borings -09, and-10 located in background.



Photo 2. View of boring –08 looking southwest. Borings -09, -10 located in background.



Photo 3. View of borings –06 and -07 looking west-southwest.



Photo 4. View of boring -06 looking west-southwest. borings –07, through –10 are located in the background

Hole No. KCP0501

DRILLING LOG	DIVISION	INSTALLATION	SHEET / OF
	DETROIT DISTRICT	KAUKAUNA, WISCONSIN	1 OF 1 SHEETS

1. PROJECT	FOX RIVER - KAUKAUNA PARCEL J
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	ALTECH SERVICES LLC
4. HOLE NO. *(As shown on drawing title and file number)*	KCP0501
5. NAME OF DRILLER	J. DAVIS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN (ft)	10.0
8. DEPTH DRILLED INTO ROCK (ft)	0.0
9. TOTAL DEPTH OF HOLE (ft)	10.0
10. SIZE AND TYPE OF BIT	2-INCH
11. MANUFACTURER'S DESIGNATION OF DRILL	GEOPROBE
12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
13. DEPTH GROUND WATER (ft)	
14. ELEVATION GROUND WATER (ft)	
15. SURFACE ELEVATION (ft)	
16. DATE HOLE	STARTED 9/28/05 / COMPLETED 9/28/05
17. TOTAL CORE RECOVERY FOR BORING	N/A %
18. GEOLOGIST	M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOVERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0 / 0.3		Sandy Loam, dark brown, dry, (TOPSOIL) loose.			0-2 0.0 2.0	
1.0		Silty Sand, dark brown, dry, (SM) friable.				
1.5		Gravelly Sand, yellow brown, dry, (SWG) friable.				
7.0		Gravelly Sand, grayish brown to light brown, dry, (SWG) friable.			4-6 4.0 6.0	
8.0		Sandy Clay, mottled brown black, moist, (CLS) soft, pliable, no odor.				
8.5		Sandy Gravel, dark brown to black, wet, (GWS) loose, no water collected.			8-10 8.0 10.0	
10.0		Sandy Clay, mottled brown gray, moist, (CLS) pliable.				

Table 7

Summary of Parcel J Lead Concentrations

In Excess of WDNR Default Criteria

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample I.D.	Sampling Depth	Sampling Date	Lead Analytical Results (mg/kg)
KPC0301	0 - 0.5'	8/25/2003	290
KPC0301	1.5 - 2'	8/25/2003	280
KPC0303	0 - 0.5'	8/25/2003	320
KCP0401	**2.5'**	**7/16/2004**	**4,200**
KCP0404	**6"**	**7/20/2004**	**11,000**
KCP0405	**6"**	**7/16/2004**	**570**
KCP0407	2.5'	7/20/2004	290
KCP0408	3'	7/16/2004	290
KCP0409	**4'**	**7/20/2004**	**510**
KCP0410	2'	7/16/2004	420
KCP0412	4'	7/20/2004	330
KCP0414	**1'**	**7/16/2004**	**630**
KCP0415	**1'**	**7/20/2004**	**5,700**
KCP0417	1'	7/16/2004	430
KCP0501	**0 - 2'**	**9/29/2005**	**2,100**
KCP0502	0 - 2'	9/29/2005	440

11000 **Result Also Exceeds Industrial Direct Contact Criteria**

SUPERFUND PRELIMINARY ASSESSMENT

USACE - Parcel J
City of Kaukauna, Wisconsin
U.S. EPA ID: WIN000508686
WDNR BRRTS No. 02-45-548419

Prepared by:
Wisconsin Department of Natural Resources
Northeast Region – Green Bay

October 2019
Revision No. 2

Prepared by: B.J. LeRoy Date:

B.J. LeRoy, PG
Hydrogeologist
Northeast Region Green Bay Office
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources

Reviewed by: Jane Lemcke Date: 11/12/19

Jane Lemcke
Site Assessment Team Leader
Madison Office
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources

Approved by: David M. Brauner Date: 11/5/19

David Brauner
Site Assessment Manager - Region 5
Division of Superfund
U.S. Environmental Protection Agency

October 30, 2019

TABLE OF CONTENTS

Section **Page**

1.0 INTRODUCTION 1

2.0 SITE BACKGROUND 1
2.1 Location and Climate 1
2.2 Site Description 1
2.3 Operational History and Waste Characteristics 2
2.4 Regulatory Status 2
2.5 Past Environmental Investigations 2
2.6 Other Releases in the Area 3

3.0 FIELD INSPECTION ACTIVITIES 3

4.0 GROUNDWATER PATHWAY 4
4.1 Hydrogeologic Setting 4
4.2 Conceptual Model 5
4.3 Groundwater Targets 5
4.4 Groundwater Conclusions 6

5.0 SURFACE WATER PATHWAY 6
5.1 Hydrologic Setting 6
5.2 Surface Water Targets 6
5.3 Surface Water Conclusions 7

6.0 SOIL EXPOSURE, SUBSURFACE INTRUSION, AND AIR PATHWAYS 7
6.1 Physical Conditions 7
6.2 Soil, Subsurface Intrusion, and Air Targets 8
6.3 Soil Exposure, Subsurface Intrusion, and Air Conclusions 8

7.0 SUMMARY AND CONCLUSIONS 9

8.0 REFERENCES 10

TABLES **Follows Page**

Table 1 – Sample Result Summary 3
Table 2 – Open and Closed Releases Within 1000 Feet 3
Table 3 – Population Summary 6

APPENDICES

Appendix A - Figures

Figure 1 – Site Location Map
Figure 2 – Parcel Information
Figure 3 – Site Features
Figure 4 – Release Location
Figure 5 – One-Mile Radius
Figure 6 – Four-Mile Radius

Appendix B - EPA Site Information Form (SIF) and EPA PCS Form

Appendix C - Site Photographs

Appendix D - Reference Documents

ABBREVIATIONS / ACRONYMS:

AOC	= Administrative Order of Consent
BRRTS	= Bureau of Remediation and Redevelopment Tracking System
CERCLA	= Comprehensive Environmental Response Compensation Liability Act
EPA	= U.S. Environmental Protection Agency
FID	= Federal Identification Number
GIS Registry	= WDNR's Geographical Information Systems Registry
mg/kg	= milligrams/kilogram
NAPL	= Non-Aqueous Phase Liquid
PA	= Preliminary Assessment
PCS	= Pre-CERCLIS Screening
ppm	= parts per million
RP	= Responsible Party
SARA	= Superfund Amendments and Reauthorization Act
TSCA	= Toxic Substances Control Act
µg/L	= micrograms per Liter
WDHS	= Wisconsin Department of Health Services
WDNR	= Wisconsin Department of Natural Resources

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) tasked the Wisconsin Department of Natural Resources (WDNR) with completion of this Pre-CERCLIS Screening (PCS) and Preliminary Assessment (PA) at the USACE Parcel J site (the "Site"), in Outagamie County, Wisconsin. The assessment lies under authority of the Comprehensive Environmental Response Compensation Liability Act of 1980 (CERCLA), and the Superfund Amendments and Reauthorization Act of 1986 (SARA). The assessment falls within the fiscal-year 2019 – 2020 Cooperative Agreement between the U.S. EPA and the WDNR.

The PCS and PA document Site conditions and information sufficient to assess threats posed to human health and the environment, and to determine the need for additional CERCLA/SARA or other appropriate action. This scope includes a review of available file information, a comprehensive target survey and an on- and off-site reconnaissance. The PCS form is included in Appendix B.

2.0 SITE BACKGROUND

2.1 Location and Climate

The Site area lies along the Fox River's south bank in Kaukauna, Wisconsin (Figure 1). According to the WDNR Bureau of Remediation and Redevelopment Tracking System (BRRTS), the Site's latitude and longitude are 44.28139 North, 88.27615 West. The Site lies within the SE¼ of the NE¼ of section 23, T21N, R18E (Reference 1). The Outagamie County Interactive GIS website indicates that the Site parcel is approximately 1.07 acres in size as Parcel Identification Number 44331 (Figure 2 and Reference 2).

The climate of Outagamie County is continental and characterized by cold and typically snowy winters with moderate and humid summers. The average January temperatures range from 10° to 25° F and average July temperatures range from 62° to 81° F. The average annual precipitation is approximately 31 inches, including 45 inches of snow. (Reference 3).

2.2 Site Description

Figure 3 shows the site area and neighboring properties. The Site area lies within the physical flood plain of the Fox River, directly adjacent to the river. The site elevation is approximately 650 feet above mean sea level. The surrounding area includes residential, commercial and industrial properties, closely surrounded by apartment and municipal buildings. Former Site use includes shipping and related industries, including a rail yard. The site now exists as green space between private residences and the Fox River.

The tax parcel is a narrow and long 1.07 acre grass strip with no buildings or other structures. The ground surface is flat. Access to the area is unrestricted. It is used as grass yard space for the adjacent properties. Public utilities serve the site area. The photo log in Appendix C shows site pictures including adjacent neighbors.

The site is grass-covered with mature trees and occasional brick walkways. The river lies to the north. Municipal buildings, an apartment complex and commercial business line the eastern Site area, opposite the river. The Site is approximately 20 to 30 feet wide on the eastern portion. Multi-unit apartment complexes rim the western site area, where the property is as wide as 46 feet. Infrequent topsoil erosion occurs in areas with heavier usage. Similar housing units lie to the west, with similar grassed banks to the river.

2.3 Operational History and Waste Characteristics

Little is known about historic Site use. In 1872, the USACE acquired navigational control of the Fox River Waterway (Reference 4-1) and ownership of this and other properties along the river. Previous reports (Reference 4-2) describe the Site as being owned by the Kaukauna Water Power Company as of 1885. Through the early 1900s, shipping became more abundant in the Fox River, and locks were added to move and maintain boats and ships on nearby properties. In a 1910 map, the Site includes small buildings, a pond and a railroad spur. By the 1950s, the Site was wooded and all structures had been removed. Through the 1970s, fill activities occurred, and by the 1990s development had begun with roadways that led to the apartment complexes that exist adjacent to the current Site. The property was likely a small part of a larger property that was parceled off during development, and other nearby sites may have similar soil contamination.

In the 1980s, the State of Wisconsin began acquiring locks and adjacent properties from the USACE. Most other USACE parcels are now owned by the State of Wisconsin. Although the 2000 MOA between the State and USACE required the USACE to complete cleanup prior to property transfer, remediation activities stalled at Parcel J due to the USACE belief that the lead contamination was caused by a previous owner. Therefore, the USACE does believe they are the responsible party.

Historic usage is not well known, though it may be speculated that the area housed soil or other materials related to the shipping industry, as occurred with most neighboring properties. This property's use is not well documented; typical site use for neighboring properties included painting activities (including stripping and repainting), waste storage and shipping-related maintenance.

2.4 Regulatory Status

The site exists as an open case in the WDNR Environmental Repair Program (ERP), BRRTS No. 02-45-548419. There is no pending action by the USACE at this time due to a dispute about the responsible party.

The case began in 2002 with a notification of discharge for a series of USACE land parcels along the Fox River lock system. The state of Wisconsin agreed to take ownership of USACE parcels as part of a cleanup and restoration effort for the historic locks. Incomplete cleanup of lead contamination continues to prevent the closure and property transaction for Parcel J. The USACE pursued remediation efforts through 2008, when they decided that they would not pay for cleanup of contamination they do not believe they created. Under Wisconsin state law, both the causer and property owner are considered responsible parties.

The only complete investigation document in the case file is a 2006 Phase II investigation (Altech Environmental Services, July, 2006), which summarizes other previously investigative work. The case file also includes correspondence documents regarding cleanup and funding discussions with the property owner and the WDNR. No remediation plans or activities are documented.

2.5 Past Environmental Investigations

Following a recommended property transfer in 2002, three years of site evaluation and sampling led to a limited Phase 2 investigation at the property (Altech, 2006). Investigation was largely driven by the property transfer of various USACE properties associated with the Fox River and lock system.

The 2006 report summarizes sampling from 2003 – 2005. Sample data showed that lead existed in soil above the Wisconsin Administrative Code NR 720 Industrial Direct Contact Criteria at multiple samples,

at concentrations as high as 11,000 mg/kg. Soil results from previous investigations are provided in Table 1 and References 5-1 through 5-5, which include both summary tables and location figures.

2.6 Other Releases in the Area

Figure 4 shows the location of other nearby open and closed releases listed in BRRTS. Within 500 feet, there are two open sites and two closed sites, one with continuing obligations for notification of residual contamination. Another four sites lie between 500 and 1000 feet from the property, one of which remains open. Two closed sites have continuing obligations. Table 2 lists the properties and general descriptions of each cleanup.

The Fox River dredging project is a Superfund site related to removal of sediment contaminated with PCBs and metals. The river abuts the northern Site boundary. The sediment dredging project is one part of a general Fox River cleanup that includes restoration of various properties with lead contamination. It's likely that lead contamination in the river and the Site are both related to shipping and lead based paint that was applied to or removed from ships and boats. No PCBs are known to exist at the Site, and no PCB sampling is documented in the case file.

The Fox Shores Apartments case to the south has a similar situation and contaminants, likely due to the same unknown contributor. In addition, site soils contain PVOCs and PAHs. This case remains open and active.

The Ghost Town Fitness Center to the southeast had a minor detect of metals in a temporary monitoring well. Several metals (lead, selenium, arsenic) were detected above the state's Wis. Admin. Code NR 140 Preventive Action Limit. The well was abandoned and the case was closed with no action required.

Kaukauna City Waste Oil collected and stored waste oil for city residents. The case is closed with a continuing obligation to maintain a cover for soil contaminated with PVOCs.

Cases farther than 500 feet away either do not share similar contaminants, or are not similar in use or setting to the Parcel J site. The other remaining cases likely have little to no effect on the Site.

3.0 FIELD INSPECTION ACTIVITIES

BJ LeRoy from the WDNR completed the Site reconnaissance in July 2019. Appendix C includes a photo log compiled from site reconnaissance and prior site investigation materials. On the surface, the property looks like a backyard used by apartment residents for recreation. The yards are well kept and there are no visual signs of contamination or disrepair.

The USACE permitted site access for the inspection and photo log. No interview was completed due to previous work at the site.

The property is as described in Section 2.2; a long, narrow, mostly grass covered flat shoreline adjacent to the Fox River. There are no buildings or other structures on site. Vegetation covers the soil in most places as shown in the photographs. Some mature trees exist along the shoreline, with roots that occasionally break through the grass to the land surface. Directly along the shore, grass erodes to allow soil exposure. Yard use is heavier to the west where multi-unit apartment buildings line the property. To the east, the property appears nearly untouched, other than lawn mowing activity. More activity appears to occur on the northwest property where apartments exit to the yard, and picnic tables show typical wear and tear of heavy use with some exposed soil.

Table 1
Sample Result Summary

Analyte	Tetrachloroethane
Media	Soil
Units	mg/kg
Non-Industrial RCL	400
Industrial RCL	800
Groundwater RCL	27

Sample	Date	Depth (ft)	
KPC0301	8/25/2003	0 - 0.5	290
KPC0301	8/25/2003	1.5 - 2	280
KPC0302	Unknown	0 - 0.5	61
KPC0303	8/25/2003	0 - 0.5	320
KPC0303	Unknown	0.5 - 1	64
KPC0401	7/16/2004	2.5	4200
KPC0402	Unknown	0.5 - 1	46
KPC0403	Unknown	0.5 - 1	18
KPC0404	7/20/2004	0 - 0.5	11000
KPC0405	7/16/2004	0 - 0.5	570
KPC0406	Unknown	0.5 - 1	150
KPC0407	7/20/2004	2.5	290
KPC0408	7/16/2004	3	290
KPC0409	7/20/2004	4	510
KPC0410	7/16/2004	2	420
KPC0411	Unknown	0 - 0.5	240
KPC0412	7/20/2004	4	330
KPC0413	Unknown	3	91
KPC0414	7/16/2004	1	630
KPC0415	7/20/2004	1	5700
KPC0416	Unknown	1	48
KPC0417	7/16/2004	1	430
KPC0501	9/25/2005	0 - 2	2100
KPC0501	9/25/2005	4 - 6	7.6
KPC0502	9/29/2005	0 - 2	440
KPC0502	9/29/2005	4 - 6	79
KPC0502	9/29/2005	7 - 9	3.3
KPC0503	Unknown	0 - 2	160
KPC0503	Unknown	4 - 6	1
KPC0503	Unknown	6 - 8	6.7
KPC0504	Unknown	0 - 2	15
KPC0504	Unknown	4 - 6	9
KPC0504	Unknown	7 - 9	4.4
KPC0505	Unknown	1 - 3	91
KPC0505	Unknown	4 - 6	8.8
KPC0505	Unknown	7 - 9	7.3
KPC0506	Unknown	0 - 2	34
KPC0506	Unknown	4 - 6	5.7
KPC0506	Unknown	7 - 9	4.5
KPC0507	Unknown	0 - 2	62
KPC0507	Unknown	2 - 4	7.8
KPC0507	Unknown	6 - 8	9
KPC0508	Unknown	0 - 2	130
KPC0508	Unknown	4 - 6	10
KPC0508	Unknown	7 - 9	5.8
KPC0509	Unknown	0 - 2	67
KPC0509	Unknown	4 - 6	12
KPC0509	Unknown	7 - 9	3.5
KPC0510	Unknown	0 - 2	120
KPC0510	Unknown	4 - 6	8.9
KPC0510	Unknown	6 - 8	3.6

Table 2
Open and Closed Releases Within 1000 Feet

Site Name	BRRTS No.	Site Status	Cleanup Required
500 Feet			
Fox Shores Apartments	0245582746	Open	Lead, arsenic, PAHs and VOCs in soil.
Ghost Town Fitness Center	0245547911	Closed	Arsenic and selenium in soil.
Fox River OU2	0245582407	Open	Fox River Superfund Site – PCB/metal contamination in sediment.
Kaukauna City Waste Oil Collection Site	0345001729	Continuing Obligation	PVOCs in soil and groundwater due to waste oil storage and collection.
1000 Feet			
Gunderson Cleaners	0345402371	Open	CVOCs from dry cleaning operation.
Jim's Car Wash	0345000082	Closed	CVOC and metals in soil and groundwater from plating operations
Van Hoof Service LLC – Heating Oil	0345244868	Continuing Obligation	Petroleum in soil due to service station activities; required surface cap for groundwater and direct contact protection.
Van Hoof Oil and Service	0345002042	Continuing Obligation	Petroleum in soil due to service station activities; required surface cap for groundwater and direct contact protection.

The area contains mostly residential buildings to the west, and far south, with commercial, residential, municipal and light manufacturing to the east and near south. Residential buildings are typically 10 to 20-unit apartments surrounding the site. Farther to the south and southwest, single family homes form downtown neighborhoods.

City service buildings are in the near area, with fire, police, municipal, utility and highway buildings within a few blocks. To the east lies the downtown, with restaurants, taverns and other commercial businesses. Most downtown businesses are well kept and occupied. Traffic is light to moderate with personal cars and trucks at various homes and businesses.

River View Middle School is the nearest school, approximately 800 feet to the east. The closest daycares are over 2000 feet away.

Residences include approximately 12 multi-unit apartment buildings adjacent to the property, with approximately 200 total units. An additional 25 single family residences lie within ¼ mile of the property, and most of the City of Kaukauna lies within one mile, with a population of 16,246 as of 2018 (Reference 6).

The immediate surrounding area is a flat-lying flood plain of the Fox River. The river is the prominent physical feature in the Site area with several bridges and easy access for recreational activity. Lying directly north of the site, the river flows from west to east through the downtown as shown on Figure 1. Precipitation that doesn't infiltrate the ground flows to either the storm sewer or directly to the river. From the site, most precipitation likely flows to the storm sewer which discharges at various locations to the river.

The river represents the only mapped wetland and navigable waterway within 1000 feet of the site. Mapped wetlands typically do not intersect the property. According to the Wisconsin Surface Water Data Viewer, most soils at the site and surrounding area are not wetland indicating soils (Reference 7).

Fisherman use the river for a wide variety of sport fishing. However, the WDNR advises restricting fish consumption due to PCBs and mercury in the water and sediment. The river is considered in poor condition for fish and aquatic life, according to 2019 DNR reporting (Reference 8). No fisherman were observed during the site visit.

Groundwater is the principle water source for the City of Kaukauna and surrounding area (Reference 9). Five municipal wells serve the city with groundwater from bedrock aquifers consisting of Ordovician and Cambrian dolomite and sandstone. Municipal wells range in depth from 726 to 806 feet deep, with 120 to 239 feet of surface casing. Wells are sampled regularly with few violations and no significant contamination issues.

Four private potable wells reportedly exist within one mile of the site, with no wells closer than 1000 feet. The well logs and locations are included in Appendix D, Reference 10. Wells are screened between 76 and 82 feet below ground surface.

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting

Wisconsin lies in the Interior Plains Province and the Great Lakes Basin of the United States (Reference 11-1 and 11-2). The site lies in southeast Outagamie County within the Lower Fox River Basin, and the Garners Creek-Fox River Watershed (Reference 12). Wisconsinan-aged glaciers and subsequent drainage formed the basin's land surface into watersheds that eventually drain to Lake Michigan. The

watershed contains the Lower Fox River which flows west to east, directly adjacent to the Site area (Reference 13).

Site-area surficial deposits are typically low permeability lacustrine sand, silt and clay sediment (Reference 14). Sediments consist of varied deposits from shoreline to deep water lake sediment, to fluvial deposits of re-worked lake sediment. Local sediment thickness ranges from 0 to 100 feet thick in the area (Reference 15), typically less than 20 feet thick at the site (Reference 16).

The soil profile formed in the top few feet of glacial deposits is classified only as disturbed soil (udorthent, or Uo) at the site location. Adjacent soil is Kewaunee (KkE3), which is the likely predecessor to the anthropogenically disturbed soil. The USDA soil survey lists Kewaunee as a well drained, 0-6" thick soil formed from loess or clay till (Reference 17).

The uppermost bedrock consists of fractured and porous Ordovician dolomite or sandstone that form the upper regional aquifer. Bedrock dips slightly to the east toward Lake Michigan. Ordovician-aged dolomite overlies the Cambrian St. Peter Sandstone, a regional aquifer with high capacity and high use. (Reference 18).

Private potable wells screened in the aquifer range from approximately 76 to 568 feet in depth. Four private wells exist within one mile of the Site (Reference 19). Unconsolidated formation thickness ranges from 26 to 70 feet and is typically cased so that it is not used as a groundwater source. Drillers' notes most often include references to clay or hard pan, and infrequently note gravel. (Reference 10).

Five municipal wells surround the site, from 0.2 to one mile away (Reference 20). Wells range from 726 to 841 feet deep. The city draws approximately 1.2 million gallons of water per day (800 gallons per minute) (Reference 9). Municipal wells are screened in the Ordovician dolomite aquifer and the Cambrian sandstone aquifer.

4.2 Site Conceptual Model

The Site lies in a discharge zone, directly adjacent to the Fox River. Water enters the site through precipitation and upland flow. Most precipitation likely flows overland to the river. A small amount of precipitation may infiltrate the ground surface and recharge the water table, which is approximately 5 feet below ground surface (Reference 16).

Local and shallow groundwater generally flows to the site area from the south. The Fox River dominates the shallow local flow system, accepting discharge from groundwater. Shallow Site groundwater flows northward to the river. Some shallow groundwater may also migrate downward from the shallow unconsolidated system to recharge the uppermost aquifer.

Regionally, topographic highs formed by dolomite bedrock create recharge areas where infiltration migrates to groundwater and flows generally toward the Fox River (Reference 21).

4.3 Groundwater Targets

The population within a 4-mile radius, approximately 51,882 people (Reference 22), relies primarily on groundwater as a water source. Approximately one third of this population lives within the Kaukauna city limits, where residents are assumed to be using municipally-supplied water. The City of Kaukauna groundwater supply comes from five wells located within one mile of the site (Reference 20). Four wells lie between ½ and 1 mile from the site, and one well is within approximately 1/3rd of a mile away. Four wells City wells are screened in the Ordovician dolomite aquifer and Cambrian sandstone aquifer. City well water is blended from the five wells and redistributed as needed to the City of Kaukauna.

In addition, water supply wells for the Kimberly, Darboy and Little Chute lie between two and four miles to the northeast, east and southeast (Reference 20). Two wells are just inside 2 miles away; two wells are between 2 and 3 miles away; four wells lie between 3 and 4 miles from the site. The wells are screened between 525 and 805 feet below ground surface, which is a consistent elevation with wells in Kaukauna. Screened formations include Ordovician dolomite and sandstone, and Cambrian sandstone. Wells in these three communities lie upgradient from the Parcel J site.

Five high capacity wells exist within 4 miles of the property, each used for non-potable sources. Three golf courses, a race track and the Kaukauna water utility use high capacity wells as process water for various operations.

The rural population within 4 miles relies primarily on private residence wells. Approximately 760 residences (Reference 23) reportedly use private well water within 4 miles. The WDNR was unable to determine which of these wells still exist. However, wells outside the city limits are assumed to be continuing water sources. Approximately half the area lies outside city limits. Two potential private drinking water wells lie approximately 1000 feet from the Site (Reference 19).

Table 3 lists approximate populations served by wells within specific radii of the Site area. A WDNR GIS specialist used ESRI Community Analyst to estimate populations within each area. The total population within the four-mile radius of the Site is approximately 51,882 people (Reference 22). Populations between 1-2 miles, 2-3 miles and 3-4 miles are based on ESRI Community analyst estimates. Associated maps are attached as Figures 5 and 6.

Current municipal wells are sampled for a variety of parameters. Water samples from five municipal wells indicate no violations in the public water supply (Reference 9). The city does not typically sample the public water supply for lead. No other signs of contamination exists in sample results from recent groundwater sampling events.

4.4 Groundwater Conclusions

A known, observed lead release from the Site exists in shallow soil, but has not been linked to groundwater. No monitoring well data exists for the Site. Lead is a naturally occurring substance in Wisconsin, and can be found in groundwater at low levels. Little to no data exists in the Site area that could be correlated with the Site. To date, the Site area, geologic and hydrogeologic characteristics, and nature and extent of contamination have been studied on a limited basis and are not well defined.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

Site area topography is flay lying within the physical flood plain of the Lower Fox River (Reference 1). Precipitation drains overland, primarily to the river due to its proximity. The river itself lies directly adjacent to the Site. Due to ample groundwater availability and local use advisories including PCBs, the river is not used as a source of potable water, and it is not considered a valuable sport fishing waterway (Reference 8). Within the region's watershed, topographic highs on either side of the river valley guide runoff toward the river. The Fox River drains directly to Lake Michigan in Green Bay, approximately 24 miles from the Site.

5.2 Surface Water Targets

Table 3
Population Summary

Radius from Site Area	0-0.25 Mile	0.25-0.5 Mile	0.5-1 Mile	1-2 Miles	2-3 Miles	3-4 Miles	Total
Population Inside Specific Radius [1,2]	450	1,982 (2,432)	6681 (9113)	13,019 (22,132)	15,400 (37,532)	14,350 (51,882)	51,882
Approximate Number of Households[2]	271	830 (1,101)	2,790 (3,891)	5,201 (9,092)	5,890 (14,982)	5,389 (20,371)	20,371
Number of Private Wells[3]	2	2 (4)	29 (33)	108 (141)	297 (438)	322 (760)	760
Modified Groundwater Population [4]	5	3,856 (3,861)	15,473 (19,333)	7,961 (27,394)	12,264 (39,558)	12,324 (51,882)	51,882

1 - The two numbers in each cell represent the total inside the specific radius (total cumulative inside radius).

2 – Reference 22

3 – Reference 23

4 – Modified groundwater population (each cell denoted by specific radius/cumulative); private well users plus the number of people served by city wells inside the radius

The river system does not supply drinking water due to ample groundwater supply and widespread chemical water advisories. The WDNR advises sport fishers not to over-consume fish from the Fox River and its downstream watershed (Reference 24).

No recorded wetlands lie in the Site's near vicinity (Reference 25), other than the river itself. At the site and throughout the area, most soil is considered disturbed land. Wetland-indicating soils exist father downstream, and farther away from the river valley where the property hasn't been anthropogenically disturbed (Reference 26). Area soil lies flat and drains poorly. According to the FEMA Flood Insurance Map database, the Site has a minimal chance of flooding in a given year, likely due to dams and proximity to the river mouth (Reference 27).

The WDNR identified endangered resources that have been recorded in the Site vicinity. This list and information are taken from the state's Natural Heritage Inventory (NHI) database, which also includes federally threatened and endangered species. This evaluation includes both the project area and a buffer of one mile for terrestrial and wetland species and a two-mile buffer for aquatic species. Descriptions are generalized due to using confidential data from the NHI database.

The database indicates three bald eagle nest sites within one mile of the project area, although none are within the United State Fish and Wildlife Service buffer of 660 feet. The bald eagle is federally protected through the Bald and Golden Eagle Protection Act, and could be exposed to lead through the uptake of organisms (primarily fish) or through surface water use.

The site is approximately 2000 feet from a migratory bird concentration site. Migratory bird concentration sites are important resting and feeding areas for birds as they fly between their breeding and wintering grounds. These areas also can be locations where large numbers of migrating birds often become concentrated due to prevailing winds and/or water barriers. Sites are used by many different species, both rare and non-rare. Birds using this area as a migratory stopover could be exposed to lead through the uptake of organisms or through surface water use.

A state endangered bird has also been recorded within one mile of the project area. This species could be exposed to lead through the uptake of organisms (primarily other birds) or through surface water use.

5.3 Surface Water Conclusions

No visual observation of contamination exists at the site or near vicinity. There is little likelihood of a further release due to overland flow or runoff.

The site lies in a discharge area within the shallow groundwater system directly adjacent to the Fox River. Previous studies, while limited, indicate that contamination exists in shallow soil and may be exposed to humans or the environment through erosion, and migration into the Fox River. There is no current evidence that this does (or doesn't) occur. The lack of flood potential and low permeability of soils indicate that surface water may be a limited migration pathway.

6.0 SOIL EXPOSURE, SUBSURFACE INTRUSION, AND AIR PATHWAYS

6.1 Physical Conditions

Lead soil contamination at the Site exists in the top four feet of soil, where it may pose a threat via subsurface migration or direct contact threat to building residents or trespassers. Lead does not pose a subsurface vapor intrusion or air pathway hazard.

The property is a mostly grass strip between apartment complexes and the Fox River. A dozen multi-unit apartments neighbor the Site, while the farther surrounding area is mixed residential, commercial and industrial with light to medium street traffic. The property itself is unsecured, though fairly private due to the river and the apartments buildings. Grass typically covers the soil, except in high-wear areas like walkways and near picnic tables.

Soil samples collected from the upper four feet exceed Wisconsin Administrative Code ch. NR 720 residual contamination levels (RCLs) for direct contact (Reference 5, Table 1). Seven soil samples range from 290 to 11,000 mg/kg of lead, well above the soil industrial and non-industrial RCLs of 800 and 400 mg/kg.

An adjacent investigation at Fox Shores Apartments identified lead in soil as high as 960 mg/kg. A second adjacent investigation at Ghost Town Fitness showed discovered only background lead concentrations in soil. No other neighboring properties have been sampled to DNR knowledge.

6.2 Soil, Subsurface Intrusion, and Air Targets

Site access is generally unrestricted, with a risk of direct contact exposure to passers-by or trespassers due to shallow soil contamination. Residents in the buildings are at higher risk for direct contact due to a higher exposure frequency. The number of adjacent apartment complexes also presents a higher risk factor.

Table 3 lists population statistics inside radii from ¼ to 4 miles. Within 50 feet, approximately 480 people live in adjacent apartment complexes. Most soil results reported in Table 1 are within 50 feet on at least one apartment building. The closest school/daycare is over 800 feet away.

6.3 Soil Exposure, Subsurface Intrusion, and Air Conclusions

While there are high concentrations of lead in soil in the unsaturated zone within four feet of the ground surface, subsurface vapor intrusion and air are not viable pathways due to the stability of lead as a solid.

7.0 SUMMARY AND CONCLUSIONS

Limited investigations at the USACE Parcel J Site show that significant lead contamination exists in shallow soil. No site groundwater results exist to date, because no monitoring wells have ever been installed on-Site. The nature and extent of lead is not well defined at depth or in other media, as previous investigations were limited in scope.

The direct contact pathway provides a route to receptors, particularly the residents in apartment complexes that line the Site perimeter. Surface water may also provide a completed pathway with the proximity of the Fox River, and the existence of uncontrolled lead in near-surface soil. The groundwater pathway is potentially complete due to a shallow water table and the bedrock aquifer system. The subsurface vapor intrusion and air pathways are not complete due to the nature of lead as a contaminant.

8.0 REFERENCES

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20. Wisconsin DNR, Historic Well Construction Report database, 2019, municipal wells.
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22. **[NEED POPULATION INFO]**
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25. Wisconsin Department of Natural Resources (DNR), Wisconsin Surface Water Data Viewer, 2019, mapped wetlands.

26. Wisconsin Department of Natural Resources (DNR), Wisconsin Surface Water Data Viewer, 2019, wetland soil location.
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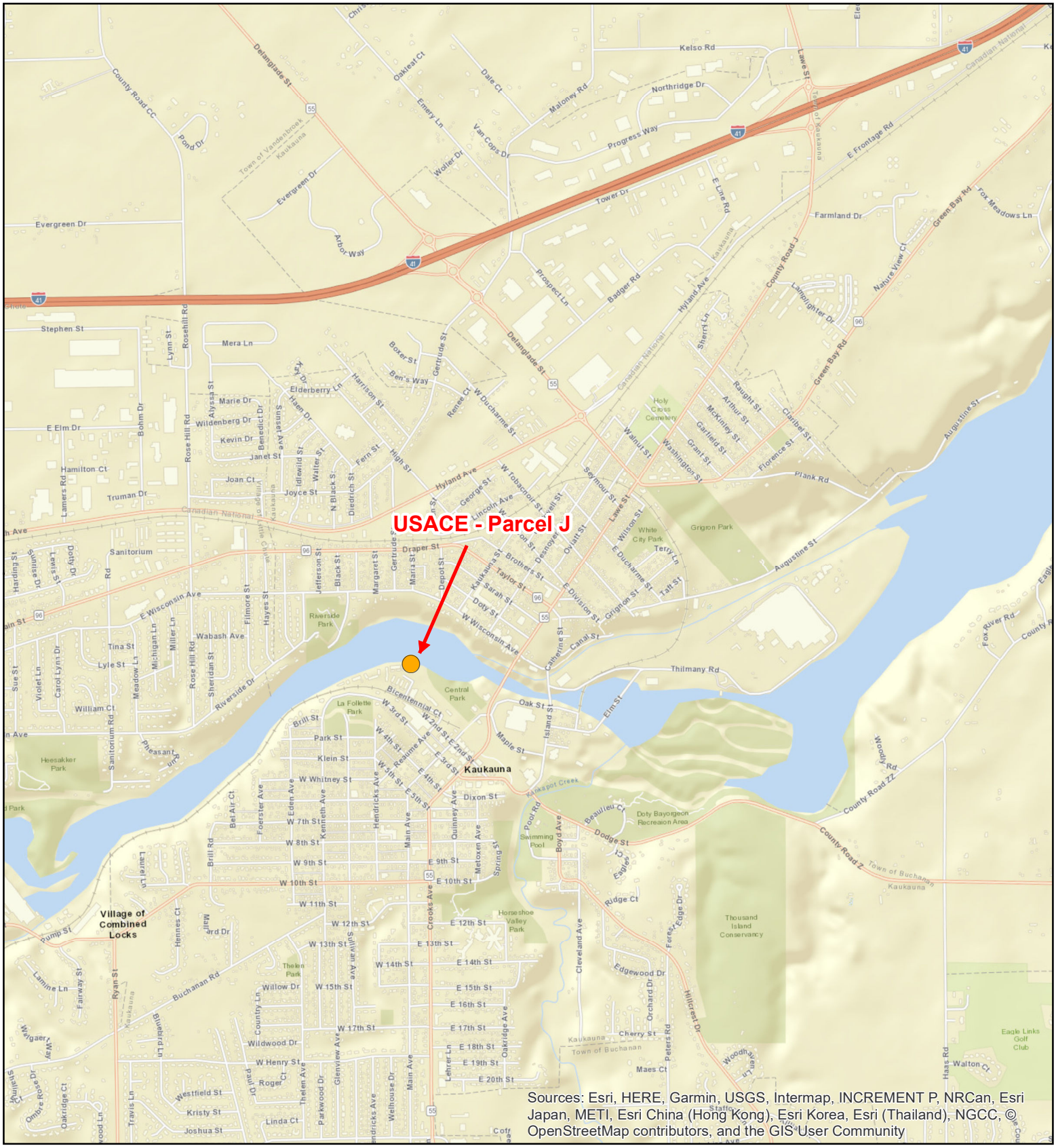
APPENDIX A

Figures



N

0 0.5 1 mi

WISCONSIN DEPT. OF NATURAL RESOURCES

Project Manager:	BJL
Drawn By:	RSS
Reviewed By:	BJL

Figure 1
Site Location Map
USACE - Parcel J Preliminary Assessment
City of Kaukauna, Outagamie County, WI

SEPTEMBER 2019 US EPA ID: WIN000508686



0 250 500 FT

N

Legend

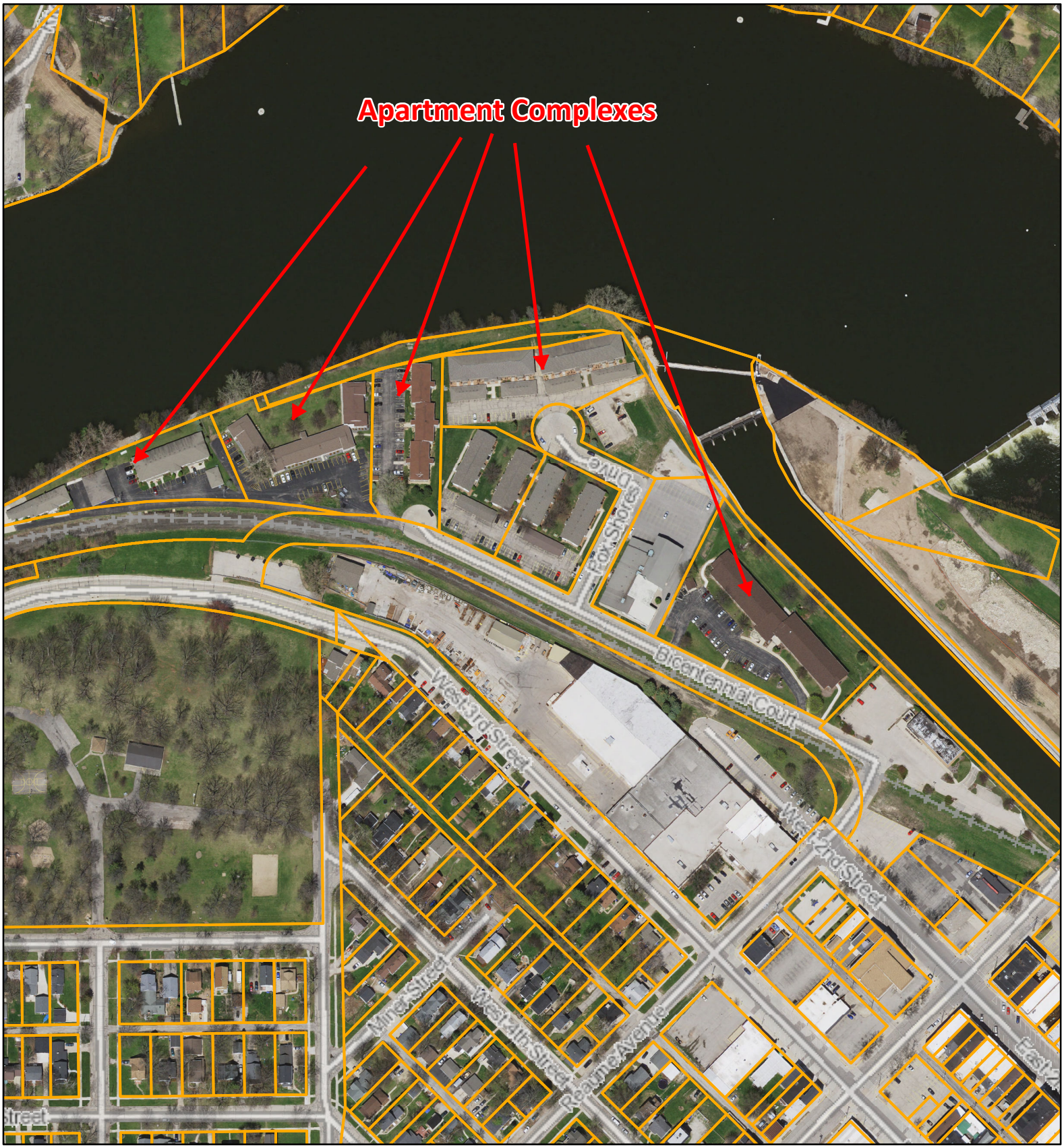
Parcel Boundary

WISCONSIN DEPT. OF NATURAL RESOURCES

Project Manager:	BJL
Drawn By:	RSS
Reviewed By:	BJL

Figure 2
Site Map
USACE - Parcel J Preliminary Assessment
City of Kaukauna, Outagamie County, WI

SEPTEMBER 2019 US EPA ID: WIN000508686



0 250 500 FT

N

Legend

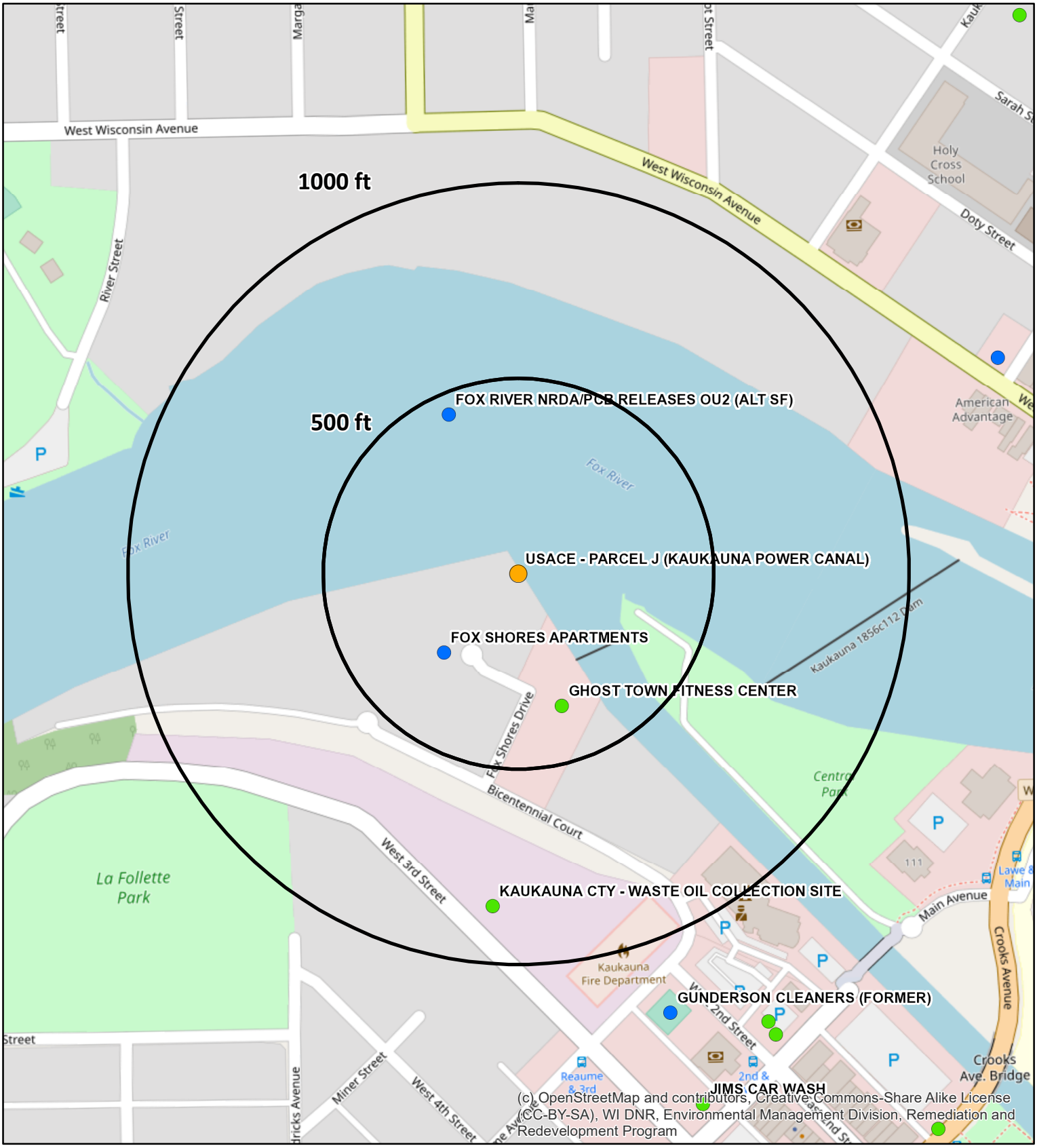
Parcel Boundary

WISCONSIN DEPT. OF NATURAL RESOURCES

Project Manager:	BJL
Drawn By:	RSS
Reviewed By:	BJL

Figure 3
Site Features
USACE - Parcel J Preliminary Assessment
City of Kaukauna, Outagamie County, WI

SEPTEMBER 2019 US EPA ID: WIN000508686



Legend

- USACE - Parcel J
- Open Site
- Closed Site

N

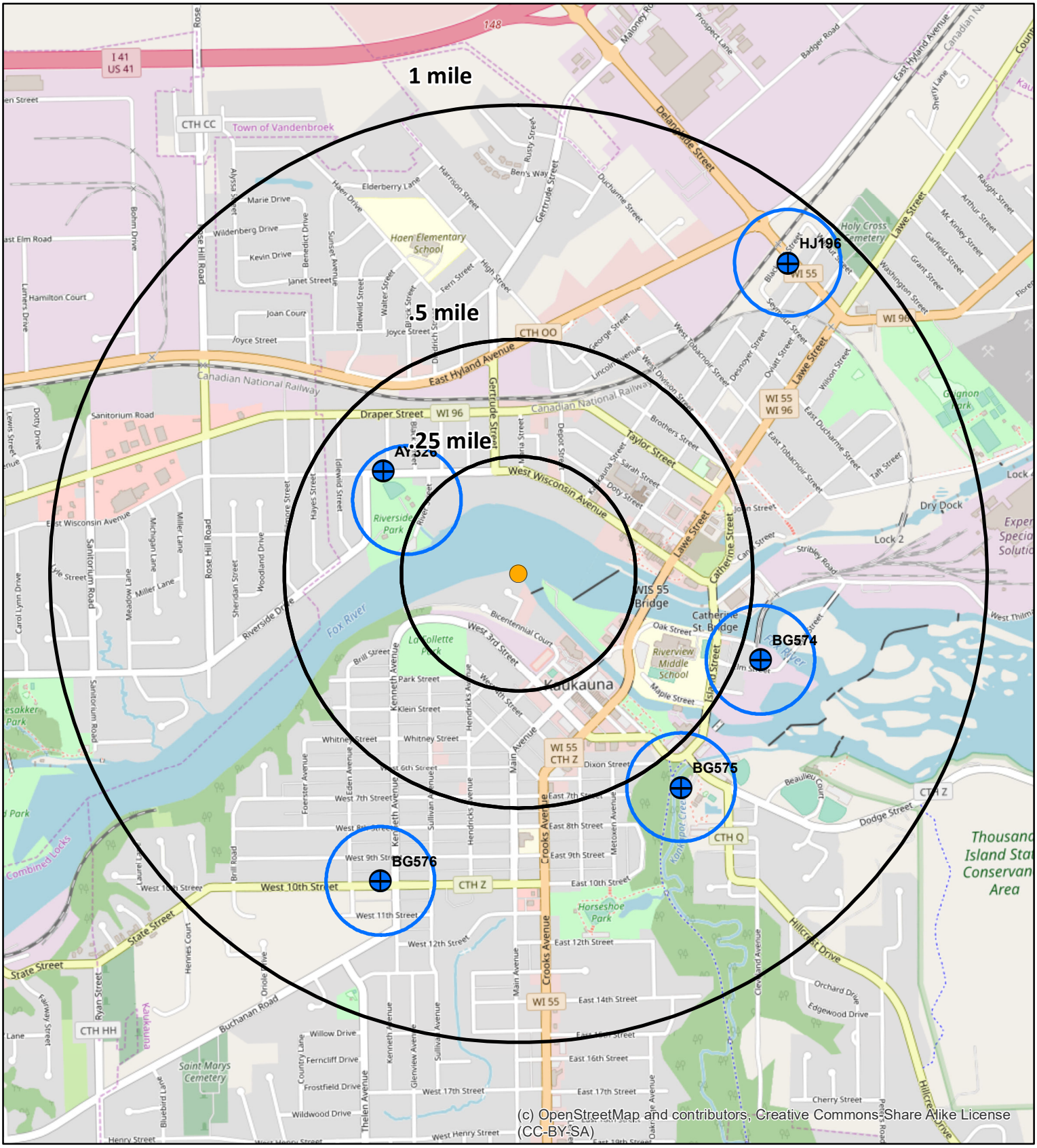
WISCONSIN DEPT. OF NATURAL RESOURCES

Project Manager:	BJL
Drawn By:	RSS
Reviewed By:	BJL

0 400 800 FT

Figure 4
Release Locations
USACE - Parcel J Preliminary Assessment
City of Kaukauna, Outagamie County, WI

SEPTEMBER 2019 US EPA ID: WIN000508686



Legend

- USACE - Parcel J
- Municipal Public Water Supply Well
- Source Water Protection Area

N

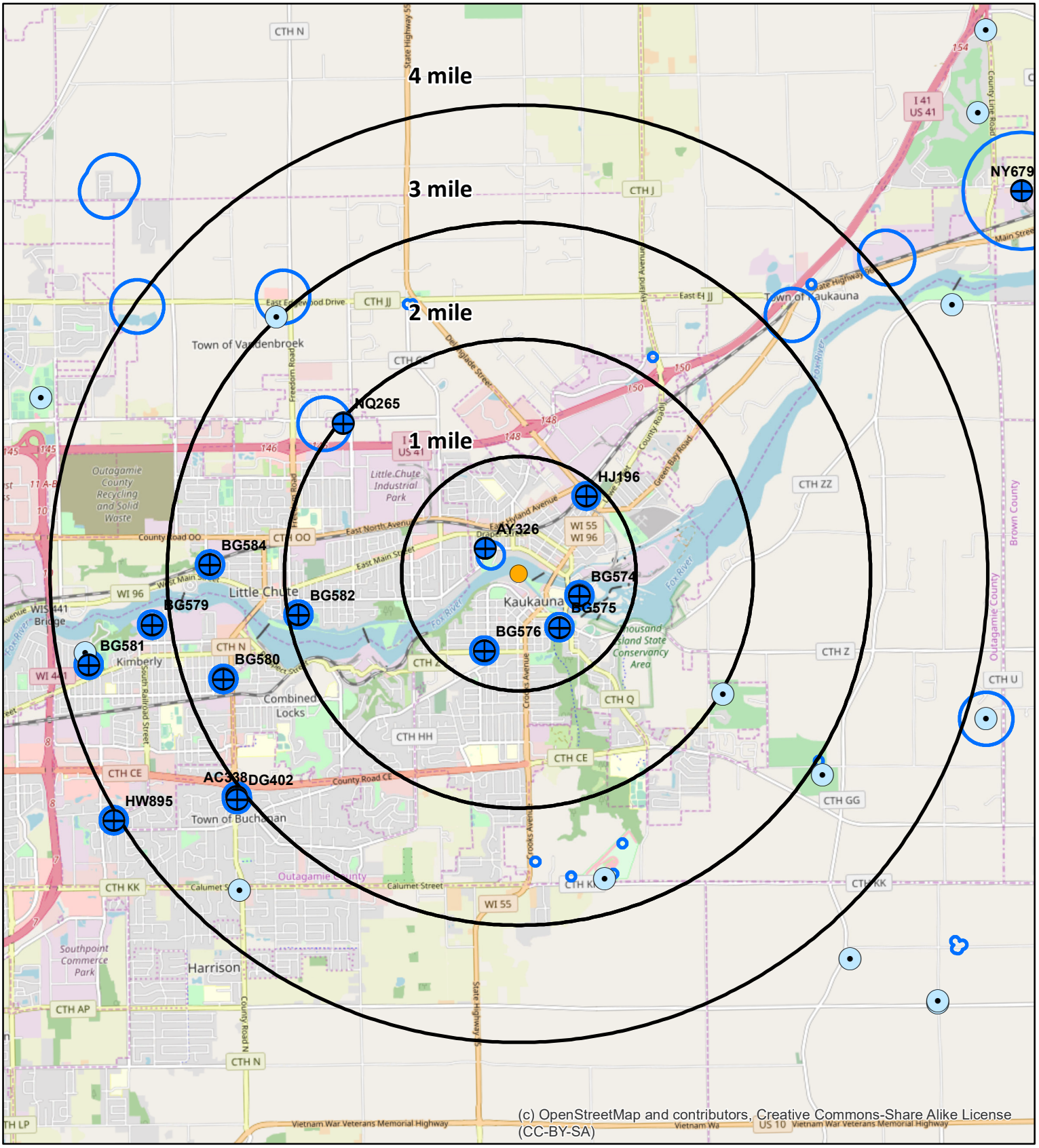
WISCONSIN DEPT. OF NATURAL RESOURCES

0 1,500 3,000 FT

Project Manager:	BJL
Drawn By:	RSS
Reviewed By:	BJL

Figure 5
One Mile Radius
USACE - Parcel J Preliminary Assessment
City of Kaukauna, Outagamie County, WI

SEPTEMBER 2019 US EPA ID: WIN000508686



Legend

- USACE - Parcel J
- Municipal Public Water Supply Well
- HiCap Wells
- Source Water Protection Area

N

WISCONSIN DEPT. OF NATURAL RESOURCES

0 6,000 12,000 FT

Project Manager:	BJL
Drawn By:	RSS
Reviewed By:	BJL

Figure 6
Four Mile Radius
USACE - Parcel J Preliminary Assessment
City of Kaukauna, Outagamie County, WI

OCTOBER 2019 US EPA ID: WIN000508686

APPENDIX B

EPA PCS and SIF Forms

Pre-CERCLA Screening Checklist/Decision Form

This form is used in conjunction with a site map and any additional information required by the EPA Region to document completion of a Pre-CERCLA Screening (PCS). The form includes a decision on whether a site should be added to the Superfund program's active site inventory for further investigation. This checklist replaces Attachment A in the December 2016 PCS Guidance document. A current version of the PCS checklist and additional information is available at: https://www.epa.gov/superfund/pre-cercla-screening.

Region: 5 **State/Territory:** WI **Tribe:** _____ EPA ID No. (If Available): _____

Site Name: USACE Parcel J

Other Site Name(s): Kaukauna Power Canal

Site Location: RIVERS EDGE AT END OF APARTMENTS ON BICENTENNIAL COURT (Street)

_____ Congressional District | Kaukauna (City) | WI (State/Terr.) | OUTAGAMIE (County) | _____ – _____ (Zip+4) | ☑ (No Zip Available)

If no street address is available: T21N R18E (Township-Range) 23 (Section)

Checklist Preparer:

BJ LeRoy (Name / Title) 04/16/2019 (Date)

Wisconsin Department of Natural Resources (Organization) (920) 662-5164 (Phone)

2984 Shawano Avenue (Street) BJ.LeRoy@Wisconsin.gov (e-Mail)

Green Bay (City) | WI (State/Terr.) | BROWN (County) | 54313- 6727 (Zip+4)

Site Contact Info/Mailing Address: BJ LeRoy
2984 Shawano Avenue, Green Bay, 54313-6727

CERCLA 105d Petition for Preliminary Assessment? No **If Yes, Petition Date (mm/dd/yyyy):** _____

RCRA Subtitle C Site Status: Is site in RCRA Info? No **If Yes, RCRA Info Handler ID #:** _____

Ownership Type: Brownfields/Public **Additional RCRA Info ID #(s):** _____

Site Type: Other **State ID #(s):** BRRTS # 02-45-548419

Site Sub-Type: Other - Open field/riverbank **Other ID #(s):** _____

Federal Facility? Yes **Federal Facility Owner:** Dept of the Army

Formerly Used Defense Site (FUDS)? (Make selection)

Federal Facility Docket? (Make selection) **If Yes, FF Docket Listing Date (mm/dd/yyyy):** _____

Federal Facility Docket Reporting Mechanism: (Make selection)

Native American Interest? No **If Yes, list Tribe:** _____

Additional Tribe (s): (Make Selection)

Additional Tribe (s): (Make Selection)

Site Description

Use this section to briefly describe site background and conditions if known or (easily) available, such as: operational history; physical setting and land use; site surface description, soils, geology and hydrogeology; source and waste characteristics; hazardous substances/contaminants of concern; historical releases, previous investigations and cleanup activities; previous regulatory actions, including permitting and enforcement actions; institutional controls; and community interest.

Parcel J is a strip of river bank no more than 46 feet wide, immediately upstream (west) of the Kaukauna City Dam and Power Canal, on the south side of the river. The property has more than a century of activity, dating back to 1885 with the Kaukauna Water Power Company, and likely before. As of 1910, a railroad spur and associated buildings existed on and adjacent to the property. The USACE took over supervision of river traffic in the late 1800s, and the property transferred to federal ownership in the early 1900s.

Photographs from the 1950s show a mostly wooded lot and existence of a small pond. Also according to aerial photographs, filling activities took place beginning in the 1960s, and an unimproved road existed until at least 1992. Since approximately 2000, residential apartment complexes neighbor the riverbank. The riverbank exists as partially-wooded grass yard as of 2019.

Geospatial Information

Latitude: +44.281215 **Longitude:** -88.276265

Decimal Degree North (e.g., 38.859156) Decimal Degree West (e.g., 77.036783)

Provide 4 significant digits at a minimum, more if your collection method generates them.

Except for certain territories in the Pacific Ocean, all sites in U.S. states and territories are located within the northern and western hemispheres and will have a positive latitude sign and negative longitude sign. Coordinate signs displayed above are based on the State/Territory entry on page A-1. Geospatial data tips from the PCS Guidance document are available **here**.

Point Description: Select the option below that best represents the site point for future reference and to distinguish it from any nearby sites. See additional information **here**.

- ☐ Geocoded (address-matched) Site Address
- ☐ Site Entrance (approximate center of curb-cut)
- ☒ Approximate Center of Site
- ☐ Other Distinguishing Site Feature (briefly describe):

Point Collection Method: Check the method used to collect the coordinates above and enter the date of collection. See additional information **here**.

- ☒ Online Map Interpolation
- ☐ GPS (handheld, smartphone, other device or technology with accuracy range < 25 meters)
- ☐ GPS Other (accuracy range is ≥ 25 meters or unspecified)
- ☐ Address Matching: Urban
- ☐ Address Matching: Rural
- ☐ Other Method (briefly describe below):

Collection Date (mm/dd/yyyy): 04/15/2019

POINT-SELECTION CONSIDERATIONS

- Often the best point is a feature associated with the environmental release or that identifies the site visually.
- Use the curb cut of the entrance to the site if there is a clear primary entrance and it is a good identifier for the overall location.
- The approximate center of the site (a guess at the centroid) is useful for large-area sites or where there are no appropriate distinguishing features.
- Use the geocoded address if that is the only or best option available, but if possible use something more representative for sites larger than 50 acres.

Complete this checklist to help determine if a site should be added to the Superfund Active site inventory. See Section 3.6 of the PCS guidance for additional information.	YES	NO	Unknown
1. An initial search for the site in EPA's Superfund active, archive and non-site inventories should be performed prior to starting a PCS. Is this a new site that does not already exist in these site inventories?	☒	☐	☐
2. Is there evidence of an actual release or a potential to release?	☐	☐	☐
3. Are there possible targets that could be impacted by a release of contamination at the site?	☒	☐	☐
4. Is there documentation indicating that a target has been exposed to a hazardous substance released from the site?	☒	☐	☐
5. Is the release of a naturally occurring substance in its unaltered form, or is it altered solely through naturally occurring processes or phenomena, from a location where it is naturally found?	☒	☐	☐
6. Is the release from products which are part of the structure of, and result in exposure within, residential buildings or business or community structures?	☐	☐	☐
7. If there has been a release into a public or private drinking water supply, is it due to deterioration of the system through ordinary use?	☐	☐	☐
8. Are the hazardous substances possibly released at the site, or is the release itself, excluded from being addressed under CERCLA?	☐	☐	☐
9. Is the site being addressed under RCRA corrective action or by the Nuclear Regulatory Commission?	☐	☐	☐
10. Is another federal, state, tribe or local government environmental cleanup program other than site assessment actively involved with the site (e.g., state voluntary cleanup program)?	☐	☒	☐
11. Is there sufficient documentation or evidence that demonstrates there is no likelihood of a significant release that could cause adverse environmental or human health impacts?	☐	☒	☐
12. Are there other site-specific situations or factors that warrant further CERCLA remedial/integrated assessment or response?	☐	☐	☒

Preparer's Recommendation: ☒ **Add** site to the Superfund Active site inventory.

☐ **Do not add** site to the Superfund Active site inventory.

Please explain recommendation below:

PCS Summary and Decision Rationale

Use this section to summarize PCS findings and support the decision to add or not add the site to the Superfund active site inventory for further investigation. Information does not need to be specific but, where known, can include key factors such as source and waste characteristics (e.g., drums, contaminated soil); evidence of release or potential release; threatened targets (e.g., drinking water wells); key sampling results (if available); CERCLA eligibility; involvement of other cleanup programs; and other supporting factors. Attach additional pages as necessary.

The Parcel J property contains lead in shallow soil above the state non-industrial direct contact limit. Limited site investigations showed that the top 2-4 feet of soil are contaminated. No groundwater contamination existed as of 2006; however TCLP and SPLP samples at the time showed the potential to leach lead into groundwater at concentrations 15 times higher than the enforcement standard. Due to a dispute over the lead source, the USACE (current owner) plans no further site investigation or remediation. Site work halted in 2006, and the nature/extent of lead contamination remain unknown. Potential receptors include residents by direct contact, drinking water, and the ecological food chain through plant and/or surface water uptake.

BJ LeRoy	State staff/State contractor	04/16/2019
Checklist Preparer Name	**Checklist Preparer Organization**	**Date**

EPA Regional Review and Pre-CERCLA Screening Decision

Add site to the Superfund active site inventory for completion of a:

- ☒ Standard/full preliminary assessment (PA)
- ☐ Abbreviated preliminary assessment (APA)
- ☐ Combined preliminary assessment/site inspection (PA/SI)
- ☐ Inegrated removal assessment and preliminary assessment
- ☐ Integrated removal assessment and combined PA/SI
- ☐ Other: _____

Do not add site to the Superfund active site inventory. Site is:

- ☐ Not a valid site or incident
- ☐ Being addressed by EPA's removal program
- ☐ Being addressed by a state cleanup program
- ☐ Being addressed by a tribal cleanup program
- ☐ Being addressed under the Resource Conservation and Recovery Act
- ☐ Being addressed by the Nuclear Regulatory Commission
- ☐ Other: _____

Optional - Print name of EPA Site Assessor making this decision: _____

EPA Regional Approval: (Enter Date and then click this box to initiate digital signature stamp) _____ **Date** _____

Site Description

(All text as entered on page A-2)

Parcel J is a strip of river bank no more than 46 feet wide, immediately upstream (west) of the Kaukauna City Dam and Power Canal, on the south side of the river. The property has more than a century of activity, dating back to 1885 with the Kaukauna Water Power Company, and likely before. As of 1910, a railroad spur and associated buildings existed on and adjacent to the property. The USACE took over supervision of river traffic in the late 1800s, and the property transferred to federal ownership in the early 1900s.

Photographs from the 1950s show a mostly wooded lot and existence of a small pond. Also according to aerial photographs, filling activities took place beginning in the 1960s, and an unimproved road existed until at least 1992. Since approximately 2000, residential apartment complexes neighbor the riverbank. The riverbank exists as partially-wooded grass yard as of 2019.

In the early 2000s, the USACE began transferring a series of properties along the Fox River to the State of Wisconsin, in order to upgrade and preserve historic locks once used for shipping commerce. At that time, several limited site investigations at Parcel J identified elevated levels of lead in soil from an unknown source. The property transaction (and site cleanup) stalled when the state required site remediation prior to taking ownership from the USACE. The last active site work ended in 2006.

The site investigations between 2003 and 2006 showed that lead existed (at the time) in shallow soil between 290 and 11,000 mg/kg, which is above Wisconsin's non-industrial direct contact standard of 250 mg/kg. Site soil is a mix of poorly-correlating unconsolidated river sediment, including sand, gravel, silt and clay in medium to very thick beds. Generally the site investigations extended to a depth of 10 feet or less, with lead concentrated in the top 2 to 4 feet.

The lead concentration in sediment is unknown for Parcel J; however, extensive sampling from the Fox River PCB dredging may exist in site investigations from other parcels.

Shallow groundwater samples contained lead below state enforcement standards of 15 ppb. However, SPLP and TCLP analysis showed the ability to leach lead to groundwater at concentrations above 150 ppb (15 times the enforcement standard). No groundwater wells exist at the site as of 2019.

The lead source is unknown. Potential sources may include the rail spur, lead paint removal, paint shop buildings and even a blacksmith shop that formerly existed on or near the property. The USACE maintains that they are not the causer, and despite ownership, have not completed lead delineation and cleanup.

Potential receptors include residents by direct contact, drinking water sources and the ecological food chain by uptake or leaching to surface water.

PCS Summary and Decision Rationale

(All text as entered on page A-4)

The Parcel J property contains lead in shallow soil above the state non-industrial direct contact limit. Limited site investigations showed that the top 2-4 feet of soil are contaminated. No groundwater contamination existed as of 2006; however TCLP and SPLP samples at the time showed the potential to leach lead into groundwater at concentrations 15 times higher than the enforcement standard. Due to a dispute over the lead source, the USACE (current owner) plans no further site investigation or remediation. Site work halted in 2006, and the nature/extent of lead contamination remain unknown. Potential receptors include residents by direct contact, drinking water, and the ecological food chain through plant and/or surface water uptake.

FIGURE 1: SITE LOCATION MAPS



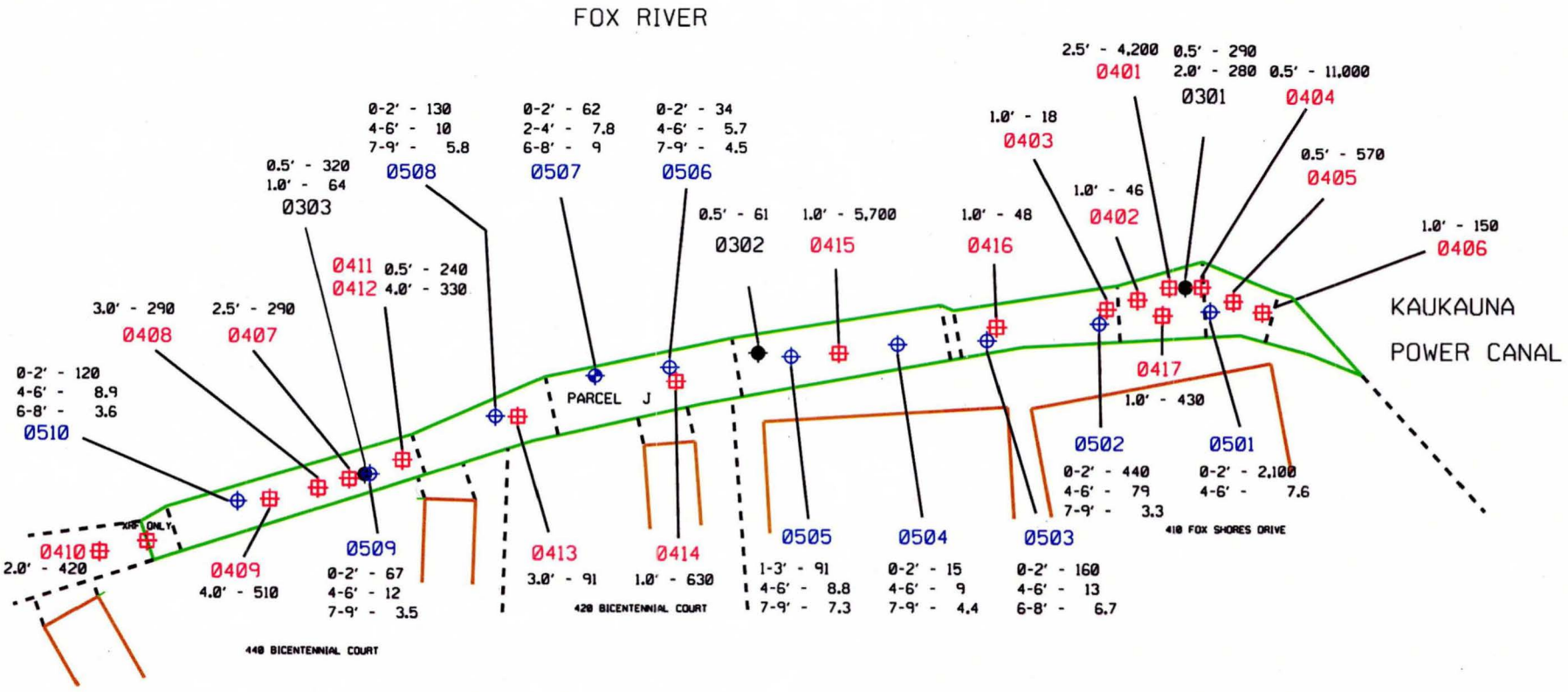


FIGURE 3: 1992 AERIAL PHOTOGRAPH



FOX RIVER KAUKAUNA POWER CANAL PARCEL "J" SAMPLING LOCATION

N



LEGEND

- PROPERTY BOUNDRY
- BUILDING OUTLINE
- SOIL BORING/SOIL SAMPLE FROM 2003 KCP03/KPC03
- SOIL BORING/SOIL SAMPLE FROM 2004 KCP04
- SOIL BORING/SOIL SAMPLE FROM 2005 KCP0905
- SOIL BORING/SOIL AND GROUNDWATER SAMPLE FROM 2005 KCP0905
- 0409 BORING IDENTIFICATION NUMBER
- 4.0' - 510 DEPTH, feet - LEAD ANALYTICAL RESULTS, mg/kg

NOTE:

1. ALL BORING LOCATIONS ARE ESTIMATED.
2. INFORMATION FOR FIGURE FROM DRAWINGS PROVIDED BY ACOE AND BY OUTAGAMIE COUNTY.

N

SCALE 1" = 100'

0 40 80 120 160 200

1		ADD TCLP AND SPLP DATA	MH	
REVISION	DATE	DESCRIPTION	BY	CHKD
DRAWN BY: MH		ALTECH ENVIRONMENTAL SERVICES SOUTHFIELD, MICHIGAN		
DESIGNED BY: MH		KAUKAUNA POWER CANAL PARCEL J KAUKAUNA, WISCONSIN		
DATE: 08-NOV-05		SOIL BORING LOCATION MAP SOIL LEAD LEVELS		
SCALE: 1" = 100'		FIGURE 5		
DRAWING NUM: 5				

...\Parcel J\Parcel J.dgn 7/25/2006 4:53:40 PM

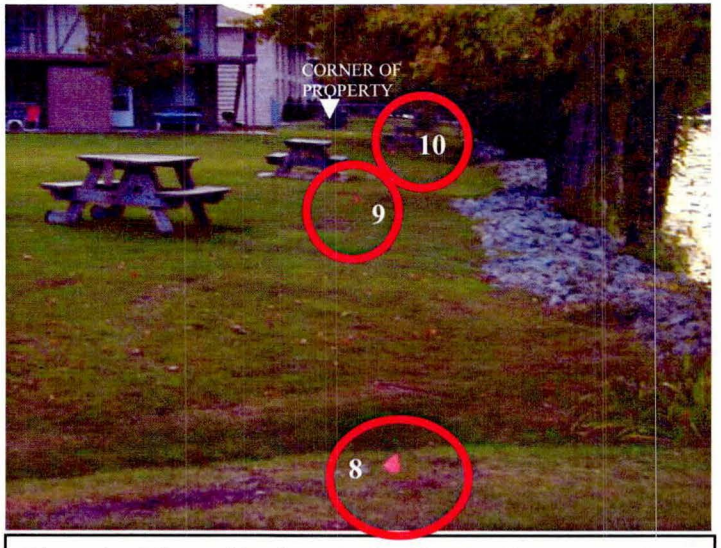


Photo 1. View of boring –08 looking southwest. Borings -09, and-10 located in background.



Photo 2. View of boring –08 looking southwest. Borings -09, -10 located in background.



Photo 3. View of borings –06 and -07 looking west-southwest.



Photo 4. View of boring -06 looking west-southwest. borings –07, through –10 are located in the background

Hole No. KCP0501

DRILLING LOG	DIVISION: DETROIT DISTRICT	INSTALLATION: KAUKAUNA, WISCONSIN	SHEET 1 OF 1 SHEETS

1. PROJECT: FOX RIVER - KAUKAUNA PARCEL J	10. SIZE AND TYPE OF BIT: 2-INCH
2. LOCATION (Coordinates or Station)	11. MANUFACTURER'S DESIGNATION OF DRILL: GEOPROBE
3. DRILLING AGENCY: ALTECH SERVICES LLC	12. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0 / UNDISTURBED 0
4. HOLE NO. *(As shown on drawing title and file number)*: KCP0501	13. DEPTH GROUND WATER (ft)
5. NAME OF DRILLER: J. DAVIS	14. ELEVATION GROUND WATER (ft)
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. SURFACE ELEVATION (ft)
7. THICKNESS OF OVERBURDEN (ft): 10.0	16. DATE HOLE: STARTED 9/28/05 / COMPLETED 9/28/05
8. DEPTH DRILLED INTO ROCK (ft): 0.0	17. TOTAL CORE RECOVERY FOR BORING: N/A %
9. TOTAL DEPTH OF HOLE (ft): 10.0	18. GEOLOGIST: M. HOPE

DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description)	PID ppm	% CORE RECOVERY	BOX OR SAMPLE NO.	CHEMICAL RESULTS
0.0 / 0.3		Sandy Loam, dark brown, dry, (TOPSOIL) loose.			0-2 0.0 2.0	
1.0		Silty Sand, dark brown, dry, (SM) friable.				
1.5		Gravelly Sand, yellow brown, dry, (SWG) friable.				
7.0		Gravelly Sand, grayish brown to light brown, dry, (SWG) friable.			4-6 4.0 6.0	
8.0		Sandy Clay, mottled brown black, moist, (CLS) soft, pliable, no odor.				
8.5		Sandy Gravel, dark brown to black, wet, (GWS) loose, no water collected.			8-10 8.0 10.0	
10.0		Sandy Clay, mottled brown gray, moist, (CLS) pliable.				

Table 7

Summary of Parcel J Lead Concentrations

In Excess of WDNR Default Criteria

Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample I.D.	Sampling Depth	Sampling Date	Lead Analytical Results (mg/kg)
KPC0301	0 - 0.5'	8/25/2003	290
KPC0301	1.5 - 2'	8/25/2003	280
KPC0303	0 - 0.5'	8/25/2003	320
KCP0401	**2.5'**	**7/16/2004**	**4,200**
KCP0404	**6"**	**7/20/2004**	**11,000**
KCP0405	**6"**	**7/16/2004**	**570**
KCP0407	2.5'	7/20/2004	290
KCP0408	3'	7/16/2004	290
KCP0409	**4'**	**7/20/2004**	**510**
KCP0410	2'	7/16/2004	420
KCP0412	4'	7/20/2004	330
KCP0414	**1'**	**7/16/2004**	**630**
KCP0415	**1'**	**7/20/2004**	**5,700**
KCP0417	1'	7/16/2004	430
KCP0501	**0 - 2'**	**9/29/2005**	**2,100**
KCP0502	0 - 2'	9/29/2005	440

11000 **Result Also Exceeds Industrial Direct Contact Criteria**

APPENDIX C

Site Photographs

Appendix D
Larson Cleaners
Preliminary Assessment



Photo #:	001
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing NW from far eastern edge of property, between county building and canal.



Photo #:	002
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing southeast toward same area as Photo #1. Municipal buildings and apartment on right (south), canal to the north.



Photo #:	003
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing northwest toward bend in property. Building is multi-unit partment complex.

Appendix D
Larson Cleaners
Preliminary Assessment



Photo #:	004
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing NW toward northern corner of property; apartment complex on left.



Photo #:	005
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Northern-most corner of property.



Photo #:	006
Date of Photo:	USACE Parcel J
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing west, toward north portion of property.

Appendix D
Larson Cleaners
Preliminary Assessment



Photo #:	007
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing west, apartment complex on left.



Photo #:	008
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Typical site use.



Photo #:	009
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Facing west, toward western edge of property.

Appendix D
Larson Cleaners
Preliminary Assessment



Photo #:	010
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Typical river bank in western property area.



Photo #:	011
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Faacing west, closer to western edge of property.



Photo #:	012
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Typical property use.

Appendix D
Larson Cleaners
Preliminary Assessment



Photo #:	013
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Small area of eroded top soil, atypical of property.



Photo #:	014
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Farther west, facing west.



Photo #:	015
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Typical mature tree root exposed at land surface.

Appendix D
Larson Cleaners
Preliminary Assessment

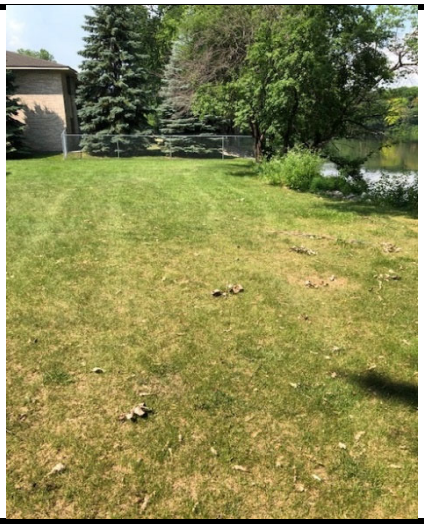


Photo #:	016
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	West edge of property.



Photo #:	017
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Western edge of property, fenced on one of three sides.



Photo #:	018
Date of Photo:	7/15/2019
Photo Location:	USACE Parcel J
Photo By:	BJ LeRoy
Photo Description:	Adjacent property, to the west.

APPENDIX D

Reference Documents

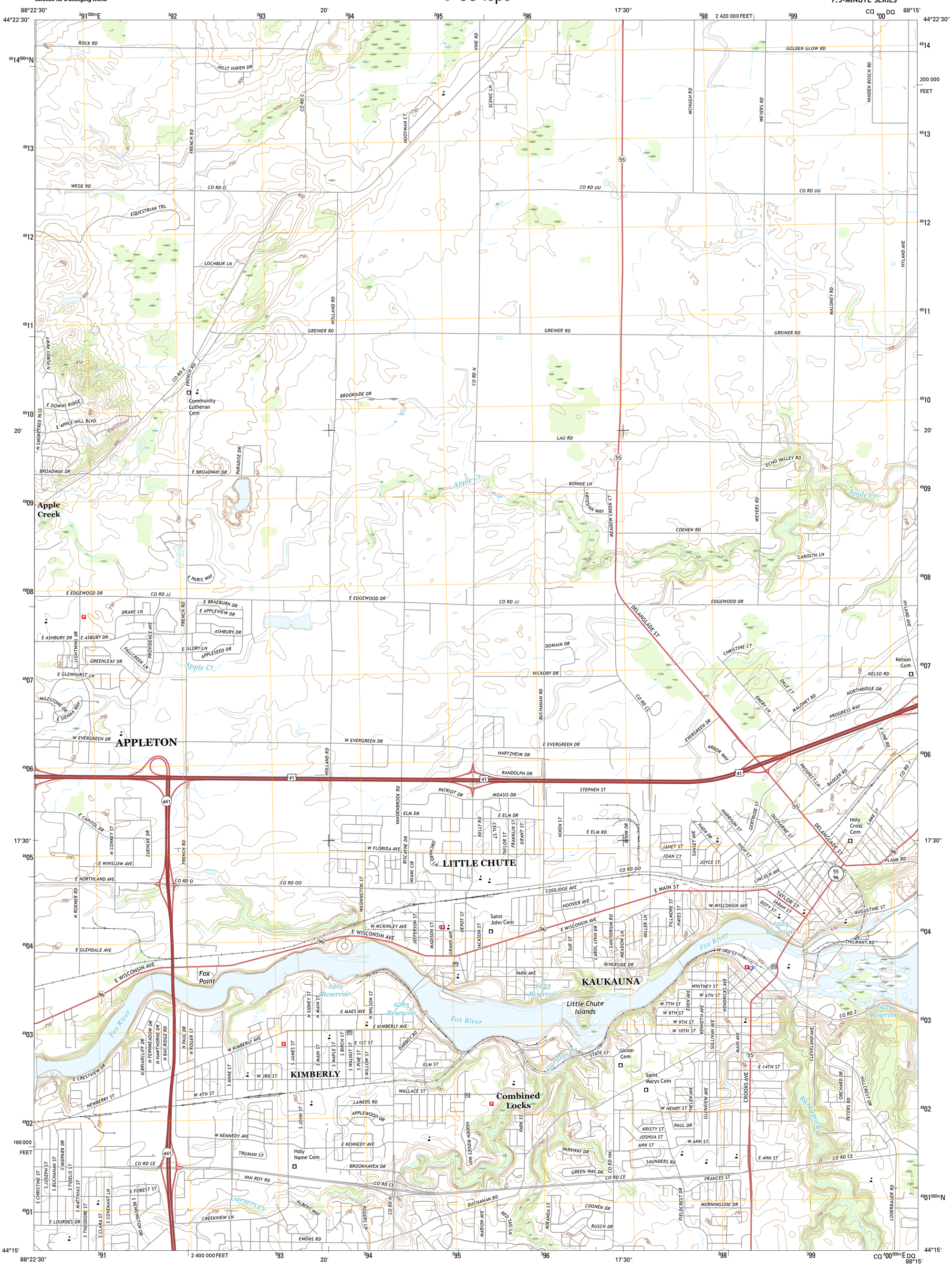
Reference 1
Topographic Map
USACE Parcel J

USGS science for a changing world

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map US Topo

KAUKAUNA QUADRANGLE
WISCONSIN-OUTAGAMIE CO.
7.5-MINUTE SERIES



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and 1 000-meter grid: Universal Transverse Mercator, Zone 16T
10 000-foot ticks: Wisconsin Coordinate System of 1983 (central zone)

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery.....NAIP, July 2013
Roads..... U.S. Census Bureau, 2015 - 2016
Names.....GNIS, 2016
Hydrography.....National Hydrography Dataset, 2013
Contours.....National Elevation Dataset, 2010
Boundaries.....Multiple sources; see metadata file 1972 - 2016
Public Land Survey System.....BLM, 2014
Wetlands.....FWS National Wetlands Inventory 1977 - 2014

MN 3° 42' 66 MILS GN 0° 55' 16 MILS
UTM GRID AND 2016 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
400
CQ DQ
Grid Zone Designation
16T

SCALE 1:24 000
1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.19



QUADRANGLE LOCATION

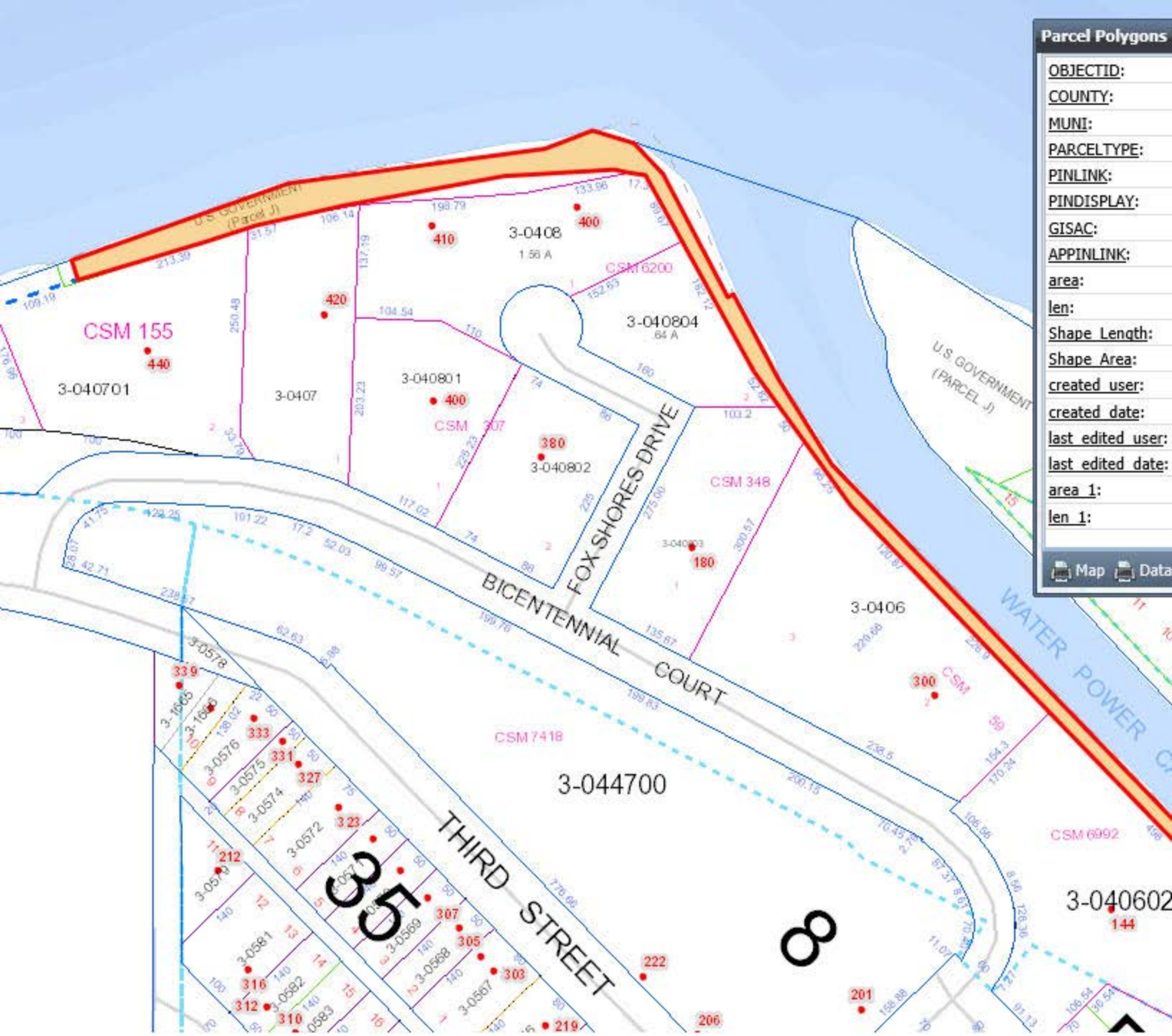
ROAD CLASSIFICATION
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route

1	2	3
4		5
6	7	8

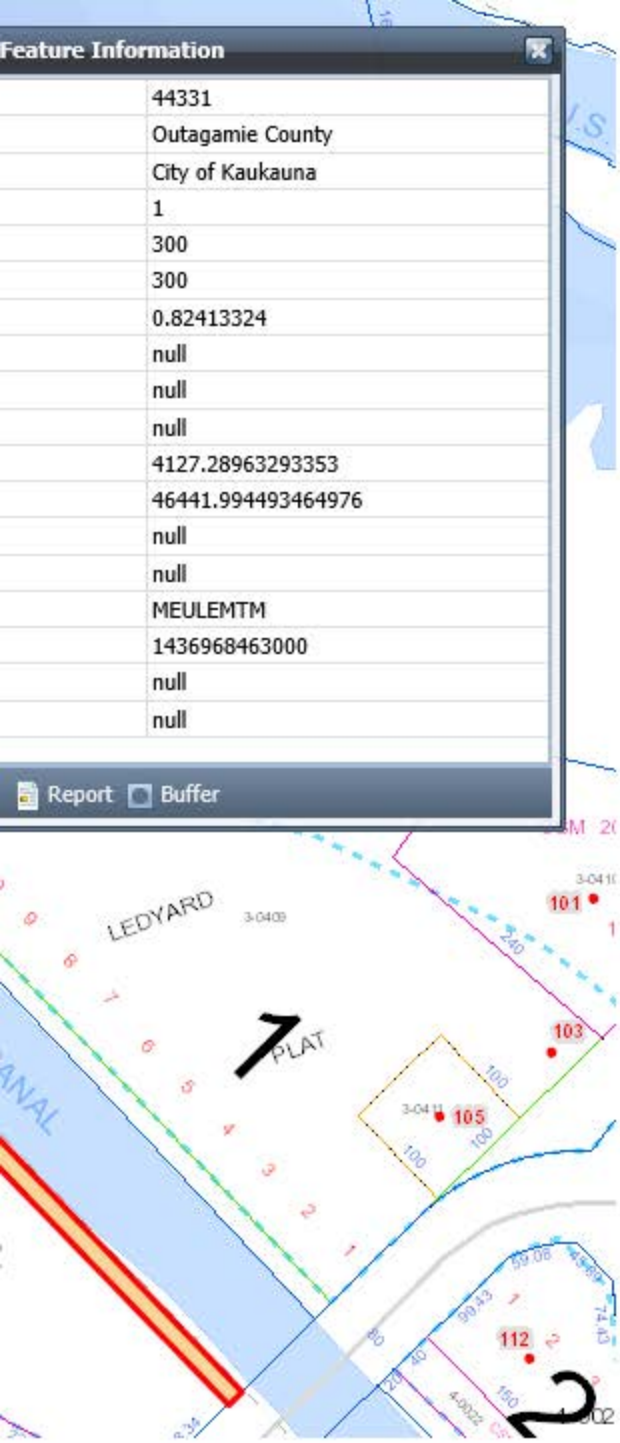
ADJOINING QUADRANGLES
1 Black Creek
2 Freedom
3 Oneida South
4 Appleton
5 Wrightstown
6 Neenah
7 Sherwood
8 Hilbert

KAUKAUNA, WI
2016

NSN. 7643016403343
NGA REF NO. USGSX24K23084



Reference 2
Parcel ID
USACE Parcel J



Reference 2
Parcel ID
USACE Parcel J

U.S. climate data

Temperature - Precipitation - Sunshine - Snowfall

Home | United States | Wisconsin

Monthly | History | Geo & Map

You are here: United Sta

Climate Appleton - Wisconsin

°C | °F

	Jan	Feb	Mar	Apr	May	Jun
Average high in °F:	25	29	40	55	67	77
Average low in °F:	10	13	23	36	47	58
Av. precipitation in inch:	1.14	1.06	1.81	2.95	3.19	4.02
Days with precipitation:	-	-	-	-	-	-
Hours of sunshine:	-	-	-	-	-	-
Average snowfall in inch:	12	9	7	3	0	0

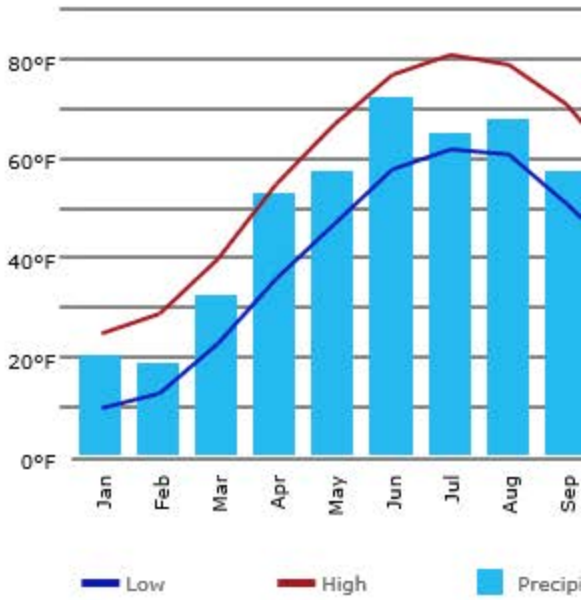
	Jul	Aug	Sep	Oct	Nov	Dec
Average high in °F:	81	79	71	57	43	29
Average low in °F:	62	61	51	40	28	15
Av. precipitation in inch:	3.62	3.78	3.19	2.52	2.2	1.57
Days with precipitation:	-	-	-	-	-	-
Hours of sunshine:	-	-	-	-	-	-
Average snowfall in inch:	0	0	0	0	3	11

Appleton weather averages

Annual high temperature:	54.4°F
Annual low temperature:	37°F
Average temperature:	45.7°F
Average annual precipitation - rainfall:	31.05
Days per year with precipitation - rainfall:	-
Annual hours of sunshine:	-
Av. annual snowfall:	45 inc



Appleton Climate Graph - Wisconsin Climate Ch





Climate data for appleton, Longitude: -88.4378, Latitude: 44.2769
Average weather Appleton, WI - 54911 - 1981-2010 normals

Reference 3
Climate Information
USACE Parcel J

1.3 SITE HISTORY

In 1872, the USACE acquired navigational control of the Fox River waterway, between the cities of Menasha and De Pere, Wisconsin for commercial navigational needs for the Fox River.

Kaukauna Lock 3, one of 17 lift locks on the Lower Fox River lock system, was built by the USACE in 1879. By the 1940s, the Fox River, which originally played a major role in regional transportation and commerce, saw a major decline in navigation with the advent of railroads and highways. In 1983, the USACE closed the Lower Fox River to commercial traffic and discontinued operation and maintenance of the locks (including Kaukauna Lock 3) and placed its property holdings (including Parcel F at Kaukauna Lock 3) in caretaker status. The USACE continues to own and operate nine federal dams and retain control over four privately-owned dams on the Lower Fox River as part of its flood control responsibilities.

Beginning in the 1980's, an effort began to transfer ownership of the locks from the USACE to the State of Wisconsin with the goal of renovating and reopening the locks for commercial and recreational boating. A MOA was signed on September 11, 2000 (USACE 2015) by the Wisconsin Governor, the Secretary of the WDNR, and the Assistant Secretary of the Army for Civil Works. In the MOA, the federal government agreed to "complete any necessary remediation action required by the CERCLA.

On September 17, 2004, the USACE began transferring the ownership of the 17 locks, 38 ha (94 ac) of land bordering the Lower Fox River, three harbors, and an assortment of related buildings along the Lower Fox River to the Wisconsin DOA. The transfer of the locks excluded Parcel F at Kaukauna Lock 3 (Figure 2), due to the presence of lead contamination in soil, which is the subject of this response action.

1.3.1 Previous Investigations and Remedial Activities

Elevated concentrations of lead were detected in soil on the sloped western portion of Parcel F (between the dry dock and garage/storage shed). This lead contamination is likely the result of historic scraping of lead-based paint from exterior walls of the wooden structures located on the parcel and/or historic maintenance of boats in the boat dry dock.

Several investigations and remedial activities were conducted by USACE on Parcel F at Kaukauna Lock 3 to evaluate the potential for, delineate the extent of, and address lead contamination in the vicinity of site building structures. Historic sample locations and excavation footprints are shown on Figure 3 and prior analytical results are listed in Tables 1 and 2. No background samples for lead in soil were collected during these investigations.

1.3.2 Recent Remedial Activities

Based on the results of previous investigations, the USACE issued an Action Memorandum for a Time-Critical Removal Action for the removal of Lead contamination from Parcel F at Kaukauna Lock 3 in June 2015 (USACE 2015). The proposed scope of work called for the deconstruction of the storage building and adjacent catwalk along with removal, transportation and disposal of asbestos bearing materials from the storage building. Additionally, lead contaminated soil along the western side of Parcel F and contaminated sediments within the dry dock area exhibiting lead levels

Dam, and Property Northeast of the Dam. These Property features are located on Canal and Augustine Streets in Kaukauna, Wisconsin. The Property parcels cover 50.4 acres. The layout of the Property is shown on Figure 5.

5.5.2 Property History

Locks 1, 2, 3, 4, and 5 were built in 1883, 1903, 1879, 1879, and 1898, respectively. The portion of the Lock 3 Property now supporting the Project Office and the Generator Building was acquired by the U.S. Government in 1947 by condemnation procedures. Current and known historical structure locations are shown on Figure 5.

Property Southwest of Dam

The Property southwest of the dam was depicted as part of the Kaukauna Water Power Company canal system in the 1885 Sanborn Map. The 1910 U.S. Government Map shows a small building with a well (purpose unknown), railroad spur, and a water closet. In 1952, 1956, and 1964, the Property was wooded, contained a small pond, and no structures. Surface disturbances were observed at the Property on the 1964 aerial photograph which may have been filling activities. The area of disturbance was larger in the 1971 aerial photograph. The 1974 historic map and 1992 topographic map show an unimproved roadway on the Property. This roadway is not apparent in the 1981 aerial photograph. In the 1992 aerial photograph, a square-shaped disturbance and driveway on the southeast portion of this Property are apparent. The locations of the disturbed areas are shown on Figure 5.

Property Northeast of Dam

From 1885 to 1951, the Property northeast of the dam contained small buildings/sheds related to the commercial establishments on Wisconsin Street. A "needle house" and "Guard Lock Skeleton Gates" were shown on the 1910 U.S. Government Map. From 1952 to 1964, this Property was open and vacant. In 1971, the Property was disturbed to construct an access road onto the Property.

Lock 1

The 1885, 1890, 1894, 1900, and 1906 Sanborn Maps show small outbuildings related to the adjoining lumber, paper, and hub-and-spoke manufacturing facilities on Lock 1 Property. The maps also show flumes related to these facilities crossing the Property and draining into the U.S. Canal. The 1910 U.S. Government Map shows a coal shed, warehouse, Lockmaster's dwelling, and barn immediately north of Lock 1. Small buildings associated with neighboring properties to the north of Lock 1, including a machine shop, are also shown on the Property. Buildings associated with the Union Bar and Paper Co. and Thilmany Paper Mill are also shown on the Property south of Lock 1. The neighboring property buildings on the northern portion of the Lock 1 Property remained on the Property until at least 1925. These buildings, including the machine shop, were removed from the Property by 1945. The 1952 and subsequent aerial photographs, and the 1956 Sanborn Map show an access road for Thilmany Paper on the southern shore of the Lock 1 Property. The areas of the Property used by adjacent commercial and industrial facilities are shown on Figure 5. In the 1981 aerial photograph, the large oil house, Lockmaster's dwelling, and garage are observed. The 1992 aerial photograph also shows a circular structure and a small area of surface disturbance/debris along the canal bank. The purpose of the circular structure is not known. During the site visit, the Lockmaster's dwelling, garage, large oil house, small oil house, and a lockshelter were observed at the Property.

Table 7

Summary of Parcel J Lead Concentrations

In Excess of WDNR Default Criteria

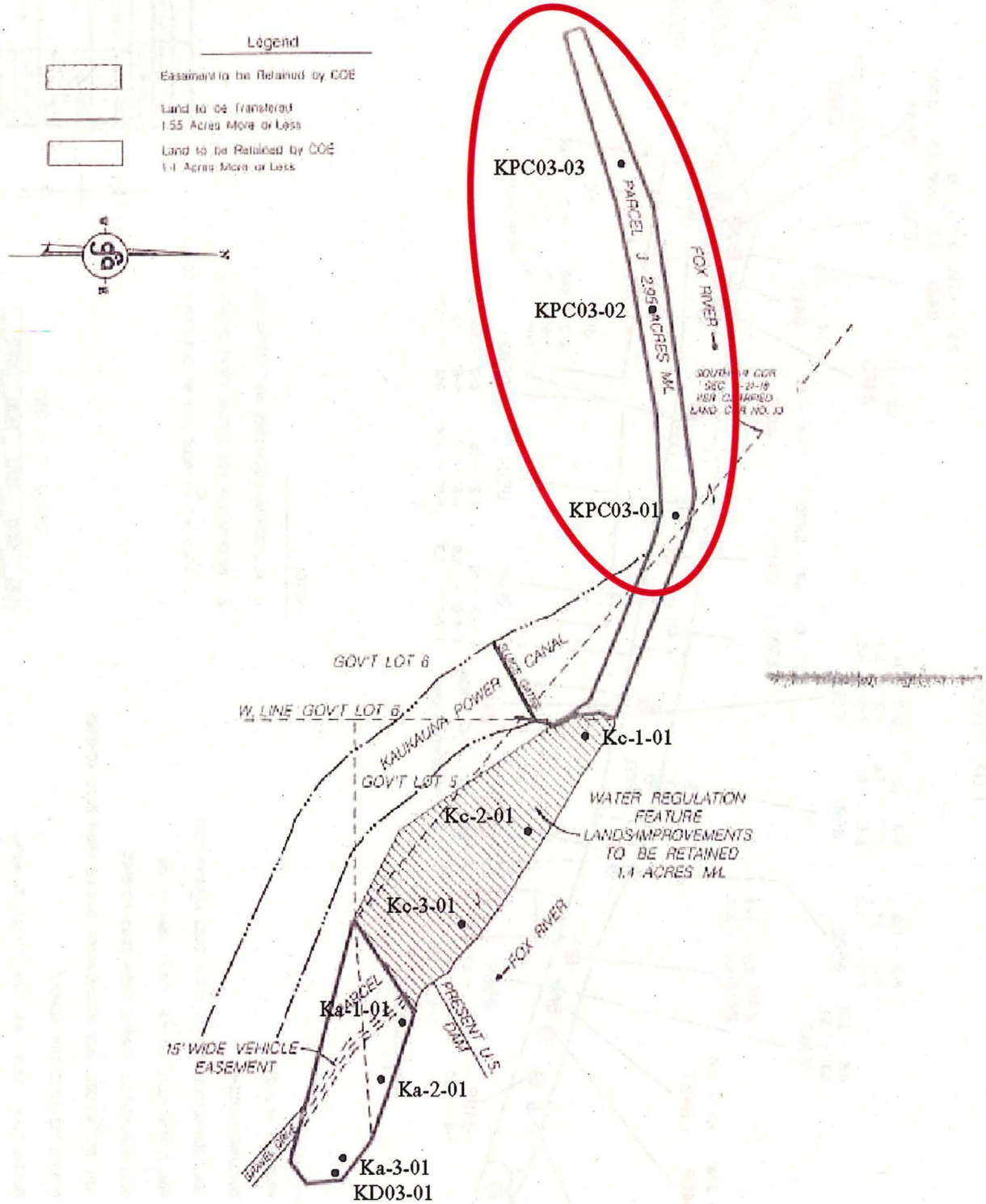
Fox River, Kaukauna, Wisconsin

Altech Project # 9201-0038

Sample I.D.	Sampling Depth	Sampling Date	Lead Analytical Results (mg/kg)
KPC0301	0 - 0.5'	8/25/2003	290
KPC0301	1.5 - 2'	8/25/2003	280
KPC0303	0 - 0.5'	8/25/2003	320
KCP0401	**2.5'**	**7/16/2004**	**4,200**
KCP0404	**6"**	**7/20/2004**	**11,000**
KCP0405	**6"**	**7/16/2004**	**570**
KCP0407	2.5'	7/20/2004	290
KCP0408	3'	7/16/2004	290
KCP0409	**4'**	**7/20/2004**	**510**
KCP0410	2'	7/16/2004	420
KCP0412	4'	7/20/2004	330
KCP0414	**1'**	**7/16/2004**	**630**
KCP0415	**1'**	**7/20/2004**	**5,700**
KCP0417	1'	7/16/2004	430
KCP0501	**0 - 2'**	**9/29/2005**	**2,100**
KCP0502	0 - 2'	9/29/2005	440

11000 **Result Also Exceeds Industrial Direct Contact Criteria**

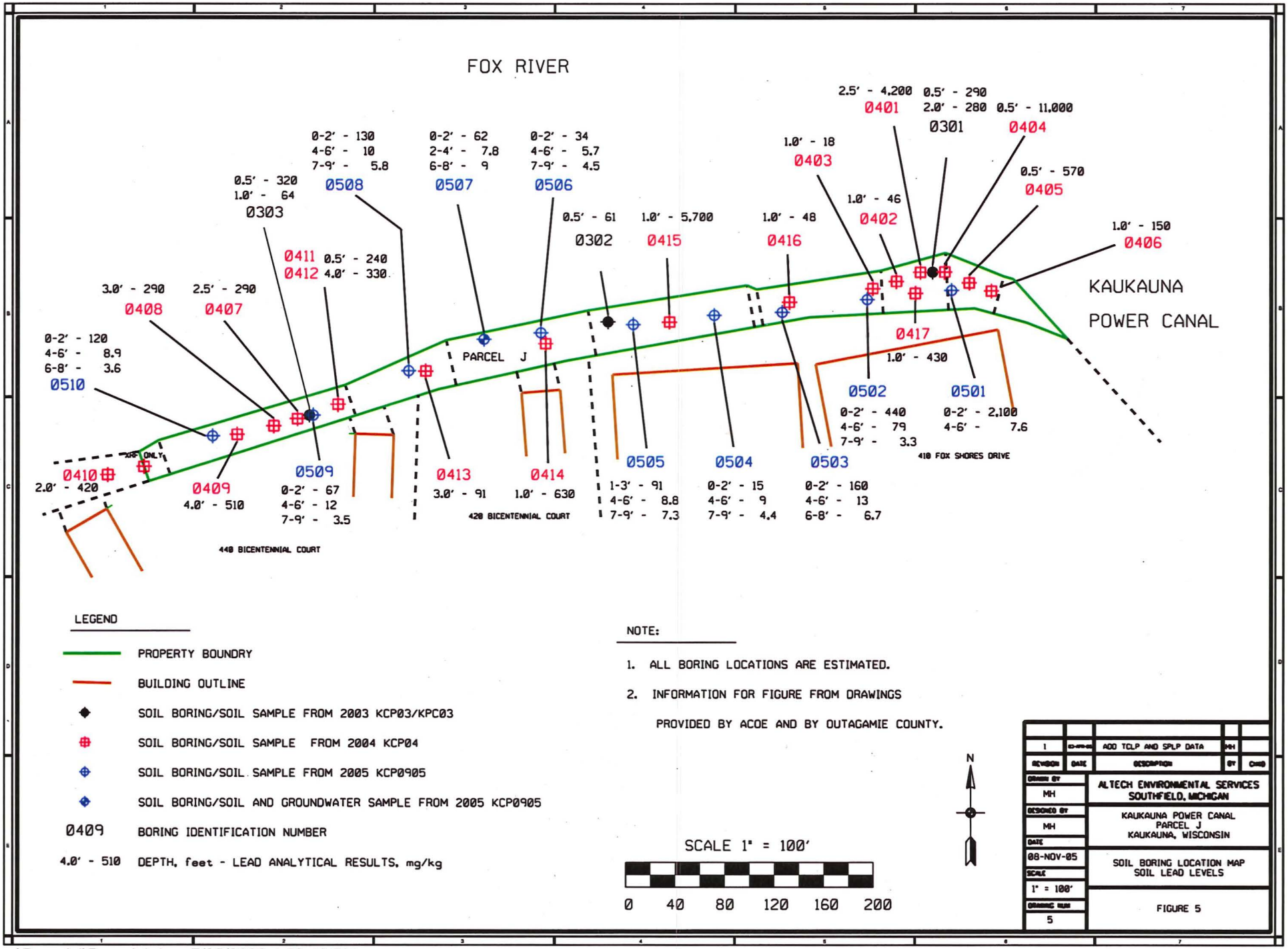
FIGURE 4: PARCEL J – 2003 SAMPLE LOCATIONS



KAUKAUNA POWER CANAL PARCEL J

ACTEC

Reference 5
Soil Sample Results
USACE Parcel J



LEGEND

- PROPERTY BOUNDRY
- BUILDING OUTLINE
- SOIL BORING/SOIL SAMPLE FROM 2003 KCP03/KPC03
- SOIL BORING/SOIL SAMPLE FROM 2004 KCP04
- SOIL BORING/SOIL SAMPLE FROM 2005 KCP0905
- SOIL BORING/SOIL AND GROUNDWATER SAMPLE FROM 2005 KCP0905
- 0409 BORING IDENTIFICATION NUMBER
- 4.0' - 510 DEPTH, feet - LEAD ANALYTICAL RESULTS, mg/kg

NOTE:

1. ALL BORING LOCATIONS ARE ESTIMATED.
2. INFORMATION FOR FIGURE FROM DRAWINGS PROVIDED BY ACOE AND BY OUTAGAMIE COUNTY.

N

SCALE 1" = 100'

0 40 80 120 160 200

REVISION	DATE	DESCRIPTION	BY	CHKD
1		ADD TCLP AND SPLP DATA	MH	

DRAWN BY	MH
DESIGNED BY	MH
DATE	08-NOV-05
SCALE	1" = 100'
DRAWING NUM	5

ALTECH ENVIRONMENTAL SERVICES
SOUTHFIELD, MICHIGAN

KAUKAUNA POWER CANAL
PARCEL J
KAUKAUNA, WISCONSIN

SOIL BORING LOCATION MAP
SOIL LEAD LEVELS

FIGURE 5

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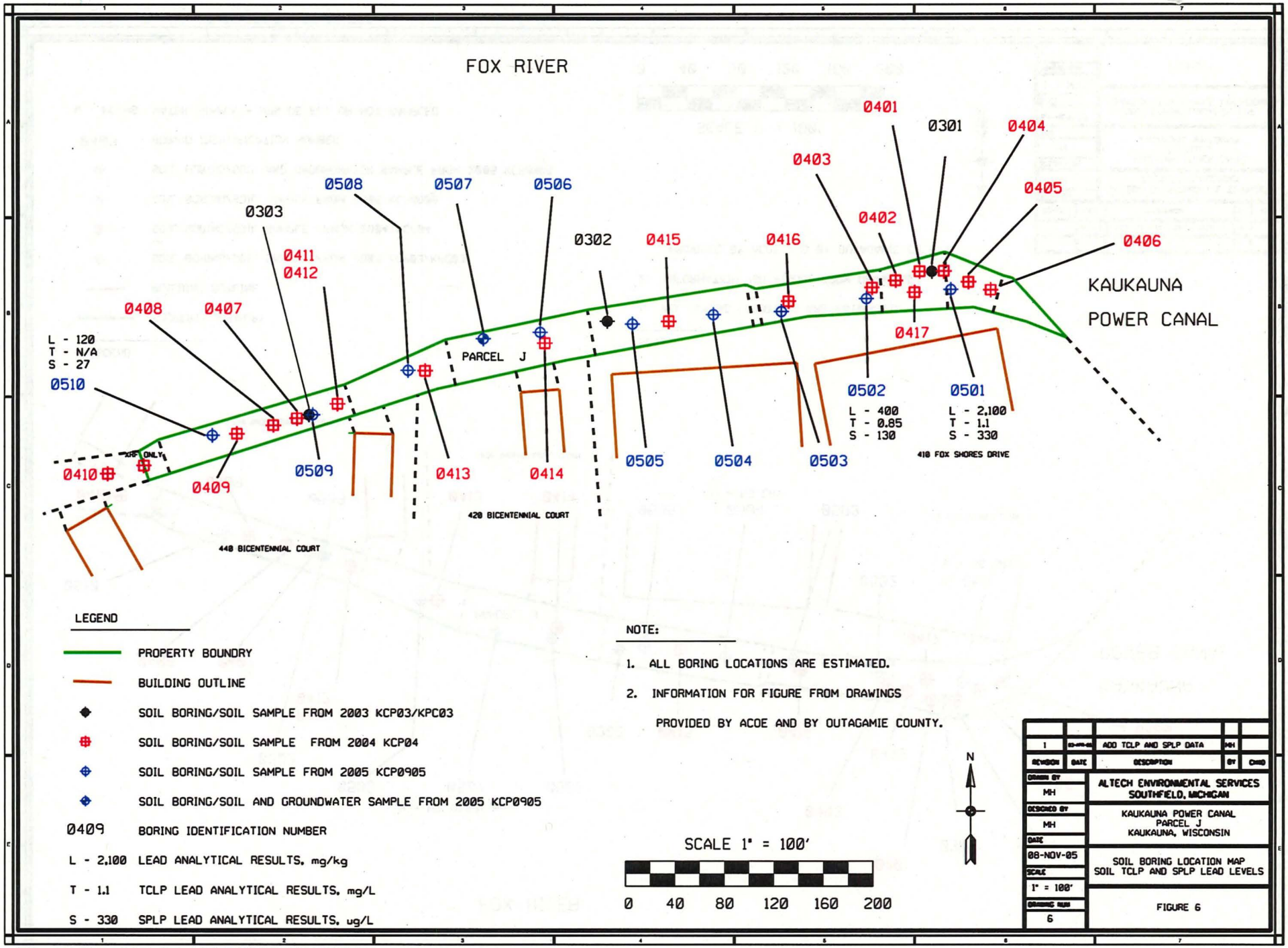
Reference 5
Soil Sample Results
USACE Parcel J



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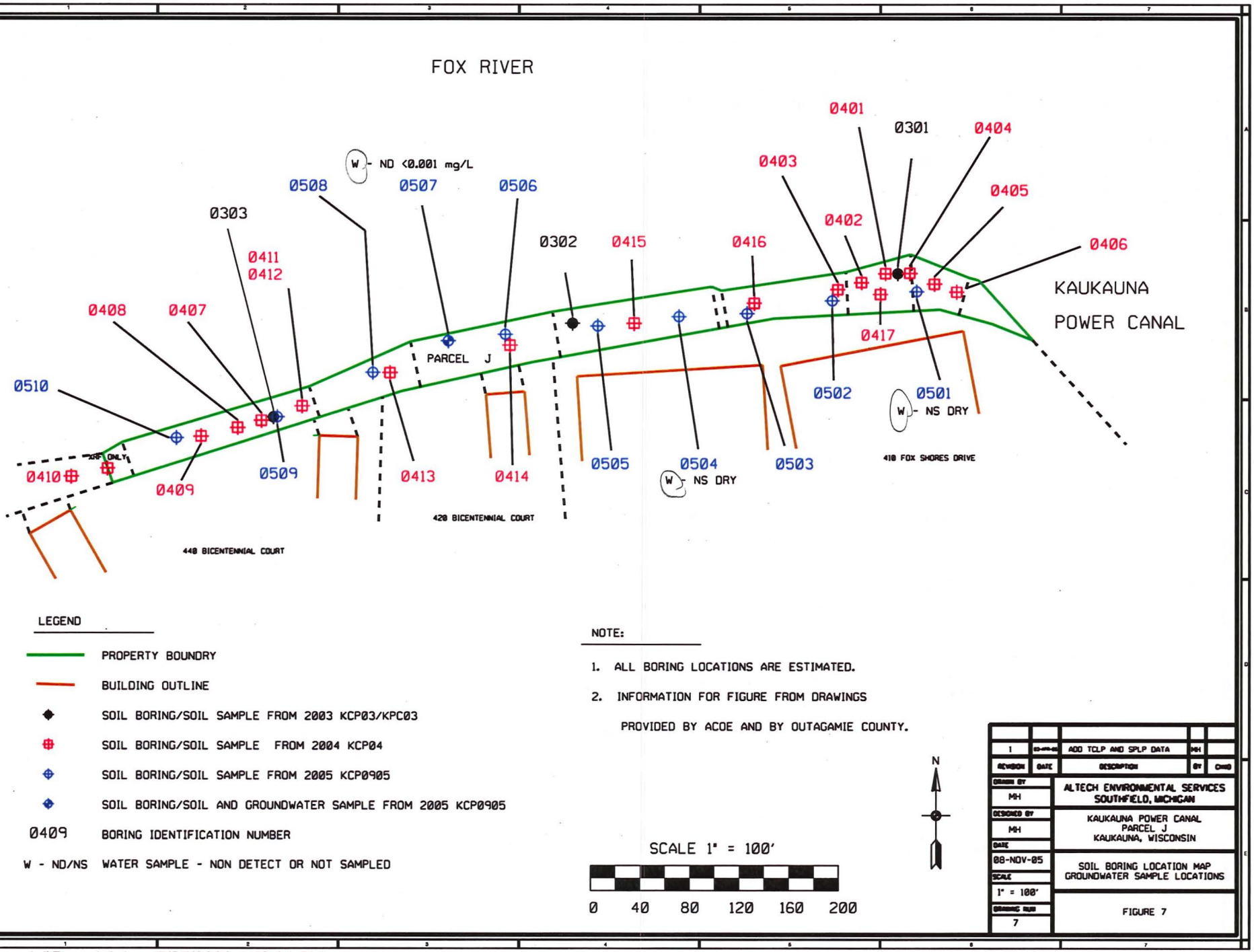
Reference 5
Soil Sample Results
USACE Parcel J



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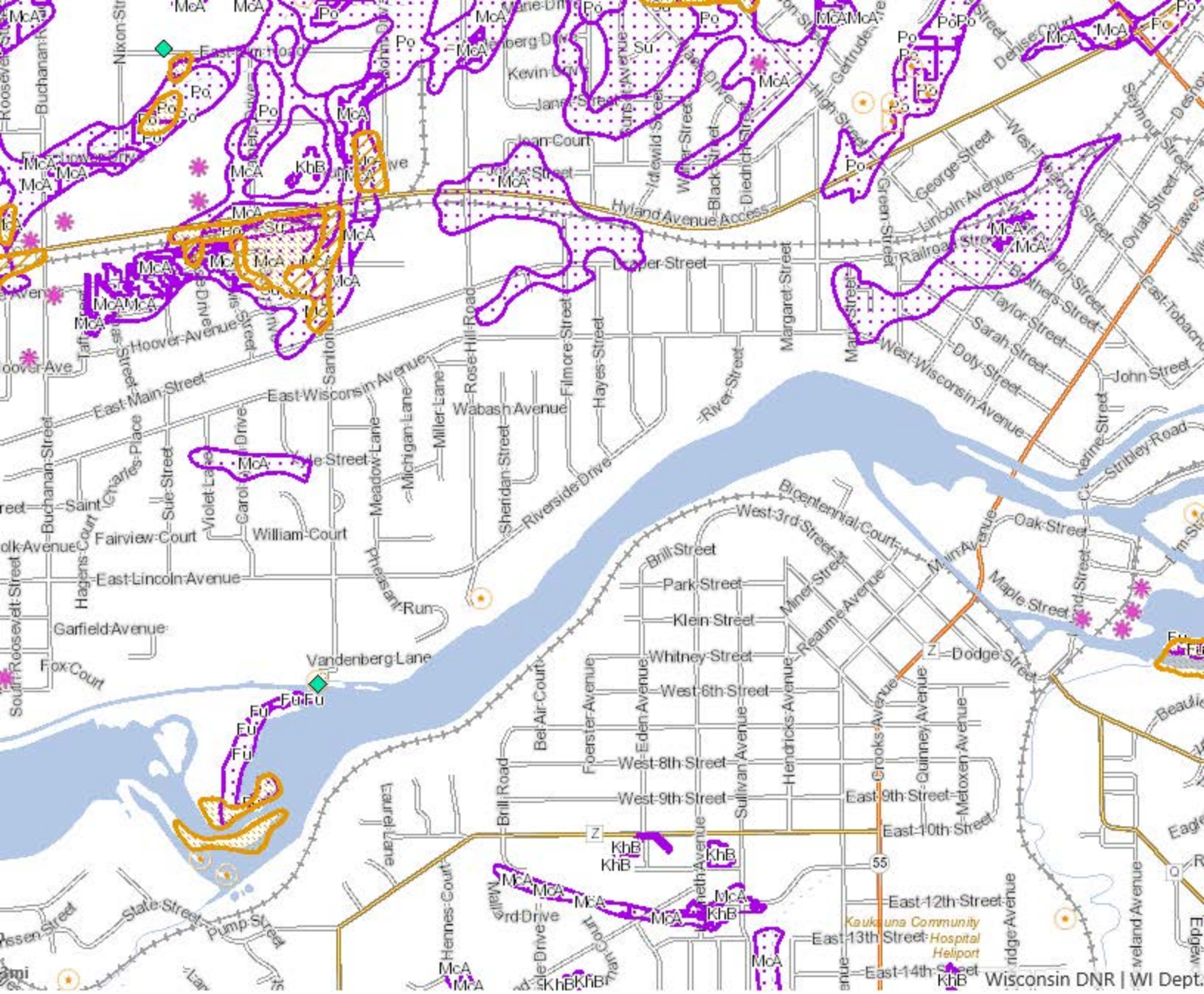
Reference 5
Soil Sample Results
USACE Parcel J

Reference 6
Population Information
USACE Parcel J



Table

ALL TOPICS	Kaukauna city, Wisconsin
Total merchant wholesaler sales, 2012 ($1,000) (c)	258,087
PEOPLE	
Population	
Population estimates, July 1, 2018, (V2018)	16,246
Population estimates base, April 1, 2010, (V2018)	15,474
Population, percent change - April 1, 2010 (estimates base) to July 1, 2018, (V2018)	5.0%
Population, Census, April 1, 2010	15,462



Reference 7
Wetland Indicators
USACE Parcel J

Wisconsin Water Search - Find Rivers, Streams, Lakes, Bays and Harbors

Enter the name of the water you wish to find. Use the export tool to save your data.

Enter Water Name or WBIC 117900
Water Type
County
Watershed Code
Watershed Name
Basin Name
HUC 8 Watershed
HUC 10 Watershed
HUC 12 Watershed

Official Name (Click for Details)	Local Name (Click for Map)	Start Mile	End Mile	Water Size	Water Type	WBIC	County	Last Year Monitored	Fish & Aquatic Life Condition	Trout Clas
Fox River	Lower Fox River (Mouth To Depere Dam)	0.00	7.39	7.4 Miles	RIVER	117900	Brown, Columbia, Green Lake, Marquette, Outagamie, Waushara, Winnebago	2019	Poor	
Fox River	Lower Fox River (Depere Dam To Middle Appleton Dam)	7.39	32.18	24.8 Miles	RIVER	117900	Brown, Columbia, Green Lake, Marquette, Outagamie, Waushara, Winnebago	2019	Poor	

Reference 8
Watershed Quality
USACE Parcel J



Presented By

Kaukauna Utilities

KAUKAUNA UTILITIES

ANNUAL WATER QUALITY REPORT

WATER TESTING PERFORMED IN 2017

Reference 9
Kaukauna Public Water Report
USACE Parcel F

PWS ID#: 44503360

Quality First

Once again we are pleased to present our annual water quality report. As in years past, we are committed to delivering the best-quality drinking water possible. To that end, we remain vigilant in meeting the challenges of new regulations, source water protection, water conservation, and community outreach and education while continuing to serve the needs of all of our water users. Thank you for allowing us the opportunity to serve you and your family.

We encourage you to share your thoughts with us on the information contained in this report. After all, well-informed customers are our best allies.

Information on the Internet

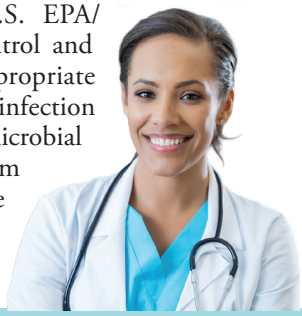
The U.S. EPA (https://goo.gl/TFAMKc) and the Centers for Disease Control and Prevention (www.cdc.gov) Web sites provide a substantial amount of information on many issues relating to water resources, water conservation, and public health. Also, the Wisconsin Department of Natural Resources has a Web site (dnr.wi.gov/topic/drinkingwater) that provides complete and current information on water issues in Wisconsin, including valuable information about our watershed.

How Is My Water Treated and Purified?

The treatment process consists of a series of steps. First, raw water is pumped from our wells and sent to the filter plant, where we add potassium permanganate and manganese sulfate to the water before it reaches the filter tank. The addition of these substances oxidizes the iron, causing small particles to adhere to one another (called floc), which makes the particles big enough to be filtered out as the water passes through the layers of anthracite and manganese greensand in the filter tank. This process removes the iron and also reduces the radium levels in the drinking water. Then we add chlorine to the water for disinfection. Finally, the water is pumped to the distribution system.

Important Health Information

Some people may be more vulnerable to contaminants in drinking water than the general population. Immunocompromised people such as those with cancer undergoing chemotherapy, those who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants may be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. The U.S. EPA/CDC (Centers for Disease Control and Prevention) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline at (800) 426-4791 or http://water.epa.gov/drink/hotline.



Water Conservation

You can play a role in conserving water and save yourself money in the process by becoming conscious of the amount of water your household is using and by looking for ways to use less whenever you can. It is not hard to conserve water. Here are a few tips:

- Automatic dishwashers use 15 gallons for every cycle, regardless of how many dishes are loaded. So get a run for your money and load it to capacity.
- Turn off the tap when brushing your teeth.
- Check every faucet in your home for leaks. Just a slow drip can waste 15 to 20 gallons a day. Fix it and you can save almost 6,000 gallons per year.
- Check your toilets for leaks by putting a few drops of food coloring in the tank. Watch for a few minutes to see if the color shows up in the bowl. It is not uncommon to lose up to 100 gallons a day from an invisible toilet leak. Fix it and you save more than 30,000 gallons a year.
- Use your water meter to detect hidden leaks. Simply turn off all taps and water-using appliances. Then check the meter after 15 minutes. If it moved, you have a leak.

Source Water Assessment

The Department of Natural Resources conducted assessments for all drinking water sources across the state. The purpose of the assessments was to determine the susceptibility of each drinking water source to potential contaminant sources and establish a relative susceptibility rating of High, Moderate, or Low for each source. The Kaukauna Utilities system is susceptible to contamination by volatile organic compounds, nitrate, beryllium, and microbes. The system has Moderate susceptibility to contamination by synthetic organic compounds (SOCs). The system has Low susceptibility to ethylene dibromide (EDB). For additional information on the source water assessment, call Jeff Helmuth at (608) 266-5234.

QUESTIONS?

For more information about this report, or for any questions relating to your drinking water, please call Kevin Obiala, Water Department Superintendent, at (920) 462-0233.

Where Does My Water Come From?



The source of Kaukauna Utilities water is five groundwater wells that are located throughout the city. The depths of the wells range from 500 to 850 feet. Our daily pumping averages around 1.2 million gallons a day, which calculates to 438 million gallons of treated water a year. We have the capability of pumping in excess of 4 million gallons a day. The distribution system consists of approximately 100 miles of water main, ranging from 6 to 16 inches in diameter. We have three iron filters, which serve the dual purpose of removing both iron and radium from the water. We have two water towers, one on the north side and one on the south side of the city, each with a capacity of 500,000 gallons. We also have three underground reservoirs, with a combined capacity of 600,000 gallons of water.

Benefits of Chlorination

Disinfection, a chemical process used to control disease-causing microorganisms by killing or inactivating them, is unquestionably the most important step in drinking water treatment. By far the most common method of disinfection in North America is chlorination.

Before communities began routinely treating drinking water with chlorine (starting with Chicago and Jersey City in 1908), cholera, typhoid fever, dysentery, and hepatitis A killed thousands of U.S. residents annually. Drinking water chlorination and filtration have helped to virtually eliminate these diseases in the U.S. Significant strides in public health are directly linked to the adoption of drinking water chlorination. In fact, the filtration of drinking water plus the use of chlorine is probably the most significant public health advancement in human history.

How chlorination works:

Potent Germicide Reduction in the level of many disease-causing microorganisms in drinking water to almost immeasurable levels.

Taste and Odor Reduction of many disagreeable tastes and odors like foul-smelling algae secretions, sulfides, and odors from decaying vegetation.

Biological Growth Elimination of slime bacteria, molds, and algae that commonly grow in water supply reservoirs, on the walls of water mains, and in storage tanks.

Chemical Removal of hydrogen sulfide (which has a rotten egg odor), ammonia, and other nitrogenous compounds that have unpleasant tastes and hinder disinfection. It also helps to remove iron and manganese from raw water.

Community Participation

You are invited to participate in our public forum and voice your concerns about your drinking water. We meet the third Wednesday of each month beginning at 4 p.m. at Kaukauna Utilities Operations Building, 777 Island Street, Kaukauna, WI.

Count on Us

Delivering high-quality drinking water to our customers involves far more than just pushing water through pipes. Water treatment is a complex, time-consuming process. Because tap water is highly regulated by state and federal law, water treatment plant and system operators must be licensed and are required to commit to long-term, on-the-job training before becoming fully qualified. Our licensed water professionals have a basic understanding of a wide range of subjects including mathematics, biology, chemistry, and physics. Some of the tasks they complete on a regular basis include:

- Operate and maintain equipment to purify and clarify water
- Monitor and inspect machinery, meters, gauges, and operating conditions
- Conduct tests and inspections on water and evaluate the results
- Maintain optimal water chemistry
- Apply data to formulas that determine treatment requirements, flow levels, and concentration levels
- Document and report test results and system operations to regulatory agencies
- Serve our community through customer support, education, and outreach
- So the next time you turn on your faucet, think of the skilled professionals who stand behind each drop.

Water Main Flushing

Distribution mains (pipes) convey water to homes, businesses, and hydrants in your neighborhood. The water entering distribution mains is of very high quality; however, water quality can deteriorate in areas of the distribution mains over time. Water main flushing is the process of cleaning the interior of water distribution mains by sending a rapid flow of water through the mains.

Flushing maintains water quality in several ways. For example, flushing removes sediments like iron and manganese. Although iron and manganese do not themselves pose health concerns, they can affect the taste, clarity, and color of the water. Additionally, sediments can shield microorganisms from the disinfecting power of chlorine, contributing to the growth of microorganisms within distribution mains. Flushing helps remove stale water and ensures the presence of fresh water with sufficient dissolved oxygen, disinfectant levels, and an acceptable taste and smell.

During flushing operations in your neighborhood, some short-term deterioration of water quality, though uncommon, is possible. You should avoid tap water for household uses at that time. If you do use the tap, allow your cold water to run for a few minutes at full velocity before use, and avoid using hot water, to prevent sediment accumulation in your hot water tank.



Please contact us if you have any questions or if you would like more information on our water main flushing schedule.

Substances That Could Be in Water

To ensure that tap water is safe to drink, the U.S. EPA prescribes regulations limiting the amount of certain contaminants in water provided by public water systems. U.S. Food and Drug Administration regulations establish limits for contaminants in bottled water that must provide the same protection for public health. Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of these contaminants does not necessarily indicate that the water poses a health risk.

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals, in some cases, radioactive material, and substances resulting from the presence of animals or from human activity. Substances that may be present in source water include:

Microbial Contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, or wildlife;

Inorganic Contaminants, such as salts and metals, which can be naturally occurring or may result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming;

Pesticides and Herbicides, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses;

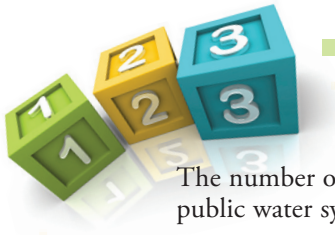
Organic Chemical Contaminants, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production and may also come from gas stations, urban stormwater runoff, and septic systems;

Radioactive Contaminants, which can be naturally occurring or may be the result of oil and gas production and mining activities.

For more information about contaminants and potential health effects, call the U.S. EPA's Safe Drinking Water Hotline at (800) 426-4791.

How Is My Water Treated and Purified?

The treatment process consists of a series of steps. First, raw water is pumped from our wells and sent to the filter plant, where we add potassium permanganate and manganese sulfate to the water before it reaches the filter tank. The addition of these substances oxidizes the iron, causing small particles to adhere to one another (called floc), which makes the particles big enough to be filtered out as the water passes through the layers of anthracite and manganese greensand in the filter tank. This process removes the iron and also reduces the radium levels in the drinking water. Then we add chlorine to the water for disinfection. Finally, the water is pumped to the distribution system.



BY THE NUMBERS

34 BILLION — The number of gallons of water produced daily by public water systems in the U.S.

1 MILLION — The number of miles of drinking water distribution mains in the U.S.

135 BILLION — The amount of money spent annually on maintaining the public water infrastructure in the U.S.

300 MILLION — The number of Americans who receive water from a public water system.

2 BILLION — The age in years of the world's oldest water found in a mine at a depth of nearly two miles.

Test Results

Our water is monitored for many different kinds of substances on a very strict sampling schedule. The information in the data tables shows only those substances that were detected between January 1 and December 31, 2017. Remember that detecting a substance does not necessarily mean the water is unsafe to drink; our goal is to keep all detects below their respective maximum allowed levels. The state recommends monitoring for certain substances less often than once per year because the concentrations of these substances do not change frequently. In these cases, the most recent sample data are included, along with the year in which the sample was taken.

We participated in the 3rd stage of the U.S. EPA's Unregulated Contaminant Monitoring Rule (UCMR3) program by performing additional tests on our drinking water. UCMR3 benefits the environment and public health by providing the EPA with data on the occurrence of contaminants suspected to be in drinking water, in order to determine if the EPA needs to introduce new regulatory standards to improve drinking water quality. Contact us for more information on this program.

REGULATED SUBSTANCES

SUBSTANCE (UNIT OF MEASURE)	YEAR SAMPLED	MCL [MRDL]	MCLG [MRDLG]	AMOUNT DETECTED	RANGE LOW-HIGH	VIOLATION	TYPICAL SOURCE
Alpha Emitters (pCi/L)	2017	15	0	4.8	3.1–4.8	No	Erosion of natural deposits
Barium (ppm)	2017	2	2	0.004	0.003–0.004	No	Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits
Combined Radium (pCi/L)	2017	5	0	3.1	1.5–3.1	No	Erosion of natural deposits
Fluoride (ppm)	2017	4	4	2.0	1.9–2.0	No	Erosion of natural deposits; Water additive that promotes strong teeth; Discharge from fertilizer and aluminum factories
Haloacetic Acids [HAAs] (ppb)	2017	60	NA	3	2–3	No	By-product of drinking water disinfection
TTHMs [Total Trihalomethanes] (ppb)	2017	80	NA	8.9	7.6–8.9	No	By-product of drinking water disinfection

Tap water samples were collected for lead and copper analyses from sample sites throughout the community.

SUBSTANCE (UNIT OF MEASURE)	YEAR SAMPLED	AL	MCLG	AMOUNT DETECTED (90TH%TILE)	SITES ABOVE AL/TOTAL SITES	VIOLATION	TYPICAL SOURCE
Copper (ppm)	2017	1.3	1.3	0.1540	0/30	No	Corrosion of household plumbing systems; Erosion of natural deposits
Lead (ppb)	2017	15	0	3.40	1/30	No	Corrosion of household plumbing systems; Erosion of natural deposits

SECONDARY SUBSTANCES

SUBSTANCE (UNIT OF MEASURE)	YEAR SAMPLED	SMCL	MCLG	AMOUNT DETECTED	RANGE LOW-HIGH	VIOLATION	TYPICAL SOURCE
Sulfate (ppm)	2017	250[1]	NA	550.00	460.00–550.00	No	Runoff/leaching from natural deposits; Industrial wastes

UNREGULATED SUBSTANCES

SUBSTANCE (UNIT OF MEASURE)	YEAR SAMPLED	AMOUNT DETECTED	RANGE LOW-HIGH	TYPICAL SOURCE
Nickel (ppb)	2017	2.5000	2.2000–2.5000	Alloy products
Sodium (ppm)	2017	16.00	12.00–16.00	Naturally occurring

[1] Secondary contaminants are regulated merely to protect the aesthetics of drinking water like taste, appearance, and odor. The U.S. EPA has not established adverse health effects associated with exceedances of SMCLs

Definitions

AL (Action Level): The concentration of a contaminant that, if exceeded, triggers treatment or other requirements that a water system must follow.

MCL (Maximum Contaminant Level): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

MCLG (Maximum Contaminant Level Goal): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

MRDL (Maximum Residual Disinfectant Level): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

MRDLG (Maximum Residual Disinfectant Level Goal): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

NA: Not applicable

pCi/L (picocuries per liter): A measure of radioactivity.

ppb (parts per billion): One part substance per billion parts water (or micrograms per liter).

ppm (parts per million): One part substance per million parts water (or milligrams per liter).

SMCL (Secondary Maximum Contaminant Level): SMCLs are established to regulate the aesthetics of drinking water like appearance, taste and odor.

file original in Sec. 22, copy in Sec. 23

State of Wisconsin
Department of Natural Resources
Private Water Supply
Box 7921
Madison, Wisconsin 53707

NOTE:
White Copy – Division's Copy
Green Copy – Driller's Copy
Yellow Copy – Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300–15 Rev. 5-85

MAR 3 1 1987

1. COUNTY: Outagamie

CHECK (✓) ONE: ☒ Town ☐ Village ☐ City

Name: Vandenbroek

2. LOCATION: ¼ Section or Gov't. Lot: ~~SW¼ SW¼~~ | Section: ~~14~~ | Township: 21N. | Range: 18E.

3. NAME ☒ OWNER ☐ AGENT AT TIME OF DRILLING CHECK (✓) ONE: Joe Sanderfoot

OR – Grid or Street No.: 1850 | Street or Road Name: Sanitorium Rd.

ADDRESS: 1850 Sanitorium Rd.

AND – If available subdivision name, lot & block No.: Sec. 22-23 per Road

POST OFFICE: Little Chute, Wis. ZIP CODE: 54140

4. Distance in feet from well to nearest: (Record answer in appropriate block)

Building	Sanitary Bldg. Drain		Sanitary Bldg. Sewer		Floor Drain Connected To:		Storm Bldg. Drain		Storm Bldg. Sewer	
	C.I.	Other	C.I.	Other	C.I. Sewer	Other Sewer	C.I.	Other	C.I.	Other
50	–	–	–	–	–	–	–	–	–	–

Street Sewer		Other Sewers		Foundation Drain Connected to:		Sewage Sump		Clearwater Sump	Septic Tank	Holding Tank	Sewage Absorption Unit	Manure Hopper or Retention or Pneumatic Tank
San.	Storm	C.I.	Other	Sewer		C.I.	Other				Seepage Pit	
–	–	–	–	Clearwater Dr.		–	–	–	–	50	Seepage Bed	–
											Seepage Trench –	

Privy	Pet Waste Pit	Pit: Nonconforming Existing	Subsurface Pumproom Nonconforming Existing	Barn Gutter	Animal Barn Pen	Animal Yard	Silo With Pit	Glass Lined Storage Facility	Silo w/o Pit	Earthen Silage Storage Trench Or Pit	Earthen Manure Basin
–	–	Well	–	–	–	–	–	–	–	✓	–
		Pump									
		Tank									

Temporary Manure Stack or Platform	Watertight Liquid Manure Tank or Basin	Manure Pressure Pipe	Subsurface Gasoline or Oil Tank	Waste Pond or Land Disposal Unit (Specify Type)	Manure Storage Basin: Concrete Floor Only / Concrete Floor and Partial Concrete Walls	Other (Describe)
–	–		110	–		–

5. Well is intended to supply water for: Shop

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	67	6	67	82

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification Mfg. & Method of Assembly	From (ft.)	To (ft.)
6	ASTM A-53	Surface	67
	Sumitomo Metals		
	Welded joint		
	Wt. 18.97 per ft.		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Drilling mud	Surface	67

9. FORMATIONS

Kind	From (ft.)	To (ft.)
clay	Surface	60
hard pan	60	67
limestone	67	82

10. TYPE OF DRILLING MACHINE USED

☐ Cable Tool
☐ Rotary-air w/drilling mud
☐ Rotary-w/drilling mud
☒ Rotary-hammer w/drilling mud & air
☐ Rotary-hammer & air
☐ Reverse Rotary
☐ Jetting with Air / Water

Well construction completed on June 24, 19 86

11. MISCELLANEOUS DATA

Yield Test: 4 Hrs. at 30 GPM

Depth from surface to normal water level 50 Ft.

Depth of water level when pumping 50 Ft. Stabilized ☒ Yes ☐ No

Well is terminated 8 inches ☒ above ☐ below final grade

Well disinfected upon completion ☒ Yes ☐ No

Well sealed watertight upon completion ☒ Yes ☐ No

Water sample sent to Madison laboratory on January 28, 19 87

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature: Leonard J. Willems Registered Well Driller

Business Name and Complete Mailing Address:
Willems Well Drilling
R. 1 Greenleaf, Wis. 54126

Reference 10
Private Well #1
USACE Parcel J

6826

WGNRD

ELL CONSTRUCTOR'S REPORT
ORM 3300–15

NOTE
WHITE COPY – DIVISION'S COPY
GREEN COPY – DRILLER'S COPY
YELLOW COPY – OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

OU-42-G

COUNTY	CHECK ONE	NAME
Outagamie	☐ Town ☒ Village ☐ City	Kaukauna

LOCATION – ¼ Section	Section	Township	Range
[redacted] NE	[redacted]	21N	19E R18E

R – Grid or street no. | Street name
PRIVATE CLAIM | # 1

ND – If available subdivision name, lot & block no.

3. OWNER AT TIME OF DRILLING
Thilmany Pulp & Paper Company
ADDRESS

POST OFFICE
Kaukauna, Wisconsin 54130

Distance in feet from well to nearest: (Record answer in appropriate block)	BUILDING	SANITARY SEWER C. I.	SANITARY SEWER TILE	FLOOR DRAIN C. I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C. I.	WASTE WATER DRAIN TILE

LEAR WATER DRAIN C. I.	LEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE

THER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)

Well is intended to supply water for: PERM WELL # 56418

DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
	Surface				

CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
		Surface	

GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
	Surface	

9. FORMATIONS

Kind	From (ft.)	To (ft.)
See other side.	Surface	

10. TYPE OF DRILLING MACHINE USED

☒ Cable Tool ☐ Direct Rotary ☐ Reverse Rotary
☐ Rotary – air w/drilling mud ☐ Rotary – hammer with drilling mud & air ☐ Jetting with ☐ Air ☐ Water

Well construction completed on October, 1974

Well is terminated ____ inches ☐ above ☐ below final grade

Well disinfected upon completion ☒ Yes ☐ No

Well sealed watertight upon completion ☒ Yes ☐ No

1. MISCELLANEOUS DATA

ield test: ____ Hrs. at ____ GPM

epth from surface to normal water level ____ ft.

epth to water level when pumping ____ ft.

/ater sample sent to ____ laboratory on: ____ 19

our opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, pe of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should given on reverse side.

GNATURE T. E. Leicht

LAYNE-NORTHWEST Registered Well Driller

COMPLETE MAIL ADDRESS
6005 West Martin Drive
Milwaukee, Wisconsin 53213

Div. Layne-Western Co., Inc.

Please do not write in space below

T. E. LEICHT/ls 1-15-75

OLIFORM TEST RESULT	GAS – 24 HRS.	GAS – 48 HRS.	CONFIRMED	REMARKS

EV. 3–71

OU4074

Reference 10
Private Well #2
USACE Parcel J

SEE OTHER SIDE

Sent in log on 4/10/1958 Suspense Wel 6

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County Outagamie { Town ☐ Village ☐ City ☐ } ~~Freedom~~ CITY OF KAUKAUNA ??
   Check one and give name
2. Location Sec. 24, R. 18E, T 21 N ???
   Name of street and number of premise or Section, Town and Range numbers
3. Owner [X] or Agent ☐ Alvin Schneider
   Name of individual, partnership or firm
4. Mail Address R3, Box 297A. Appleton Wis.
   Complete address required
5. From well to nearest: Building 50 ft; sewer ____ ft; drain ____ ft; septic tank ____ ft; dry well or filter bed ____ ft; abandoned well ____ ft.
6. Well is intended to supply water for: home use

RECEIVED OCT 29 1959 ENVIRONMENTAL

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
6	0	76			

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6"	new standard weight steel pipe		

9. GROUT:

Kind	From (ft.)	To (ft.)
6" diameter drive in rock	2'	

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
Top Soil (dry)	0	2
Sand (dry)	2	7
Sand & Clay (dry)	7	24
Clay dry	24	27
Sandy Hard Pan (dry)	27	38
Gravel Hard Pan (dry)	30	38
Rock (cased 2' with casing	38	76

Construction of the well was completed on: March 14 19 58

The well is terminated 8 inches [X] above, below ☐ the permanent ground surface.

Was the well disinfected upon completion?
Yes X No

Was the well sealed watertight upon completion?
Yes X No

11. MISCELLANEOUS DATA:

Yield test: 2 Hrs. at 10 GPM.

Depth from surface to water-level: 15 ft.

Water-level when pumping: 45 ft.

Water sample was sent to the state laboratory at: Appleton City on March 17 1958

Signature Ervin Jacobs (Registered Well Driller) 2256 Hillcrest St Green Bay Wis (Complete Mail Address)

Please do not write in space below

Rec'd ____ No. ____

Ans'd ____

Interpretation ____

4433

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner ____

Reference 10
Private Well #3
USACE Parcel J

WELL CONSTRUCTION REPORT
WISCONSIN STATE BOARD OF HEALTH
WELL CONSTRUCTION DIVISION

FEB 7 1942

Note: Section 31 of the Wisconsin Well Construction Code, having the force and effect of law, provides that within thirty days after completion of every well the driller shall submit a report covering all essential details of construction to the State Board of Health on a form provided by the Board.

Owner Mr. R. C. Krumke — Driller Mike Beeker

Street or RFD R. F. D. — Post Office N. Kaukauna

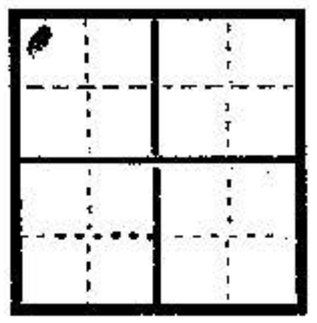
Post Office Appleton — Date Jan 22 — Permit No. 41

LOCATION OF PREMISES

Outagamie (County) Van Den Brock (Town)

Describe further by subdivision, plat, district, lake, lot, block, nearest principal highway, etc., whichever apply.

The square below represents a section of land divided into 40 acre tracts. Mark the position of the premises in the section. NW, NW



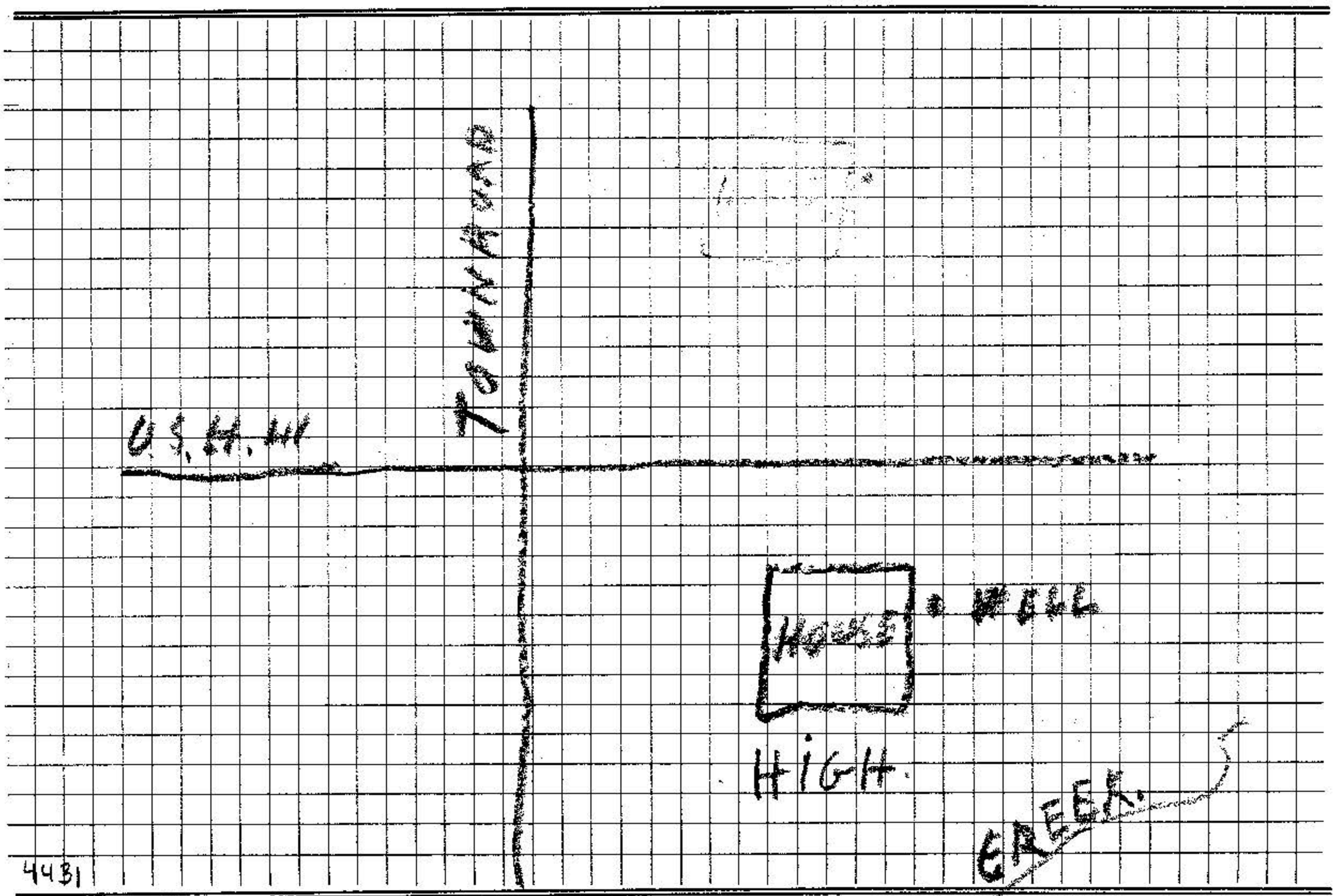
Sec. No. 29

Twp. No. 21 N

Range 18 { E / W

DIAGRAM OF PREMISES

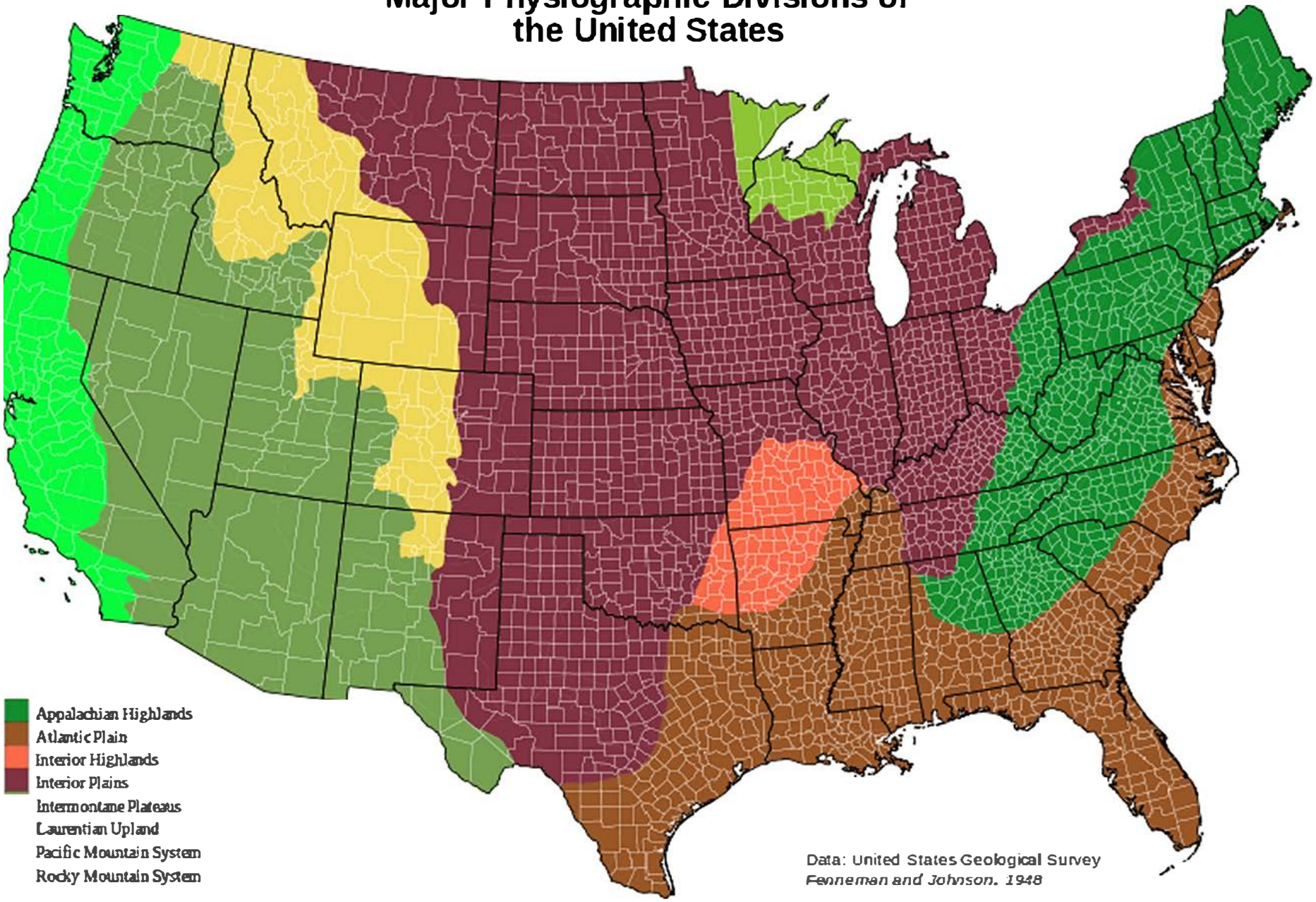
See Well Construction Report bulletin. In making the diagram in the space below consider 10 ft. as the distance between lines. Be sure to indicate NORTH.



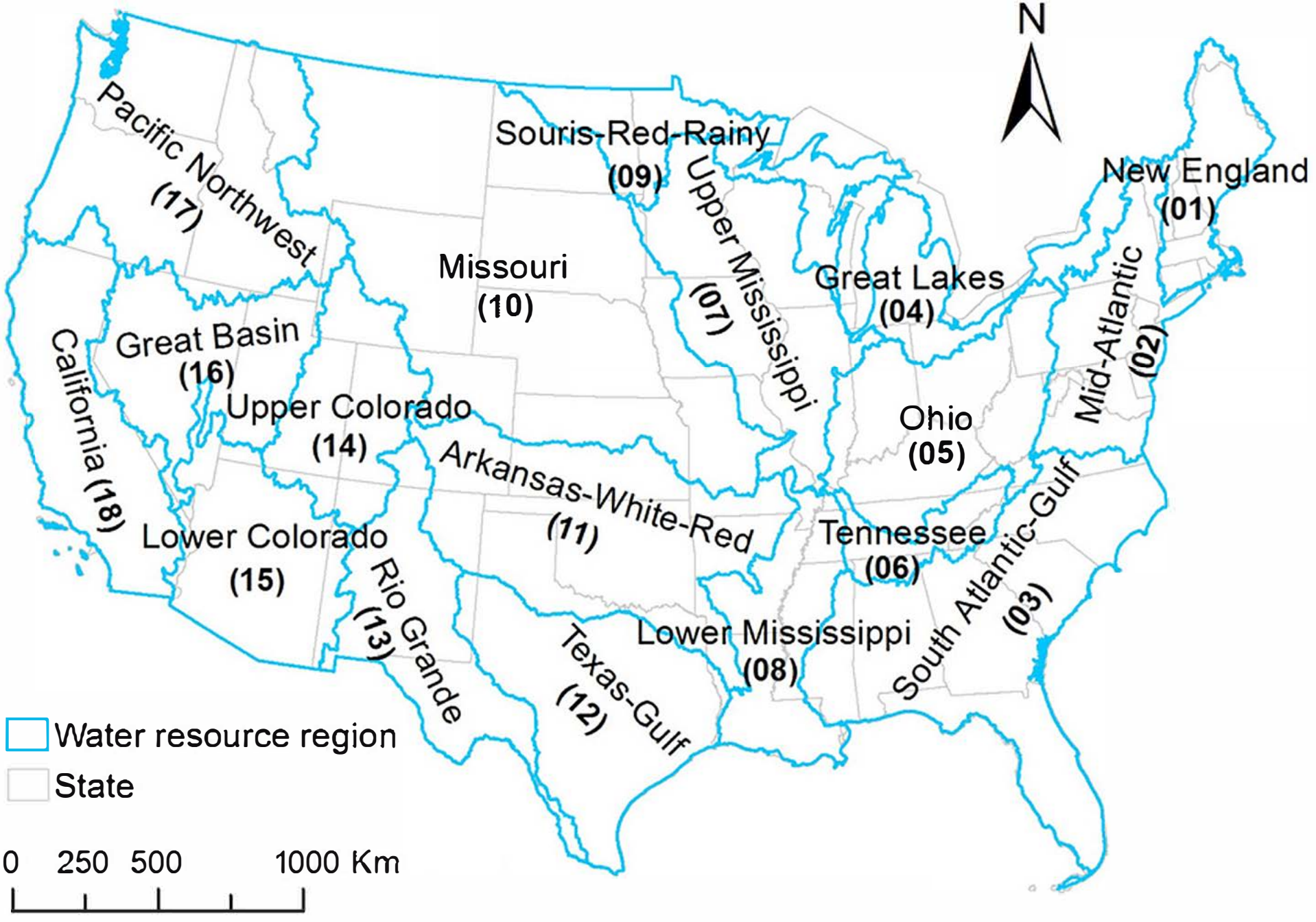
Additional copies of this form may be obtained in lots of 12 for 25¢. Send remittance with order to State Board of Health, Well Drilling Division, Madison, Wis.

Reference 10
Private Well #4
USACE Parcel J

Major Physiographic Divisions of the United States



Reference 11-1
Parcel J Site Assessment



Reference 11-2
Parcel J Site Assessment

Basins

Search watersheds
by name, location and more.

Explore
and search Wisconsin's water resources.

Read
watershed plans for Wisconsin.

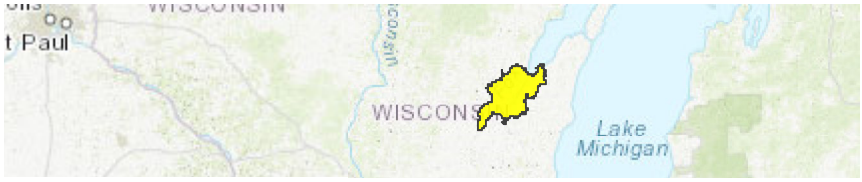

Lower Fox River

Related links

- Surface Water Data Viewer
- USGS: What is a watershed? [exit DNR]
- U.S. EPA: Healthy Watersheds Protection [exit DNR]

Contact information
Lisa Helmuth
Water Quality Bureau





Reference 12
Watershed Detail
USACE Parcel J



The Lower Fox River basin is located in northeastern Wisconsin and encompasses the following counties: Brown, Calumet, Outagamie and Winnebago. The 638 square mile (1,654 square kilometers) drainage basin is bordered by the Twin Door Kewaunee basin to the north and east, the Manitowoc River basin to the south and east, the Upper Fox River basin to the south, the Wolf River basin to the west and the Upper Green Bay basin to the north.

The Lower Fox River empties a drainage basin of 6,349 square miles (including drainage from the Wolf River and Upper Fox River basins), flowing northeast from the outlet of Lake Winnebago to the bay of Green Bay. The Fox River Valley is one of Wisconsin's most urbanized and industrialized areas. Most of these urban areas are close to the river and localized urban and industrial runoff has contributed to water quality problems. Urban nonpoint sources include runoff from existing urban areas including established commercial, industrial, freeways and residential land uses. The basin also contains many rich farmlands, which also contributes to the water quality problems in the area. Nonpoint sources include runoff from barnyards, areas winterspread with livestock manure, eroding agricultural lands and streambank erosion, cattle accessing the streams and other poor landuse practices.

Water quality studies reveal that most of the Lower Fox River basin streams and lower Green Bay suffer from excessive loadings of sediment, nutrients, bacteria and heavy metals resulting in: degraded aquatic habitat and an unbalanced fish community with low populations and limited diversity; sedimentation and excessive nutrient levels resulting in an advanced state of eutrophication; and high levels of toxic materials in bottom sediments and invertebrate organisms consumed by fish.

The Lower Fox River basin has been given statewide attention for improving and protecting water quality. Three watersheds: the East River, the Apple and Ashwaubenon Creeks and Duck Creek, have been selected as priority watersheds under the Wisconsin Nonpoint Source Water Pollution Abatement Program. The three remaining watersheds have been ranked "high" for possible selection, Plum Creek, Fox River/Appleton and Little Lake Butte Des Mort watersheds. The main focus of these projects is to reduce nutrient and sediment loadings to streams and rivers by 50% which is necessary for meaningful water quality improvements to occur.

Reference 12
Watershed Detail
USACE Parcel J

View listing of watersheds of the Lower Fox River basin

Watersheds, waters

Water resource information for specific watersheds

Watershed name/view details	Watershed size	Lists (Streams, lakes, bays & harbors)	Counties	Water management unit (WMU)	Major drainage system
Apple and Ashwaubenon Creeks	113.34 mi 2	LF02 Water lists	Outagamie, Brown	Lower Fox	Lake Michigan
Duck Creek	151.61 mi 2	LF05 Water lists	Outagamie, Brown	Lower Fox	Lake Michigan
East River	206.32 mi 2	LF01 Water lists	Manitowoc, Brown, Calumet	Lower Fox	Lake Michigan
Fox River - Appleton	39.37 mi 2	LF04 Water lists	Outagamie, Winnebago	Lower Fox	Lake Michigan
Little Lake Butte des Morts	43.77 mi 2	LF06 Water lists	Winnebago, Calumet	Lower Fox	Lake Michigan
Plum and Kankapot Creeks	84.04 mi 2	LF03 Water lists	Outagamie, Brown, Winnebago, Calumet	Lower Fox	Lake Michigan

Projects

More detail

- Monitoring stations (hint: Choose watershed, click "Create Report")
- impaired waters (hint: click "create report")
- Trout waters

Plans

Watershed plans

No watersheds have been updated recently for this basin.

Reference 12
Watershed Detail
USACE Parcel J

freshwaternetwork.org/wisconsin/#

Wisco... | Wisco... | dayca... | U.S. C... | Wisco... | Water... | Water... | Wisco... | Impai...

Tools Help

0013 Door Coun...

Previous Next | Options

esign: A Watershed Approach Wisconsin's Waters, Wetlands and Watersheds

rsheds Explorer

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wer Fox

lum Creek-Fox River

arners Creek-Fox River

o Compare Sites:

es ≥ High — Nitrogen Reduction

t — Surface Water Supply

c Habitat — Shoreline Protection

ention — Carbon Storage

tion — Floristic Integrity

Transparent

dlife Habitat:

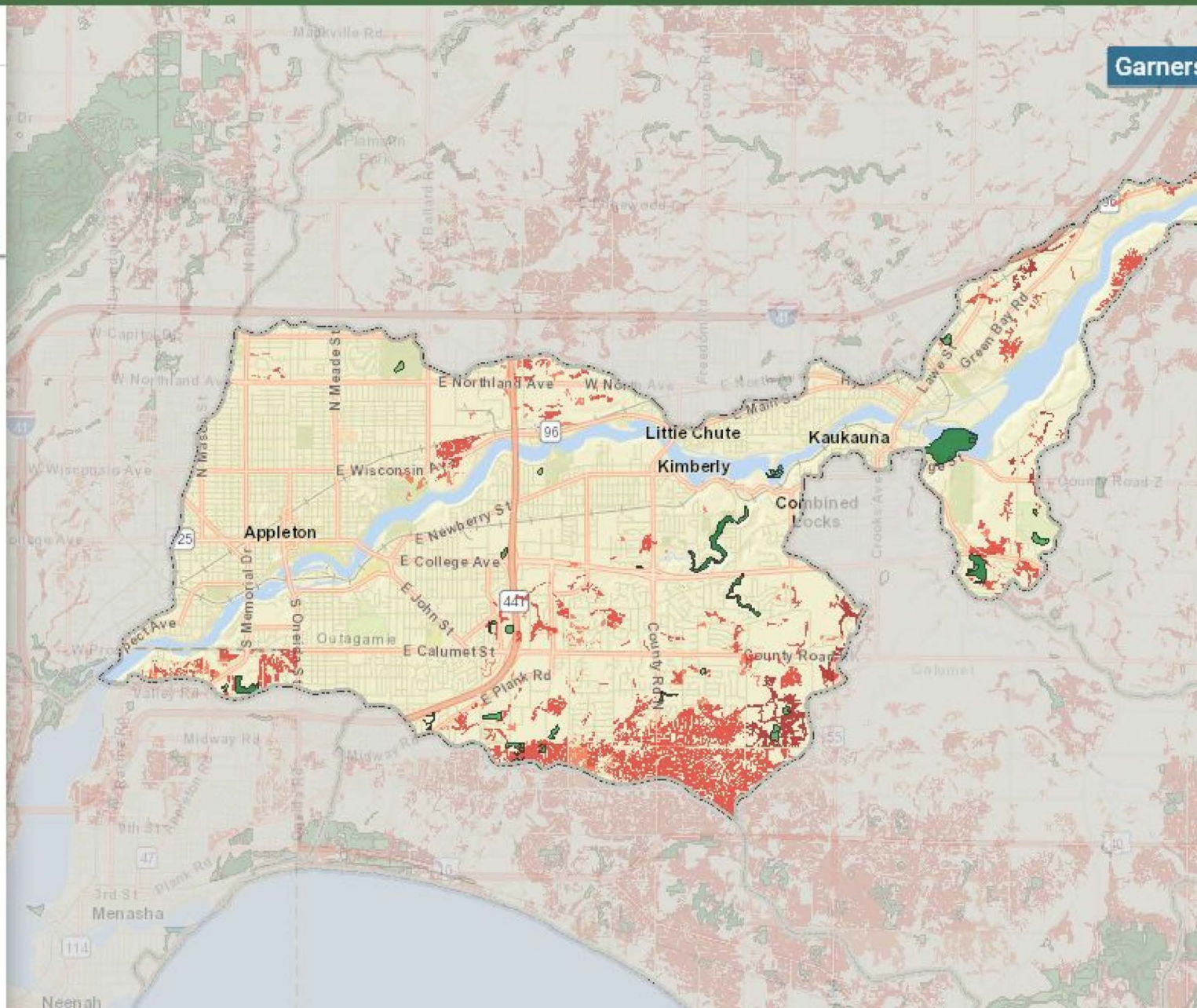
Shallow Marsh Guild

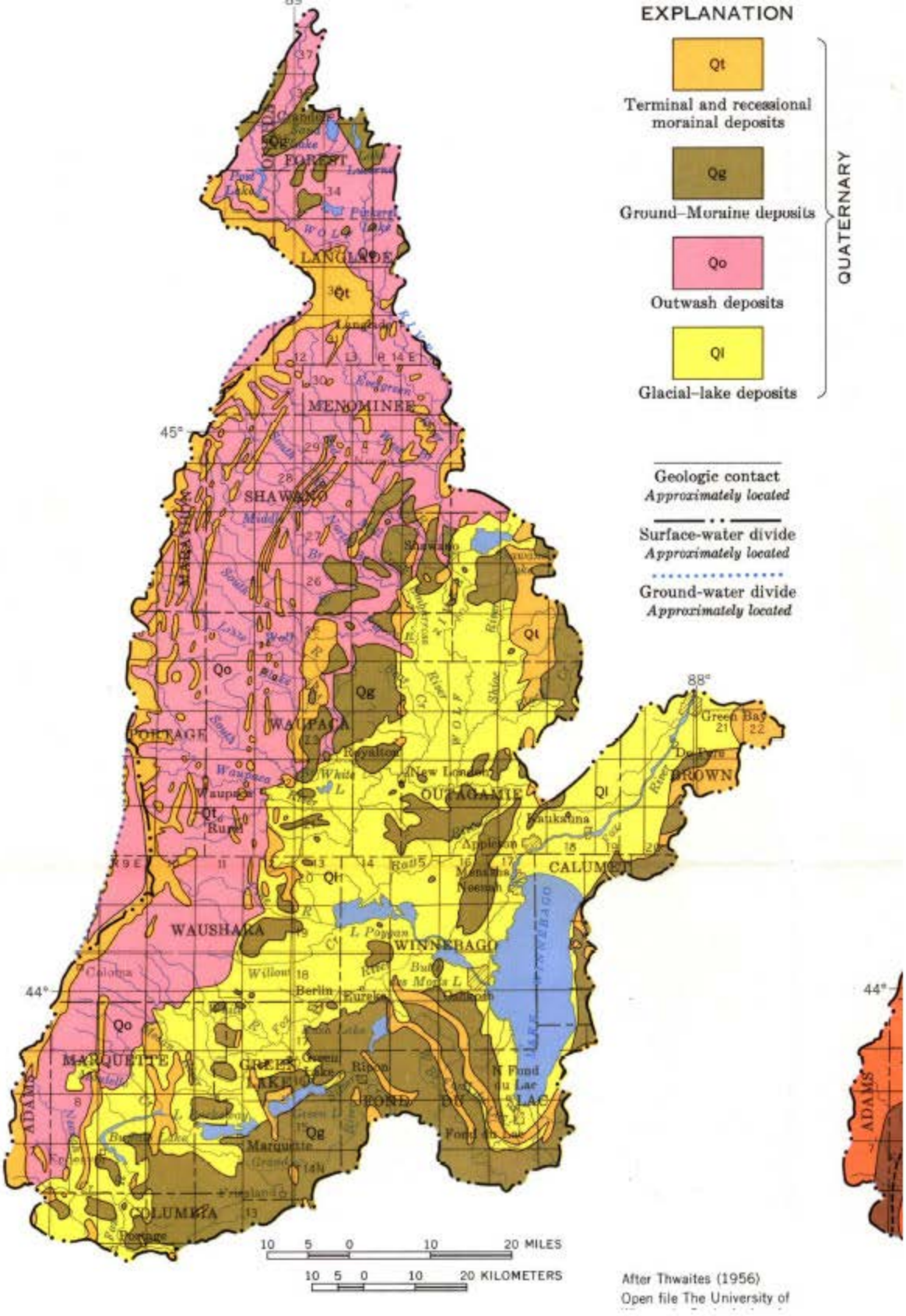
Guild — Open Waters Guild

Guild

oration Opportunities

Transparent





After Thwaites (1956)
Open file The University of

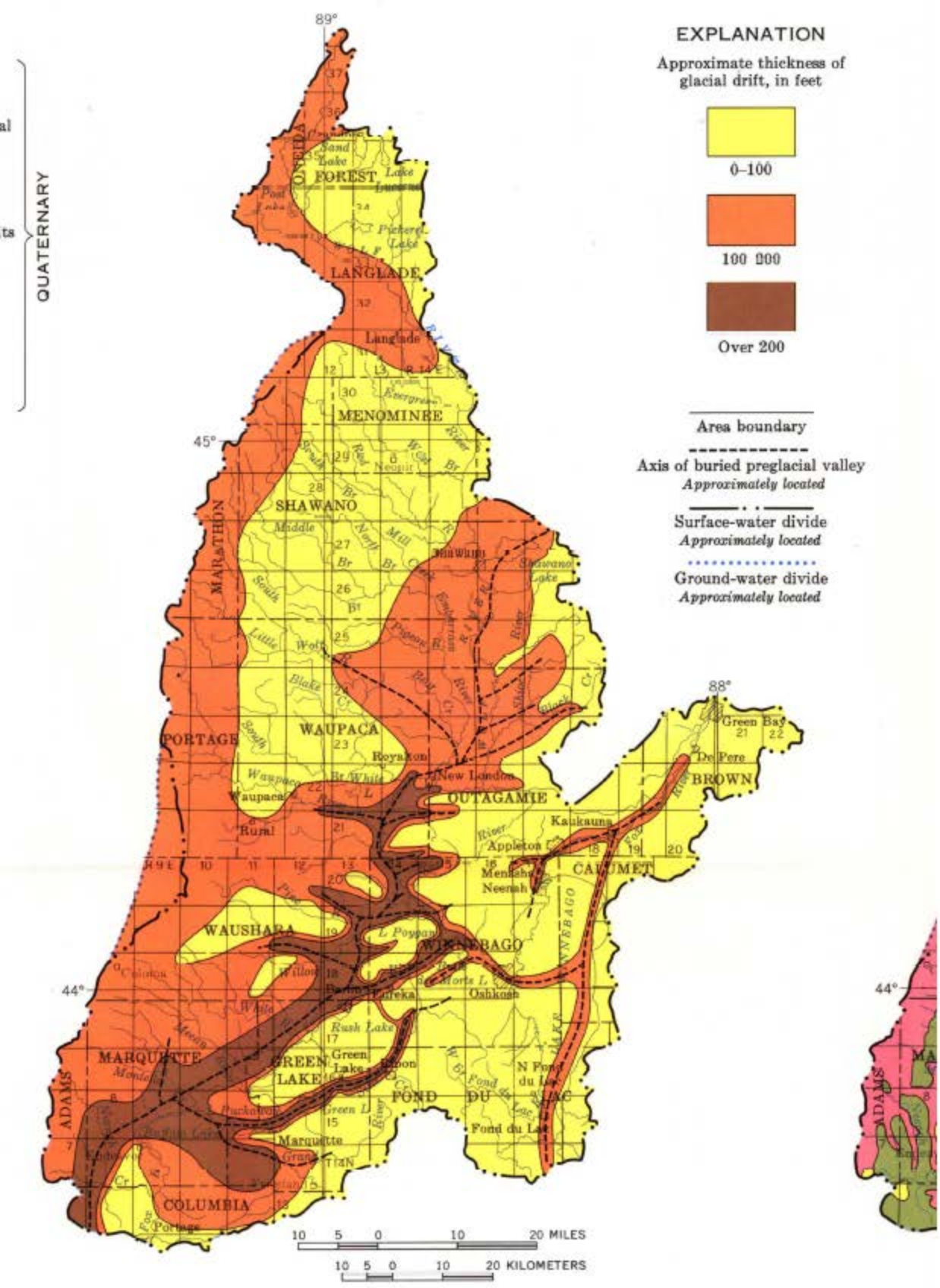
Reference 14
Surface Geology
USACE Parcel J

WATER RESOURCES OF WISCONSIN -WOLF RIVER BA

By
Perry G. Olcott

1968

Reference 14
USACE Parcel J



Reference 15
Sediment Thickness
USACE Parcel J

WATER RESOURCES OF WISCONSIN–I[illegible]'OLF RIVER BA[illegible]

By
Perry G. Olcott

1968

Reference 15
USACE Parcel

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☒ Site Invest.

Page 1 of

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Parcel C, Lock 3, Fox River, Appleton	NA	GPC-1

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Robert Last Name: Bonsall Firm: Altech Services, L.L.C.	10/2/1 (m m/d d/y y y y)	10/2/1 (m m/d d/y y y y)	Geoprobe

WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	Feet MSL	2 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane ____ N, ____ E
____ 1/4 of ____ 1/4 of Section 36, T 21 N, R 17 E
Lat 44° 15' 17.1" Long 88° 23' 41.2"
Local Grid Location ☐ N ☐ E ____ Feet ☐ S ____ Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	OUTAGAMIE	45	Appleton

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1	95%		0	0.0 - 0.67 Dark brown gravely clay.	GC			NA						Visual and olfactory screening.
			1	0.67 - 3.5 (FILL) Dark brown to reddish-brown silty to sandy clay containing 10-30% gravel. Gravel ranges in size to 1/2" and comprises varying proportions of bedrock (dolostone), coal, clinkers, slag, brick and wood fragments.	CL			NA						
			2											
			3											
			4	3.5 - 6.5 (FILL) Same as above, except black with slight hydrocarbon odor.	CL			NA						
			5											
			6											
2	70%		6.5	6.5 - 7.5 (FILL) Same as above, except and no hydrocarbon odor.	CL			NA						
			7											
			7.5	7.5 - 9.5 Dark brown silty clay with slight hydrocarbon odor.	CL			NA						
			8											
			9											
			9.5	9.5 - 9.5 Drive refusal at 9.5 feet bgs.										No sample taken.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	Altech Services, L.L.C.

Form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information including where the completed form should be sent.

Reference 16
Site Sediment Thickness
USACE Parcel J

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☒ Site Invest.

Page 1 of _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Parcel C, Lock 3, Fox River, Appleton	NA	GPC-2

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Robert Last Name: Bonsall Firm: Altech Services, L.L.C.	10/2/1 (m m/d d/y y y y)	10/2/1 (m m/d d/y y y y)	Geoprobe

WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
_ _ _ _ _ _	_ _ _ _		_____ Feet MSL	_____ Feet MSL	2 _____ inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane _____ N, _____ E
_____ 1/4 of _____ 1/4 of Section 36, T 21 N, R 17 E
Lat 44° 15' 17.5"
Long 88° 23' 40.1"
Local Grid Location ☐ N ☐ E _____ Feet ☐ S _____ Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	OUTAGAMIE	45	Appleton

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1	80%		0	0.0 - 0.33 Parking lot gravel.	GW									Visual and olfactory screening.
			2	0.33 - 5.0 (FILL) Dark brown to reddish-brown silty to sandy clay containing 10-30% gravel. Gravel ranges in size to 1/2" and comprises varying proportions of bedrock (dolostone), coal, clinkers, slag, brick and wood fragments.	CL			NA						
			4											
			6		CL									
	90%		8	5.0 - 10.0 (FILL) Same as above, except slight hydrocarbon odor.				NA						
3	50%		10	10.0 - 15.0 (FILL) Same as above, except black and moist.	CL			NA						
			12											
			14											
4	100%		16	15.0 - 17.5 Light brown, medium sand, 10% gravel, organic odor and moist.	CL			NA						
			18	17.5 - 17.5 Drive refusal at 17.5 feet bgs.										No sample taken.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	Altech Services, L.L.C.

form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information including where the completed form should be sent.

Reference 16
Site Sediment Thickness
USACE Parcel J

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☒ Site Invest.

Page 1 of _____

Facility/Project Name: Parcel C, Lock 3, Fox River, Appleton	License/Permit/Monitoring Number: NA	Boring Number: GPC-3

Boring Drilled By: Name of crew chief (first, last) and Firm First Name: Robert Last Name: Bonsall Firm: Altech Services, L.L.C.	Date Drilling Started: 10/2/1 (m m/d d/y y y y)	Date Drilling Completed: 10/2/1 (m m/d d/y y y y)	Drilling Method: Geoprobe
WI Unique Well No. _ _ _ _ _ _ _	DNR Well ID No. _ _ _ _ _	Well Name	Final Static Water Level: _____ Feet MSL
Surface Elevation: _____ Feet MSL	Borehole Diameter: 2 inches		

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane _____ N, _____ E
_____ 1/4 of _____ 1/4 of Section 36, T 21 N, R 17 E
Lat 44° 15' 17.9" Long 88° 23' 40.8"
Local Grid Location: _____ Feet ☐ N ☐ S _____ Feet ☐ E ☐ W

Facility ID	County: OUTAGAMIE	County Code: 45	Civil Town/City/ or Village: Appleton

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1	75%		0	0.0 - 0.33 Dark brown gravely clay.	GC CL			NA						Visual and olfactory screening.
			2	0.33 - 5.0 (FILL) Dark brown to reddish-brown silty to sandy clay containing 10-30% gravel. Gravel ranges in size to 1/2" and comprises varying proportions of bedrock (dolostone), coal, clinkers, slag, brick and wood fragments.				NA						
			4											
			6		CL									
	75%			5.0 - 10.0 (FILL) Same as above, except black with strong hydrocarbon odor and moist.				NA						
			8											
3	60%		10	10.0 - 12.5 (FILL) Same as above, except no odor.	CL			NA						
			12	12.5 - 12.5 Drive refusal at 12.5 feet bgs.										No sample taken.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	Altech Services, L.L.C.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Reference 16
Site Sediment Thickness
USACE Parcel J

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☒ Site Invest.

Page 1 of ____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Parcel C, Lock 3, Fox River, Appleton	NA	GPC-4

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Robert Last Name: Bonsall Firm: Altech Services, L.L.C.	10/2/1 (m m/d d/y y y y)	10/2/1 (m m/d d/y y y y)	Geoprobe

WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			____ Feet MSL	____ Feet MSL	2 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane ____ N, ____ E
____ 1/4 of ____ 1/4 of Section 36, T 21 N, R 17 E
Lat 44° 15' 17.7" Long 88° 23' 41.6"
Local Grid Location ☐ N ☐ E ____ Feet ☐ S ____ Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	OUTAGAMIE	45	Appleton

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1	75%		0	0.0 - 0.33 Dark brown gravely clay.	GW CL									Visual and olfactory screening.
			2	0.33 - 4.5 (FILL) Dark brown to reddish-brown silty to sandy clay containing 10-30% gravel. Gravel ranges in size to 1/2" and comprises varying proportions of bedrock (dolostone), coal, clinkers, slag, brick and wood fragments. With strong hydrocarbon odor.				NA					
			4		CL									
			6											
2	50%		8	4.5 - 11.0 (FILL) Same as above, except black and saturated with hydrocarbons.				NA						
			10											
3	100%		12	11.0 - 12.0 Reddish-brown clay, soft, moist with gravel at bottom.	GC			NA						
				12.0 - 12.0 Drive refusal at 12 feet bgs.										No sample taken.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	Altech Services, L.L.C.

s form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Reference 16
Site Sediment Thickness
USACE Parcel J

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☒ Site Invest.

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Parcel C, Lock 3, Fox River, Appleton	NA	GPC-5

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Robert Last Name: Bonsall Firm: Altech Services, L.L.C.	10/2/1 (m m/d d/y y y y)	10/2/1 (m m/d d/y y y y)	Geoprobe

WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
_ _ _ _ _ _	_ _ _ _		_____ Feet MSL	_____ Feet MSL	2 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane _____ N, _____ E
_____ 1/4 of _____ 1/4 of Section 36, T 21 N, R 17 E
Lat 44° 15' 17.9"
Long 88° 23' 42.8"
Local Grid Location ☐ N ☐ E _____ Feet ☐ S _____ Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	OUTAGAMIE	45	Appleton

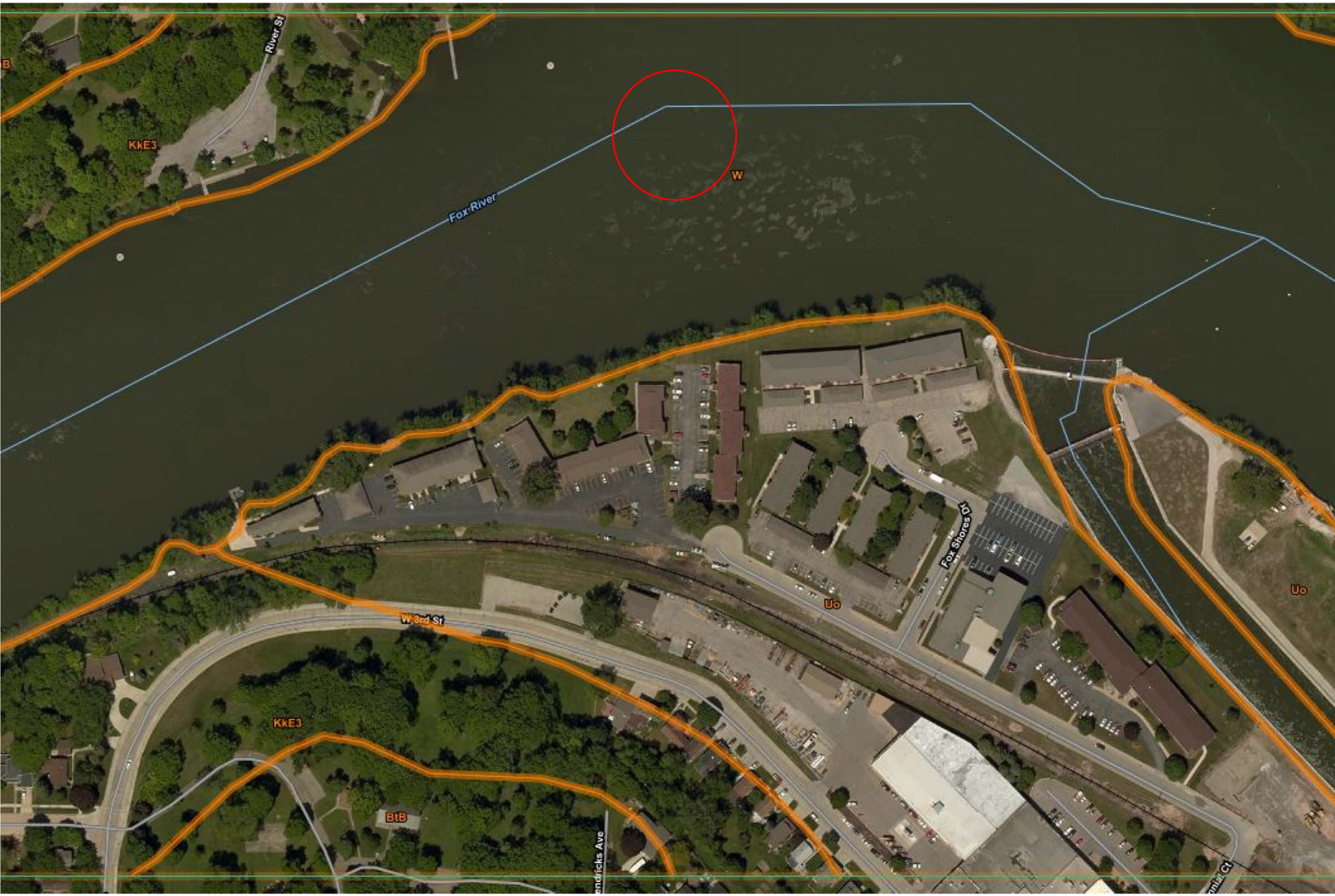
Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1	80%		0	0.0 - 0.33 Parking lot gravel.	GW			NA						Visual and olfactory screening.
				0.33 - 9.0 (FILL) Dark brown to reddish-brown silty to sandy clay containing 10-30% gravel. Gravel ranges in size to 1/2" and comprises varying proportions of bedrock (dolostone), coal, clinkers, slag, brick and wood fragments.	CL			NA						
			2											
			3											
			4											
			5											
			6											
			7											
			8											
2	60%		9	9.0 - 10.0 (FILL) Same as above, except black and moist with slight hydrocarbon odor.	CL			NA						
			10	10.0 - 10.0 Drive refusal at 10 feet bgs.										No sample taken.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	Altech Services, L.L.C.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Reference 16
Site Sediment Thickness
USACE Parcel J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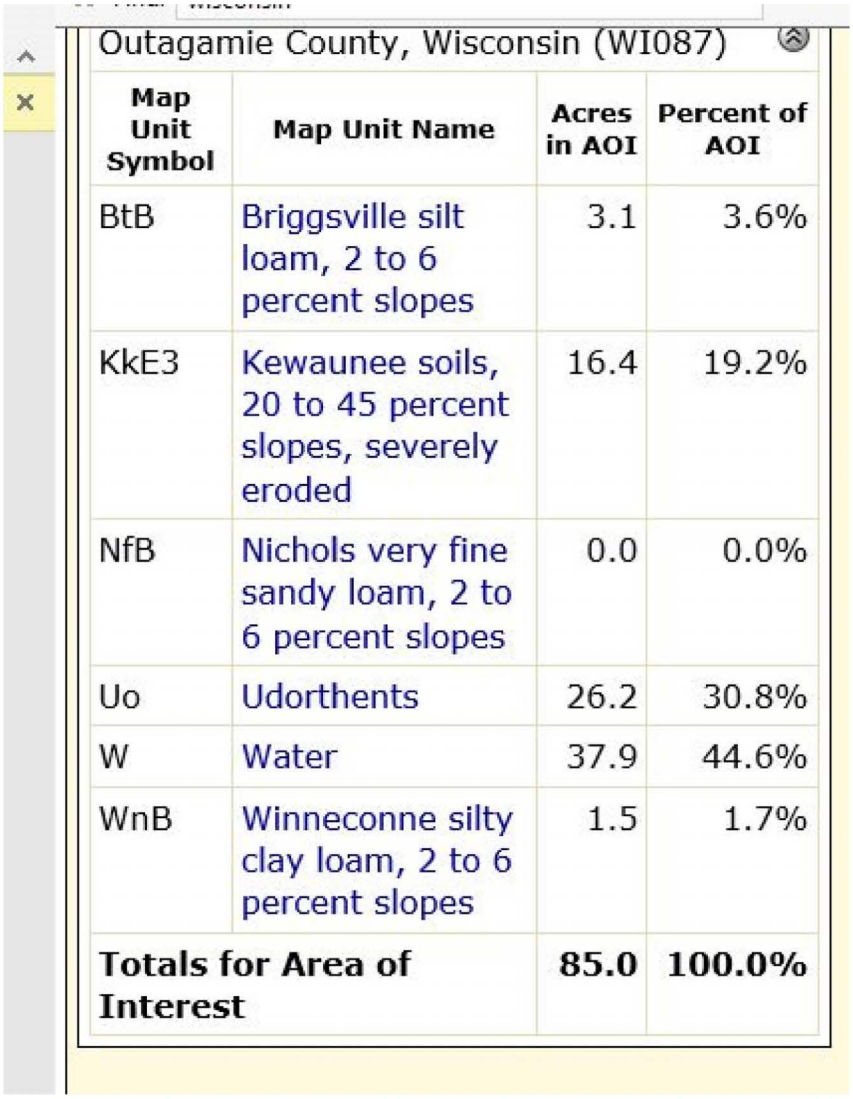
KkE3
W
Fox River
Fox Shores Ct
Uo
W 3rd St
KkE3
BtB
Uo



Outagamie County, Wisconsin (WI087)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BtB	Briggsville silt loam, 2 to 6 percent slopes	3.1	3.6%
KkE3	Kewaunee soils, 20 to 45 percent slopes, severely eroded	16.4	19.2%
NfB	Nichols very fine sandy loam, 2 to 6 percent slopes	0.0	0.0%
Uo	Udorthents	26.2	30.8%
W	Water	37.9	44.6%
WnB	Winneconne silty clay loam, 2 to 6 percent slopes	1.5	1.7%
Totals for Area of Interest		**85.0**	**100.0%**

Reference 17
Site Soil
USACE Parcel J

Map Unit Description

Printable Version

Report — Map Unit Description

Outagamie County, Wisconsin

Uo—Udorthents

Map Unit Setting

National map unit symbol: g5rd
Elevation: 590 to 1,010 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 130 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Typical profile

A,C - 0 to 60 inches: variable

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to high (0.00 to 5.95 in/hr)
Depth to water table: About 60 to 80 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

Description — Map Unit Description

Reference 17
Site Soil
USACE Parcel J

Outagamie County, Wisconsin

KkE3—Kewaunee soils, 20 to 45 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: g5q3
Elevation: 590 to 1,010 feet
Mean annual precipitation: 27 to 34 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 130 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Kewaunee and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kewaunee

Setting

Landform: Ground moraines
Landform position (two-dimensional): Shoulder, backslope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Silty loess over clayey till

Typical profile

A,E - 0 to 6 inches: silty clay loam
Bt - 6 to 27 inches: clay
C - 27 to 60 inches: silty clay

Properties and qualities

Slope: 20 to 45 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.57 in/hr)
Depth to water table: About 60 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 35 percent
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Forage suitability group: Mod AWC, adequately drained with limitations (G095AY006WI)
Hydric soil rating: No

Minor Components

Slope is greater than 45%

Percent of map unit:
Hydric soil rating: No

Slope is less than 20%

Percent of map unit:
Hydric soil rating: No

Reference 17
Site Soil
USACE Parcel J

EXPLANATION

proximate yield of water in
allons per minute to wells
apping glacial-drift aquifer

5-10

10-100

100-500

500-1000

Surface-water divide
Approximately located

Ground-water divide
Approximately located

EXPLANATION

Approximate yield of water in gallons per minute to wells tapping bedrock aquifers

10-100

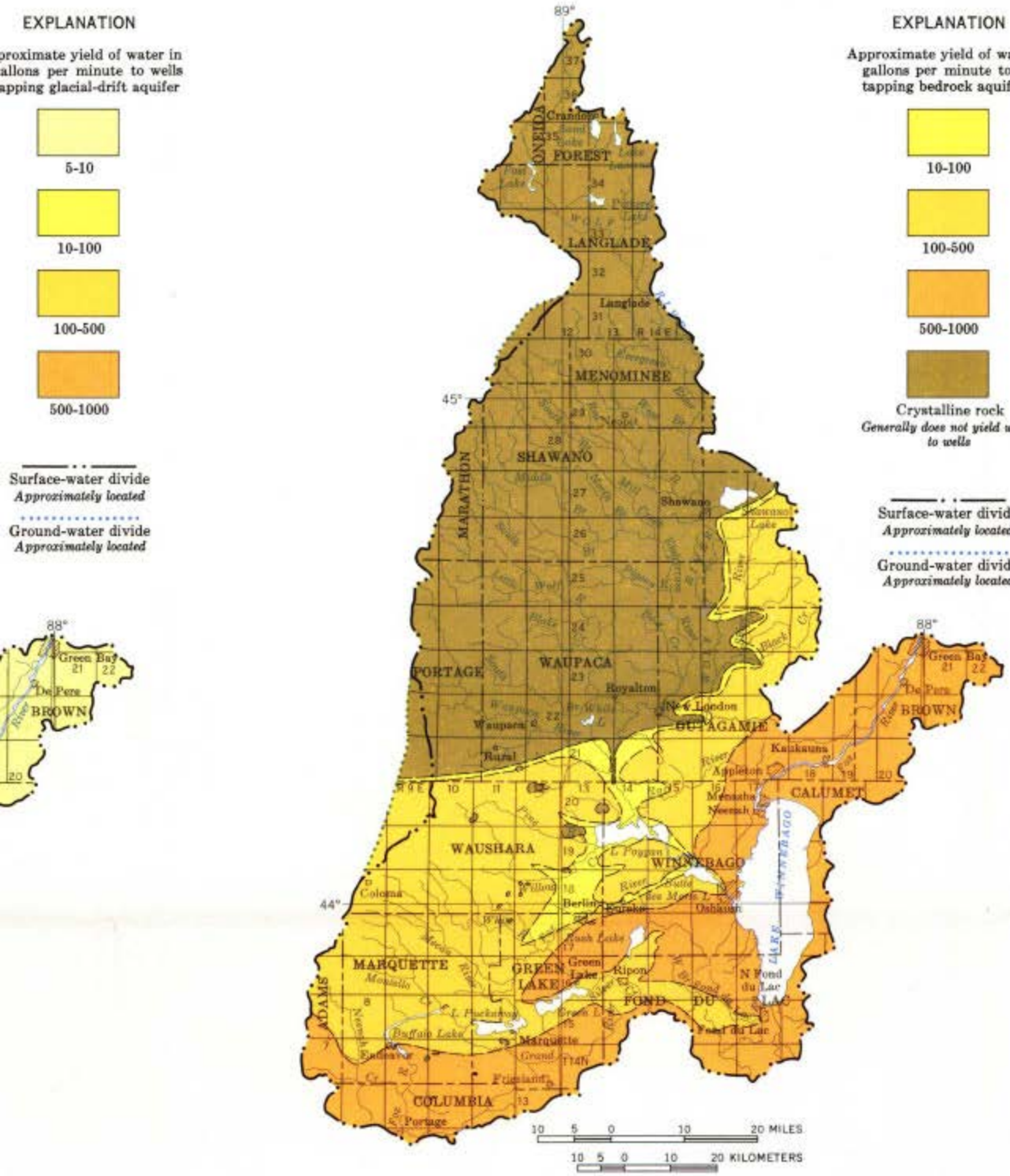
100-500

500-1000

Crystalline rock
Generally does not yield water to wells

Surface-water divide
Approximately located

Ground-water divide
Approximately located



BEDROCK AQUIFERS

AVAILABILITY OF GROUND WATER

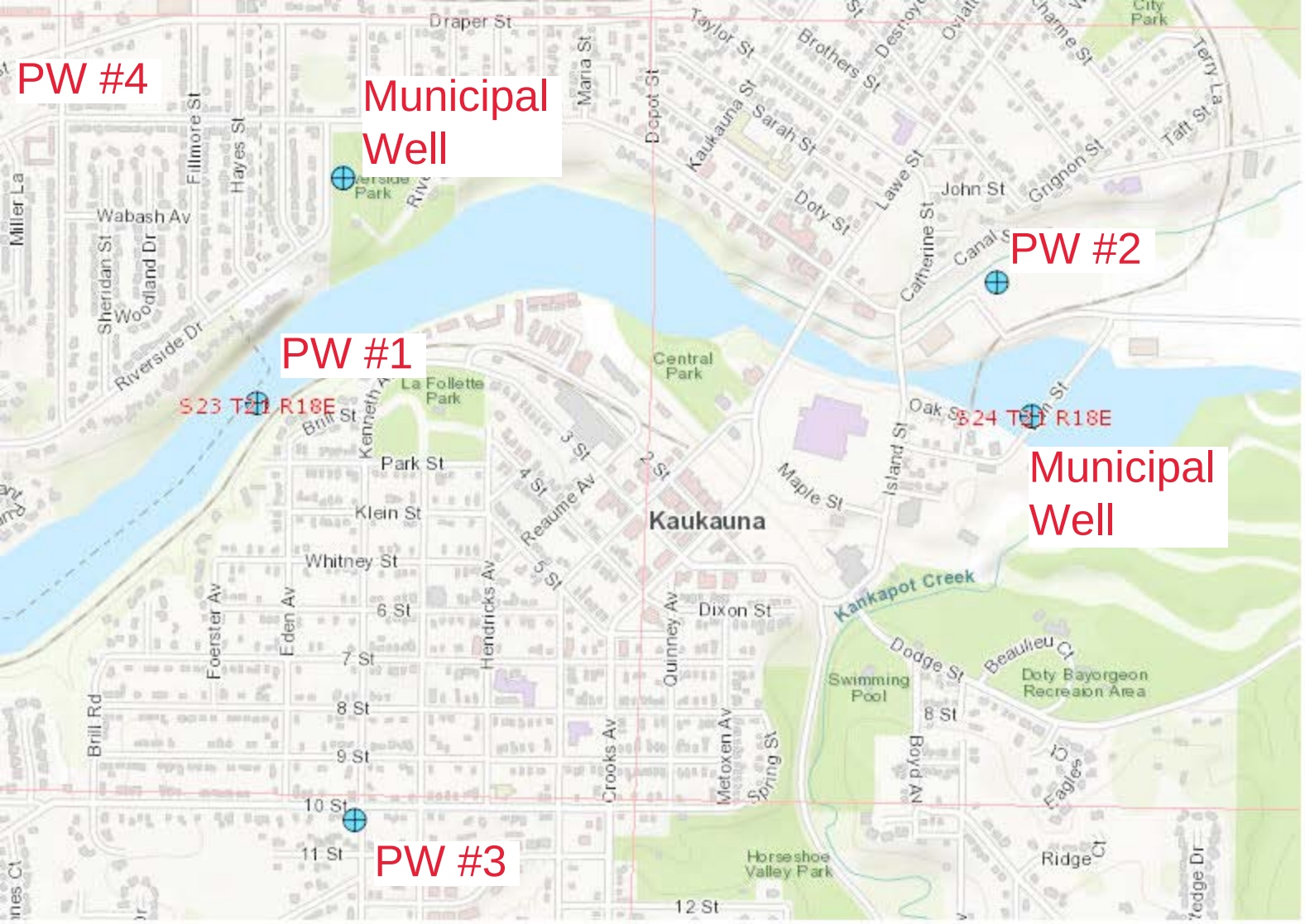
Reference 18
Groundwater Use
USACE Parcel J

Ref
USA

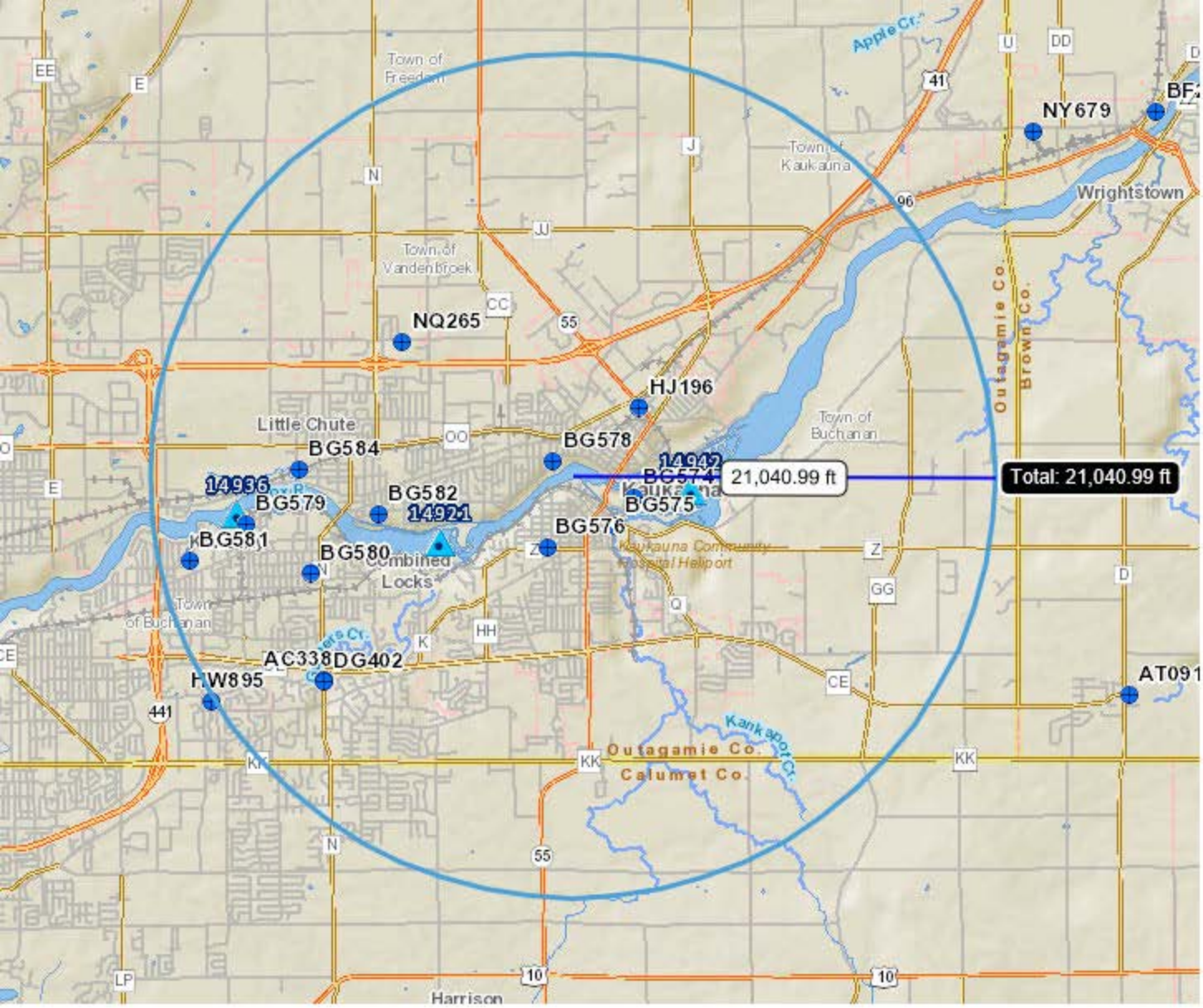
WATER RESOURCES OF WISCONSIN–FOX-WOLF RIVER BA

By
Perry G. Olcott

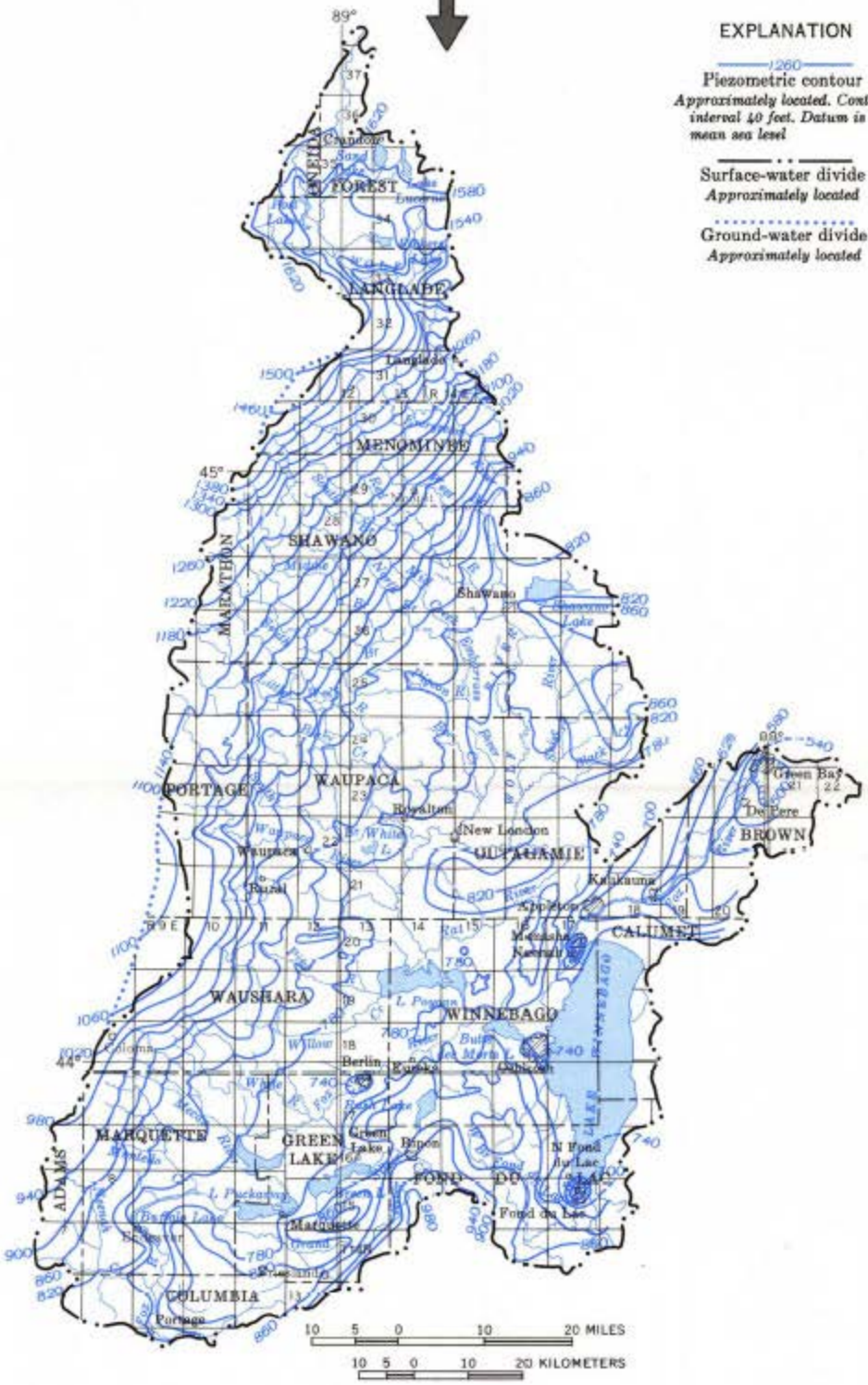
1968



Reference 19
Local Private Wells
USACE Parcel J



Reference 20
Municipal Wells Within Four Miles
USACE Parcel J



GENERALIZED PIEZOMETRIC SURFACE

Reference 21
Bedrock Groundwater Piezometric Surface
USACE Parcel J

WATER RESOURCES OF WISCONSIN–FOX-WOLF RIVER BA

By
Perry G. Olcott

1968

Demographic and Income Profile

Parcel J
400 Fox Shores Dr, Kaukauna, Wisconsin, 54130
Ring Band: 0 - 0.25 mile radius

Prepared by Esri
Latitude: 44.28160
Longitude: -88.27457

Summary	Census 2010	2019	2024
Population	444	445	450
Households	264	267	271
Families	131	128	129
Average Household Size	1.68	1.67	1.66
Owner Occupied Housing Units	133	126	130
Renter Occupied Housing Units	131	141	142
Median Age	32.7	35.7	37.6

Trends: 2019 - 2024 Annual Rate	Area	State	National
Population	0.22%	0.43%	0.77%
Households	0.30%	0.48%	0.75%
Families	0.16%	0.39%	0.68%
Owner HHs	0.63%	0.61%	0.92%
Median Household Income	3.07%	2.62%	2.70%

	2019		2024	
Households by Income	Number	Percent	Number	Percent
<$15,000	24	9.0%	18	6.6%
$15,000 - $24,999	45	16.9%	37	13.7%
$25,000 - $34,999	29	10.9%	26	9.6%
$35,000 - $49,999	44	16.5%	42	15.5%
$50,000 - $74,999	61	22.8%	57	21.0%
$75,000 - $99,999	27	10.1%	31	11.4%
$100,000 - $149,999	31	11.6%	50	18.5%
$150,000 - $199,999	6	2.2%	10	3.7%
$200,000+	0	0.0%	0	0.0%

	2019	2024
Median Household Income	$46,257	$53,817
Average Household Income	$55,708	$66,872
Per Capita Income	$25,808	$31,066

	Census 2010		2019		2024	
Population by Age	Number	Percent	Number	Percent	Number	Percent
0 - 4	31	7.0%	28	6.3%	27	6.0%
5 - 9	35	7.8%	28	6.3%	28	6.2%
10 - 14	27	6.1%	29	6.5%	28	6.2%
15 - 19	27	6.1%	29	6.5%	28	6.2%
20 - 24	43	9.6%	25	5.6%	30	6.7%
25 - 34	78	17.5%	79	17.7%	62	13.8%
35 - 44	57	12.8%	71	15.9%	77	17.1%
45 - 54	58	13.0%	55	12.3%	60	13.4%
55 - 64	39	8.7%	50	11.2%	51	11.4%
65 - 74	24	5.4%	30	6.7%	34	7.6%
75 - 84	20	4.5%	14	3.1%	18	4.0%
85+	7	1.6%	8	1.8%	6	1.3%

	Census 2010		2019		2024	
Race and Ethnicity	Number	Percent	Number	Percent	Number	Percent
White Alone	413	93.2%	404	90.8%	401	89.1%
Black Alone	4	0.9%	6	1.3%	8	1.8%
American Indian Alone	6	1.4%	7	1.6%	8	1.8%
Asian Alone	8	1.8%	11	2.5%	12	2.7%
Pacific Islander Alone	0	0.0%	0	0.0%	0	0.0%
Some Other Race Alone	1	0.2%	1	0.2%	2	0.4%
Two or More Races	11	2.5%	16	3.6%	19	4.2%
Hispanic Origin (Any Race)	10	2.3%	12	2.7%	15	3.3%

Data Note: Income is expressed in current dollars.

Source: U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2019 and 2024.

September 10, 2019

Reference 22
Population Information
Parcel J

©2019 Esri

Demographic and Income Profile

Parcel J
400 Fox Shores Dr, Kaukauna, Wisconsin, 54130
Ring Band: 0.25 - 0.5 mile radius

Prepared by Esri
Latitude: 44.28160
Longitude: -88.27457

Summary	Census 2010	2019	2024
Population	1,931	1,954	1,982
Households	804	817	830
Families	483	481	485
Average Household Size	2.40	2.39	2.39
Owner Occupied Housing Units	518	503	517
Renter Occupied Housing Units	286	314	314
Median Age	33.2	36.2	37.6
Trends: 2019 - 2024 Annual Rate	**Area**	**State**	**National**
Population	0.28%	0.43%	0.77%
Households	0.32%	0.48%	0.75%
Families	0.17%	0.39%	0.68%
Owner HHs	0.55%	0.61%	0.92%
Median Household Income	2.85%	2.62%	2.70%

	2019		2024	
Households by Income	Number	Percent	Number	Percent
<$15,000	62	7.6%	47	5.7%
$15,000 - $24,999	109	13.3%	89	10.7%
$25,000 - $34,999	76	9.3%	67	8.1%
$35,000 - $49,999	142	17.4%	131	15.8%
$50,000 - $74,999	176	21.5%	166	20.0%
$75,000 - $99,999	111	13.6%	124	14.9%
$100,000 - $149,999	99	12.1%	139	16.7%
$150,000 - $199,999	35	4.3%	57	6.9%
$200,000+	8	1.0%	10	1.2%
Median Household Income	$51,867		$59,706	
Average Household Income	$63,613		$75,518	
Per Capita Income	$26,747		$31,850	

	Census 2010		2019		2024	
Population by Age	Number	Percent	Number	Percent	Number	Percent
0 - 4	147	7.6%	133	6.8%	131	6.6%
5 - 9	145	7.5%	131	6.7%	134	6.8%
10 - 14	125	6.5%	133	6.8%	133	6.7%
15 - 19	120	6.2%	121	6.2%	127	6.4%
20 - 24	152	7.9%	112	5.7%	120	6.1%
25 - 34	335	17.3%	309	15.8%	266	13.4%
35 - 44	247	12.8%	304	15.5%	313	15.8%
45 - 54	266	13.8%	237	12.1%	246	12.4%
55 - 64	189	9.8%	231	11.8%	237	12.0%
65 - 74	106	5.5%	147	7.5%	166	8.4%
75 - 84	75	3.9%	68	3.5%	84	4.2%
85+	26	1.3%	29	1.5%	26	1.3%

	Census 2010		2019		2024	
Race and Ethnicity	Number	Percent	Number	Percent	Number	Percent
White Alone	1,804	93.4%	1,788	91.5%	1,785	90.0%
Black Alone	18	0.9%	26	1.3%	33	1.7%
American Indian Alone	24	1.2%	28	1.4%	30	1.5%
Asian Alone	37	1.9%	44	2.3%	51	2.6%
Pacific Islander Alone	0	0.0%	0	0.0%	0	0.0%
Some Other Race Alone	12	0.6%	16	0.8%	21	1.1%
Two or More Races	37	1.9%	52	2.7%	63	3.2%
Hispanic Origin (Any Race)	50	2.6%	66	3.4%	84	4.2%

Data Note: Income is expressed in current dollars.

Source: U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2019 and 2024.

©2019 Esri

Demographic and Income Profile

Parcel J
400 Fox Shores Dr, Kaukauna, Wisconsin, 54130
Ring Band: 0.5 - 1 mile radius

Prepared by Esri
Latitude: 44.28160
Longitude: -88.27457

Summary	Census 2010	2019	2024
Population	6,275	6,514	6,681
Households	2,602	2,717	2,790
Families	1,691	1,736	1,772
Average Household Size	2.40	2.38	2.38
Owner Occupied Housing Units	1,906	1,924	1,991
Renter Occupied Housing Units	696	793	799
Median Age	37.5	39.1	40.4

Trends: 2019 - 2024 Annual Rate	Area	State	National
Population	0.51%	0.43%	0.77%
Households	0.53%	0.48%	0.75%
Families	0.41%	0.39%	0.68%
Owner HHs	0.69%	0.61%	0.92%
Median Household Income	3.28%	2.62%	2.70%

	2019		2024	
Households by Income	Number	Percent	Number	Percent
<$15,000	163	6.0%	127	4.6%
$15,000 - $24,999	273	10.0%	224	8.0%
$25,000 - $34,999	243	8.9%	214	7.7%
$35,000 - $49,999	425	15.6%	391	14.0%
$50,000 - $74,999	539	19.8%	521	18.7%
$75,000 - $99,999	441	16.2%	480	17.2%
$100,000 - $149,999	396	14.6%	495	17.7%
$150,000 - $199,999	178	6.6%	262	9.4%
$200,000+	58	2.1%	76	2.7%
Median Household Income	$59,313		$69,685	
Average Household Income	$73,840		$85,885	
Per Capita Income	$30,761		$35,843	

	Census 2010		2019		2024	
Population by Age	Number	Percent	Number	Percent	Number	Percent
0 - 4	440	7.0%	416	6.4%	418	6.3%
5 - 9	397	6.3%	418	6.4%	430	6.4%
10 - 14	384	6.1%	422	6.5%	436	6.5%
15 - 19	381	6.1%	354	5.4%	407	6.1%
20 - 24	393	6.3%	327	5.0%	325	4.9%
25 - 34	961	15.3%	890	13.7%	814	12.2%
35 - 44	741	11.8%	945	14.5%	976	14.6%
45 - 54	891	14.2%	763	11.7%	790	11.8%
55 - 64	748	11.9%	840	12.9%	804	12.0%
65 - 74	443	7.1%	628	9.6%	714	10.7%
75 - 84	316	5.0%	330	5.1%	392	5.9%
85+	178	2.8%	182	2.8%	175	2.6%

	Census 2010		2019		2024	
Race and Ethnicity	Number	Percent	Number	Percent	Number	Percent
White Alone	5,956	94.9%	6,077	93.3%	6,146	92.0%
Black Alone	43	0.7%	63	1.0%	82	1.2%
American Indian Alone	50	0.8%	60	0.9%	66	1.0%
Asian Alone	66	1.1%	82	1.3%	96	1.4%
Pacific Islander Alone	2	0.0%	5	0.1%	6	0.1%
Some Other Race Alone	64	1.0%	93	1.4%	118	1.8%
Two or More Races	93	1.5%	135	2.1%	167	2.5%
Hispanic Origin (Any Race)	183	2.9%	259	4.0%	325	4.9%

Data Note: Income is expressed in current dollars.

Source: U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2019 and 2024.

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Demographic and Income Profile

Parcel J
400 Fox Shores Dr, Kaukauna, Wisconsin, 54130
Ring Band: 1 - 2 mile radius

Prepared by Esri
Latitude: 44.28160
Longitude: -88.27457

Summary	Census 2010	2019	2024
Population	12,205	12,648	13,019
Households	4,789	5,033	5,201
Families	3,373	3,492	3,593
Average Household Size	2.52	2.48	2.48
Owner Occupied Housing Units	3,618	3,674	3,817
Renter Occupied Housing Units	1,171	1,359	1,384
Median Age	37.3	39.1	39.9

Trends: 2019 - 2024 Annual Rate	Area	State	National
Population	0.58%	0.43%	0.77%
Households	0.66%	0.48%	0.75%
Families	0.57%	0.39%	0.68%
Owner HHs	0.77%	0.61%	0.92%
Median Household Income	2.93%	2.62%	2.70%

	2019		2024	
Households by Income	Number	Percent	Number	Percent
<$15,000	147	2.9%	115	2.2%
$15,000 - $24,999	395	7.8%	329	6.3%
$25,000 - $34,999	360	7.2%	308	5.9%
$35,000 - $49,999	782	15.5%	700	13.5%
$50,000 - $74,999	961	19.1%	897	17.2%
$75,000 - $99,999	766	15.2%	793	15.2%
$100,000 - $149,999	1,019	20.2%	1,224	23.5%
$150,000 - $199,999	430	8.5%	614	11.8%
$200,000+	172	3.4%	221	4.2%
Median Household Income	$70,415		$81,370	
Average Household Income	$85,699		$98,581	
Per Capita Income	$33,563		$38,721	

	Census 2010		2019		2024	
Population by Age	Number	Percent	Number	Percent	Number	Percent
0 - 4	858	7.0%	793	6.3%	809	6.2%
5 - 9	827	6.8%	826	6.5%	844	6.5%
10 - 14	877	7.2%	848	6.7%	876	6.7%
15 - 19	819	6.7%	733	5.8%	799	6.1%
20 - 24	684	5.6%	666	5.3%	602	4.6%
25 - 34	1,687	13.8%	1,702	13.5%	1,704	13.1%
35 - 44	1,600	13.1%	1,712	13.5%	1,826	14.0%
45 - 54	1,883	15.4%	1,620	12.8%	1,508	11.6%
55 - 64	1,396	11.4%	1,708	13.5%	1,669	12.8%
65 - 74	744	6.1%	1,135	9.0%	1,336	10.3%
75 - 84	533	4.4%	568	4.5%	704	5.4%
85+	296	2.4%	336	2.7%	341	2.6%

	Census 2010		2019		2024	
Race and Ethnicity	Number	Percent	Number	Percent	Number	Percent
White Alone	11,638	95.4%	11,845	93.7%	12,038	92.5%
Black Alone	74	0.6%	117	0.9%	152	1.2%
American Indian Alone	72	0.6%	87	0.7%	95	0.7%
Asian Alone	153	1.3%	202	1.6%	238	1.8%
Pacific Islander Alone	8	0.1%	16	0.1%	20	0.2%
Some Other Race Alone	101	0.8%	148	1.2%	186	1.4%
Two or More Races	158	1.3%	233	1.8%	290	2.2%
Hispanic Origin (Any Race)	266	2.2%	380	3.0%	478	3.7%

Data Note: Income is expressed in current dollars.

Source: U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2019 and 2024.

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Demographic and Income Profile

Parcel J
400 Fox Shores Dr, Kaukauna, Wisconsin, 54130
Ring Band: 2 - 3 mile radius

Prepared by Esri
Latitude: 44.28160
Longitude: -88.27457

Summary	Census 2010	2019	2024
Population	13,849	14,770	15,400
Households	5,290	5,648	5,890
Families	3,722	3,925	4,081
Average Household Size	2.61	2.61	2.61
Owner Occupied Housing Units	3,808	3,905	4,102
Renter Occupied Housing Units	1,482	1,743	1,788
Median Age	35.3	37.1	36.7

Trends: 2019 - 2024 Annual Rate	Area	State	National
Population	0.84%	0.43%	0.77%
Households	0.84%	0.48%	0.75%
Families	0.78%	0.39%	0.68%
Owner HHs	0.99%	0.61%	0.92%
Median Household Income	2.87%	2.62%	2.70%

	2019		2024	
Households by Income	Number	Percent	Number	Percent
<$15,000	248	4.4%	208	3.5%
$15,000 - $24,999	410	7.3%	360	6.1%
$25,000 - $34,999	515	9.1%	457	7.8%
$35,000 - $49,999	797	14.1%	740	12.6%
$50,000 - $74,999	1,143	20.2%	1,089	18.5%
$75,000 - $99,999	885	15.7%	933	15.8%
$100,000 - $149,999	1,086	19.2%	1,286	21.8%
$150,000 - $199,999	393	7.0%	603	10.2%
$200,000+	171	3.0%	215	3.7%

	2019	2024
Median Household Income	$66,678	$76,820
Average Household Income	$81,704	$93,417
Per Capita Income	$31,716	$36,266

	Census 2010		2019		2024	
Population by Age	Number	Percent	Number	Percent	Number	Percent
0 - 4	1,010	7.3%	981	6.6%	1,039	6.7%
5 - 9	1,094	7.9%	1,000	6.8%	1,044	6.8%
10 - 14	1,101	8.0%	1,061	7.2%	1,067	6.9%
15 - 19	949	6.9%	997	6.7%	1,003	6.5%
20 - 24	713	5.1%	900	6.1%	913	5.9%
25 - 34	1,993	14.4%	2,009	13.6%	2,274	14.8%
35 - 44	2,087	15.1%	2,053	13.9%	2,092	13.6%
45 - 54	2,142	15.5%	2,086	14.1%	1,893	12.3%
55 - 64	1,313	9.5%	1,877	12.7%	1,963	12.7%
65 - 74	803	5.8%	1,088	7.4%	1,295	8.4%
75 - 84	463	3.3%	516	3.5%	608	3.9%
85+	178	1.3%	203	1.4%	211	1.4%

	Census 2010		2019		2024	
Race and Ethnicity	Number	Percent	Number	Percent	Number	Percent
White Alone	13,166	95.1%	13,783	93.3%	14,180	92.1%
Black Alone	96	0.7%	153	1.0%	199	1.3%
American Indian Alone	81	0.6%	97	0.7%	107	0.7%
Asian Alone	164	1.2%	230	1.6%	277	1.8%
Pacific Islander Alone	3	0.0%	4	0.0%	5	0.0%
Some Other Race Alone	151	1.1%	220	1.5%	275	1.8%
Two or More Races	188	1.4%	283	1.9%	357	2.3%
Hispanic Origin (Any Race)	388	2.8%	557	3.8%	696	4.5%

Data Note: Income is expressed in current dollars.

Source: U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2019 and 2024.

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Demographic and Income Profile

Parcel J
400 Fox Shores Dr, Kaukauna, Wisconsin, 54130
Ring Band: 3 - 4 mile radius

Prepared by Esri
Latitude: 44.28160
Longitude: -88.27457

Summary	Census 2010	2019	2024
Population	11,772	13,582	14,350
Households	4,421	5,099	5,389
Families	3,283	3,755	3,954
Average Household Size	2.66	2.66	2.66
Owner Occupied Housing Units	3,520	3,964	4,217
Renter Occupied Housing Units	901	1,135	1,172
Median Age	36.9	38.9	39.8

Trends: 2019 - 2024 Annual Rate	Area	State	National
Population	1.11%	0.43%	0.77%
Households	1.11%	0.48%	0.75%
Families	1.04%	0.39%	0.68%
Owner HHs	1.25%	0.61%	0.92%
Median Household Income	1.91%	2.62%	2.70%

	2019		2024	
Households by Income	Number	Percent	Number	Percent
<$15,000	252	4.9%	214	4.0%
$15,000 - $24,999	333	6.5%	307	5.7%
$25,000 - $34,999	355	7.0%	333	6.2%
$35,000 - $49,999	594	11.6%	582	10.8%
$50,000 - $74,999	891	17.5%	863	16.0%
$75,000 - $99,999	756	14.8%	779	14.5%
$100,000 - $149,999	1,209	23.7%	1,365	25.3%
$150,000 - $199,999	491	9.6%	686	12.7%
$200,000+	217	4.3%	261	4.8%
Median Household Income	$78,147		$85,911	
Average Household Income	$91,270		$101,978	
Per Capita Income	$34,363		$38,440	

	Census 2010		2019		2024	
Population by Age	Number	Percent	Number	Percent	Number	Percent
0 - 4	864	7.3%	878	6.5%	897	6.3%
5 - 9	981	8.3%	962	7.1%	963	6.7%
10 - 14	914	7.8%	1,061	7.8%	1,050	7.3%
15 - 19	794	6.7%	955	7.0%	988	6.9%
20 - 24	467	4.0%	705	5.2%	735	5.1%
25 - 34	1,545	13.1%	1,503	11.1%	1,740	12.1%
35 - 44	1,779	15.1%	1,906	14.0%	1,812	12.6%
45 - 54	1,950	16.6%	1,986	14.6%	1,960	13.7%
55 - 64	1,126	9.6%	1,832	13.5%	1,970	13.7%
65 - 74	679	5.8%	1,010	7.4%	1,333	9.3%
75 - 84	506	4.3%	542	4.0%	648	4.5%
85+	168	1.4%	242	1.8%	253	1.8%

	Census 2010		2019		2024	
Race and Ethnicity	Number	Percent	Number	Percent	Number	Percent
White Alone	11,203	95.2%	12,702	93.5%	13,253	92.4%
Black Alone	72	0.6%	121	0.9%	160	1.1%
American Indian Alone	62	0.5%	84	0.6%	98	0.7%
Asian Alone	217	1.8%	328	2.4%	396	2.8%
Pacific Islander Alone	2	0.0%	3	0.0%	4	0.0%
Some Other Race Alone	68	0.6%	107	0.8%	137	1.0%
Two or More Races	147	1.2%	238	1.8%	302	2.1%
Hispanic Origin (Any Race)	236	2.0%	363	2.7%	458	3.2%

Data Note: Income is expressed in current dollars.

Source: U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2019 and 2024.

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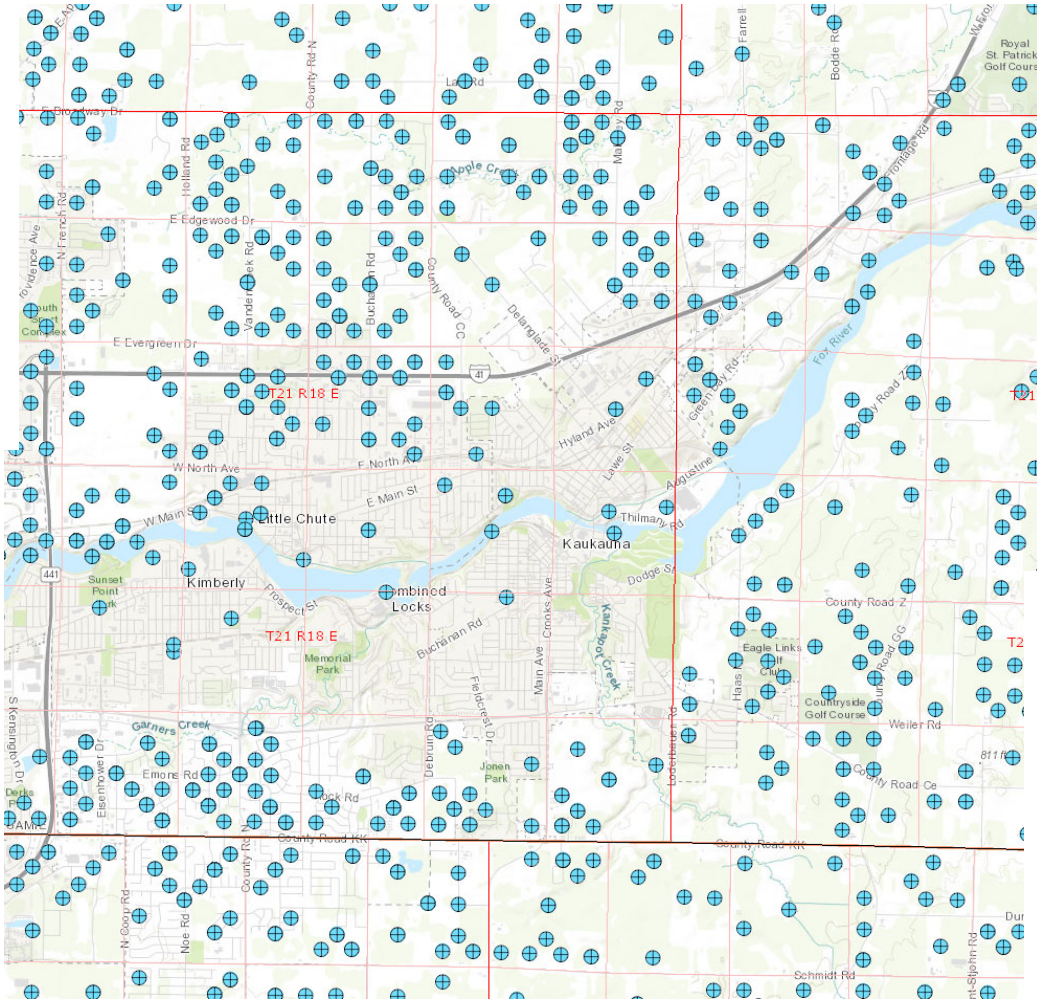
	0-0.25 Mile	0.25-0.5 Mile	0.5-1 Mile	1-2 Miles	2-3 Miles	3-4 Miles	Total
Private wells	2	2	29	108	297	322	760
Total Population	450	2432	9113	22132	37532	51882	
Total Housholds	271	1101	3891	9092	14982	20371	20371
Population by area	450	1982	6681	13019	15400	14350	51882
Households by area	271	830	2790	5201	5890	5389	20371
Household on city water	269	828	2761	5093	5593	5067	19611
Population on well water	5	5	70	259	713	773	1825
Ppopulation on city water	445	1977	6611	12760	14687	13577	50057
City wells in area	0	1	4	2	3	3	13
Population using city wells from area	0	3851	15402	7702	11551	11551	50057
Modified groundwater population	5	3856	15472	7961	12264	12324	51882

Reference 22
Population Information
Parcel J



375 Pre 88 well logs
461 Post 88 (T21R18E) well logs
76 Replacements in post 88 registry

≈760 private wells

Reference 23
Private Well Locations
USACE Parcel J

Find the advice for eating fish from Wisconsin waters

County	
Advisory Area	

Advice for eating fish from the area you selected:

County: Brown, Outagamie, Winnebago
Advisory Area: FOX RIVER FROM LITTLE LAKE BUTTE DES MORTS TO THE DAM AT DEPERE
Includes: FOX RIVER, FOX RIVER LOCK CHANNEL-KAUKAUNA, LITTLE LAKE BUTTE DES MORTS

Women up to age 50 (child bearing age) and children (under age 15) may safely eat:

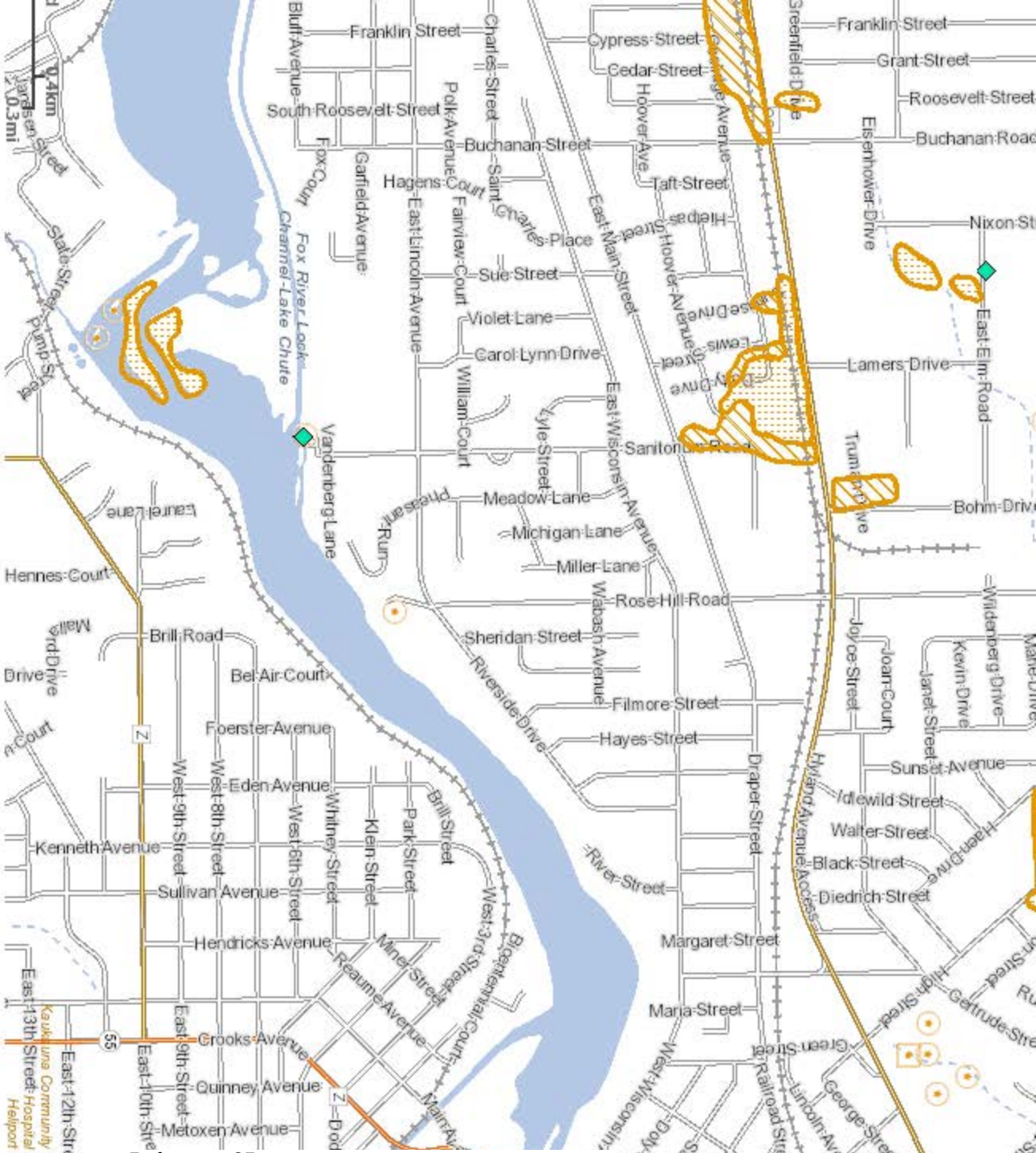
1 Meal Per Week	bluegill and sunfish, bullheads, crappies, inland trout
and	
1 Meal Per Month	channel catfish, pike, walleye, white bass, white perch, yellow perch, all other species and sizes
6 Meals Per Year	carp less than 28"
Do Not Eat	carp larger than 28", muskies

All men (15 and older) and older women (50 and older) may safely eat:

Unrestricted	bluegill and sunfish, bullheads, crappies, inland trout
1 Meal Per Week	pike, all other species and sizes
and	
1 Meal Per Month	channel catfish, muskies, walleye, white bass, white perch, yellow perch
6 Meals Per Year	carp less than 28"
Do Not Eat	carp larger than 28"

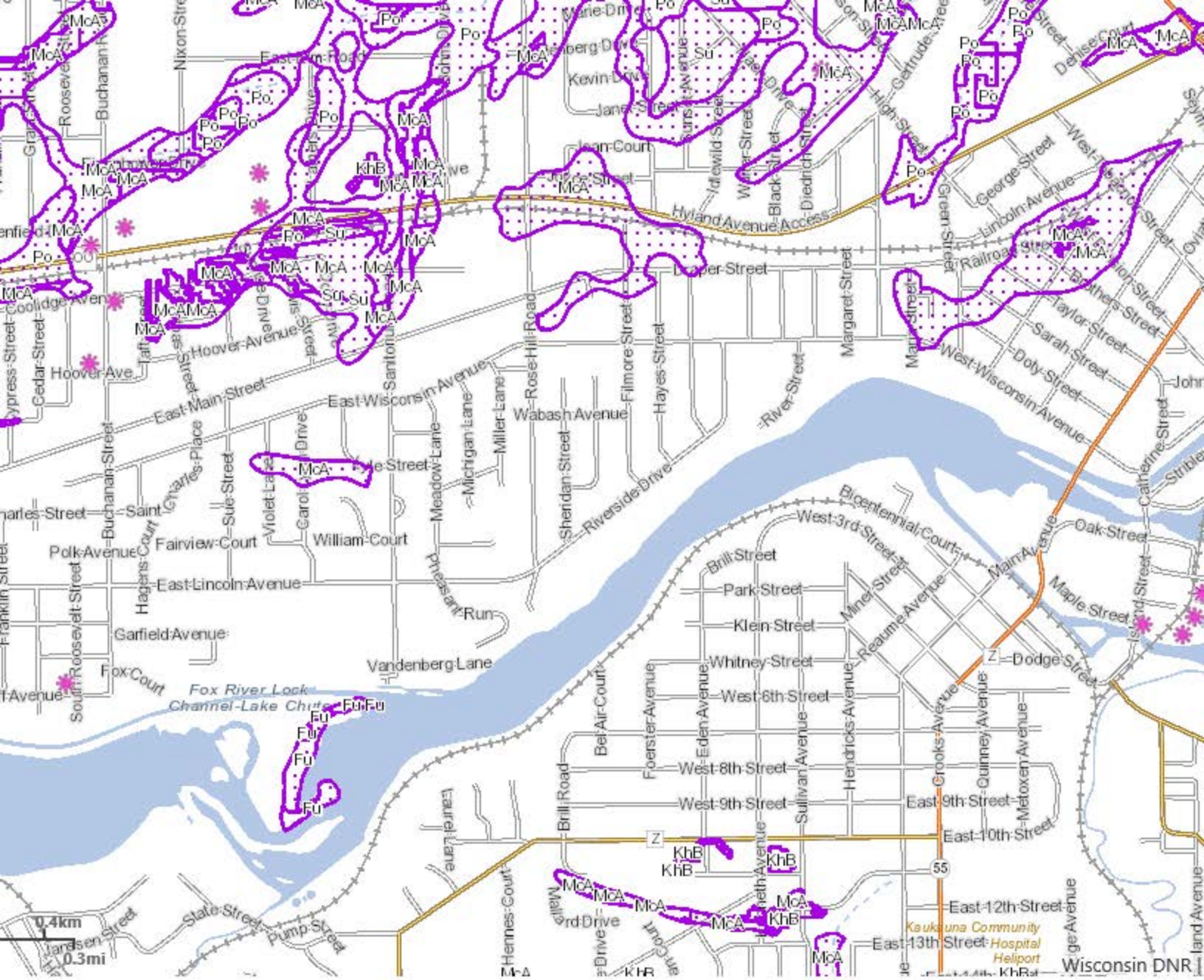
The above advice is due to the following pollutants:MERCURY, PCB
Date of Query:August 26 2019

Reference 24
Fish Consumption Advisory
USACE Parcel J

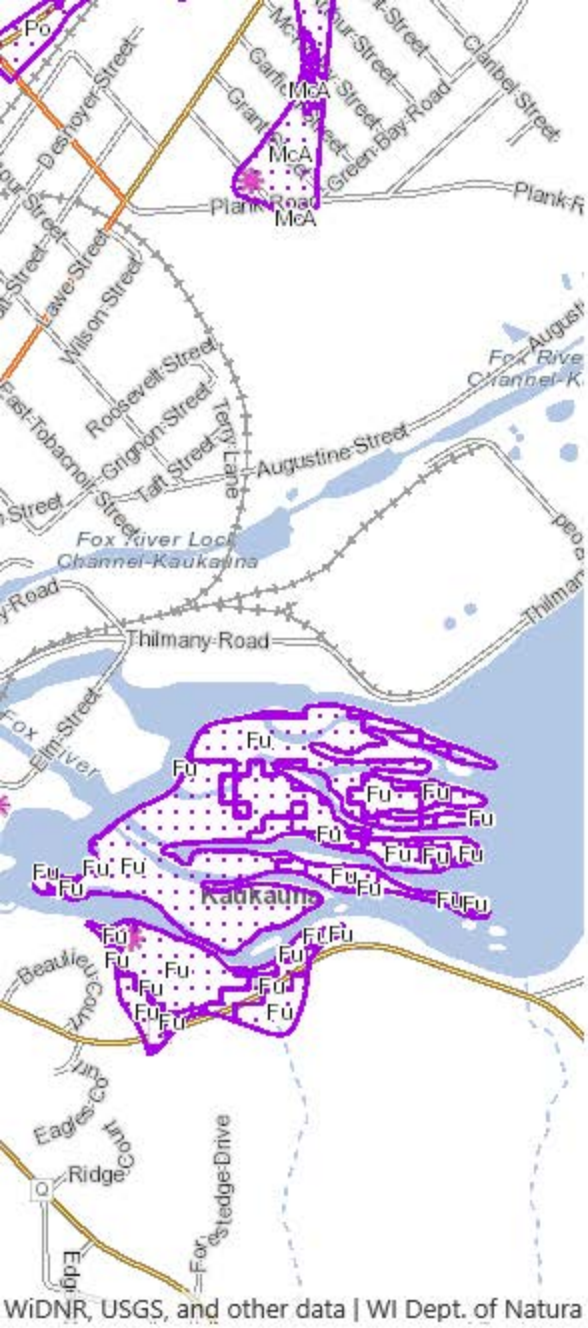

Franklin Street
Cypress Street
Cedar Street
Grant Street
Roosevelt Street
Buchanan Road
South Roosevelt Street
Buchanan Street
Hagens Court
Taft Street
Eisenhower Drive
Nixon St
East Elm Road
Lamers Drive
Bohm Drive
Sue Street
Violet Lane
Carol Lynn Drive
Sanitorium Road
Meadow Lane
Michigan Lane
Miller Lane
Rose Hill Road
Sheridan Street
Filmore Street
Hayes Street
Sunset Avenue
Idlewild Street
Walter Street
Black Street
Diedrich Street
Margaret Street
Maria Street
Green Street
Railroad Street
Lincoln Avenue
George Street
Brill Road
Bel Air Court
Foerster Avenue
Eden Avenue
Kenneth Avenue
Sullivan Avenue
Hendricks Avenue
Quinney Avenue
Metoxen Avenue
Grooks Avenue
East 9th Street
East 10th Street
East 12th Street
East 13th Street
Hennes Court
Laurel Lane
Vanderberg Lane
Fox River Lock
Channel-Lake Chute
Riverside Drive
River Street
Draper Street
Hyland Avenue Access
Joyce Street
Joan Court
Janet Street
Kevin Drive
Widenberg Drive
Fox Court
Garfield Avenue
Fairview Court
Saint Charles Place
East Lincoln Avenue
East Main Street
Hoover Avenue
Hoover Ave
Charles Street
Polk Avenue
Bluff Avenue
Franklin Street
Greenfield Drive
Hansen Street
State Street
Pump Street
Pheasant Run
William Court
Kyle Street
East Wisconsin Avenue
Wabash Avenue
Whitney Street
Klein Street
Park Street
Brill Street
West 9th Street
West 8th Street
West 6th Street
West 3rd Street
Bicentennial Court
Reaume Avenue
Miner Street
Main Ave
Kaukauna Community Hospital Heliport
55
Reference 25
Mapped Wetlands
USACE Parcel J



Reference 25
Mapped Wetlands
USACE Parcel J



Reference 26
Wetland Soils
USACE Parcel J



Reference 26
Wetland Soils
USACE Parcel J

FEMA
(//www.fema.gov/)

Navigation

Search

Languages

MSC Home (/portal/)

MSC Search by Address (/portal/search)

MSC Search All Products (/portal/advanceSearch)

MSC Products and Tools (/portal/resources/productsandtools)

Hazus (/portal/resources/hazus)

LOMC Batch Files (/portal/resources/lomc)

Product Availability (/portal/productAvailability)

MSC Frequently Asked Questions (FAQs) (/portal/resources/faq)

MSC Email Subscriptions (/portal/subscriptionHome)

Contact MSC Help (/portal/resources/contact)

FEMA Flood Map Service Center: Search By Address

Enter an address, place, or coordinates:

kaukauna WI Search

Whether you are in a high risk zone or not, you may need flood insurance (https://www.fema.gov/national-flood-insurance-program) because most homeowners insurance doesn't cover flood damage. If you live in an area with low or moderate flood risk, you are 5 times more likely to experience flood than a fire in your home over the next 30 years. For many, a National Flood Insurance Program's flood insurance policy could cost less than $400 per year. Call your insurance agent today and protect what you've built.

Learn more about steps you can take (https://www.fema.gov/what-mitigation) to reduce flood risk damage.

Search Results—Products for **KAUKAUNA, CITY OF**

Show ALL Products » (https:/

The flood map for the selected area is number **55087C0344D**, effective on **07/22/2010**

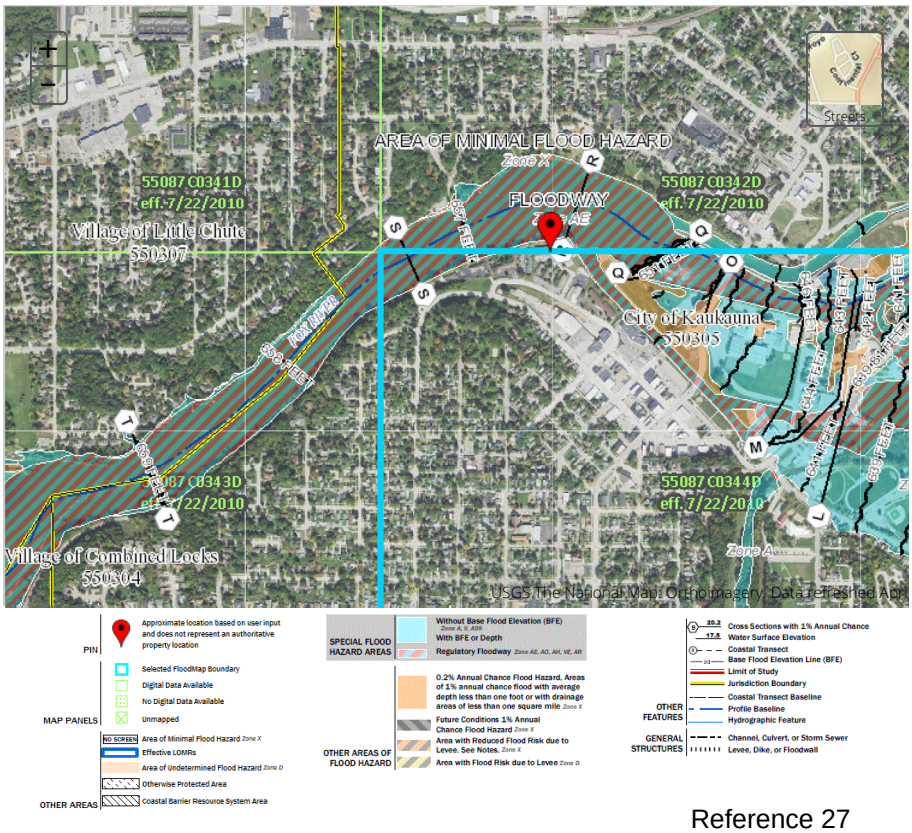
DYNAMIC MAP
PRINT MAP/ FIRMette

MAP IMAGE
DOWNLOAD FIRM PANEL
(https://msc.fema.gov/portal/downloadProduct?filepath=/55/P/Firm/55087C0344D.png&productTypeID=FINAL_PRODUCT&productS

Changes to this FIRM
Revisions (0)
Amendments (11)
Revalidations (0)

You can choose a new flood map or move the location pin by selecting a different location on the locator map below or by entering a new location in the search field above. It may take a minute or more during peak hours to generate a dynamic FIRMette. If you are a person with a disability, are blind, or have low vision, and need assistance, please contact a map specialist (https://msc.fema.gov/portal/resources/contact).

Go To NFHL Viewer » (https



Reference 27
FEMA Flood Map
USACE Parcel J

Conserving the nature of America

In the Midwest

USFWS Midwest

Midwest Ecological Services

Contact Us

What We Do

Midwest Endangered Species

Candidate Conservation

Listing

Recovery

Section 7 Consultation

Permits

Habitat Conservation Plans

Grants

Endangered Species Act

Glossary

Listed Plants and Animals

Featured Species

All Midwest Listed Species

State and County Lists

Species of Concern

Extinct Species

Wisconsin
Federally-Listed Threatened, Endangered, Proposed, and Candidate Species' County Distribution

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For more information about threatened and endangered species in Wisconsin, please contact: U.S. Fish and Wildlife Service, 2661 Scott Tower Drive, New Franken, WI 54229, Phone: (920) 866-1717

Bald Eagle

Bald eagles are no longer protected under the federal Endangered Species Act and Section 7 consultation with the U.S. Fish and Wildlife Service is no longer necessary. However, the bald eagle remains protected under the Bald and Golden Eagle Protection Act.

Information about Bald Eagles

Information about Eagle Permits and the Bald and Golden Eagle Protection Act

Gray Wolf

Due to a Federal court decision, wolves in the western Great Lakes area (including Michigan, Minnesota, and Wisconsin) were relisted under the Endangered Species Act, effective December 19, 2014.

Revised Jan. 10, 2018

Species	Status	Counties	Habitat
Mammals			
Canada lynx (*Lynx canadensis*)	Threatened	Ashland, Bayfield, Burnett, Douglas, Florence, Forest, Iron, Marinette, Oneida, Price, Sawyer, Vilas, Washburn	While no resident populations are known from Wisconsin, the species occasionally occurs in northern forested areas, and counties listed are those with the highest

Reference 28
Endangered Species
USACE Parcel J

Fact Sheets

Endangered Species Program

The mission of the U.S. Fish and Wildlife Service's Endangered Species program is conserving and restoring threatened and endangered species and their ecosystems.

U.S. Fish and Wildlife Service in the Midwest



The Midwest Region includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin.
Find a location near you »

			likelihood of occurrence.
Gray wolf *Canis lupus*	Endangered	Adams, Ashland, Barron, Bayfield, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Florence, Forest, Iron, Jackson, Juneau, Langlade, Lincoln, Marathon, Marinette, Menominee, Monroe, Oconto, Oneida, Polk, Portage, Price, Rusk, Sawyer, Shawano, St. Croix, Taylor, Vilas, Washburn, Waupaca, Waushara, Wood	Northern forested areas
Northern long-eared bat *Myotis septentrionalis*	Threatened	Statewide	Hibernates in caves and mines - swarming in surrounding wooded areas in autumn. During late spring and summer roosts and forages in upland forests.
Birds			
Kirtland's warbler *Setophaga kirtlandii =Dendroica kirtlandii*	Endangered	Adams, Bayfield, Douglas, Jackson, Marinette, Vilas, Washburn	Young jack pine stands (5 to 25 years old). Confirmed breeding in Adams county, potential breeding in the other counties.
Piping plover *(Charadrius melodus)*	Endangered	Ashland, Brown, Douglas, Manitowoc, Marinette	Sandy beaches; bare alluvial and dredge spoil islands
Piping plover *(Charadrius melodus)*	Critical Habitat	Ashland, Douglas, Manitowoc, Marinette	
Rufa Red knot *(Calidris canutus rufa)*	Threatened	Ashland and Douglas: along Lake Superior Brown and Oconto: along Green Bay Manitowoc, Ozaukee, Milwaukee, and Racine: along Lake Michigan	Coastal areas
Whooping crane (*Grus americanus*)	**Non-essential experimental population	**Adams***, Burnett, Calumet, Clark, Columbia, Crawford, Dane, Dodge, Fond du Lac, Grant, Green, Green Lake,	Open wetlands and lakeshores

Reference 28
Endangered Species
USACE Parcel J

		Iowa, Jackson, Jefferson, **Juneau***, Kenosha, LaCrosse, Lafayette, Marathon, Marquette, **Monroe***, Oconto, Pepin, Polk, Richland, Rock, Sauk, Shawano, Trempealeau, Walworth, Washington, Waushara, Winnebago, **Wood*** ***Whooping cranes have nested in these counties.**	
Reptile			
Eastern massasauga *(Sistrurus catenatus)*	Threatened	Buffalo, Columbia, Jackson, Juneau, LaCrosse, Monroe, Pepin, Rock, Sauk, Trempealeau, Walworth	Open to forested wetlands and adjacent upland areas
Mussels			
Higgins eye pearlymussel *(Lampsilis higginsii)*	Endangered	Columbia, Crawford, Dane, Grant, Iowa, Pierce, Richland, Sauk	Lower Wisconsin River
Higgins eye pearlymussel *(Lampsilis higginsii)*	Endangered	Buffalo, Crawford, Grant, LaCrosse, Pierce, Trempealeau, Vernon	Mississippi River
Higgins eye pearlymussel *(Lampsilis higginsii)*	Endangered	Pierce, Polk, St. Croix	St. Croix River
Sheepnose (*Plethobasus cyphyus*)	Endangered	Buffalo, Columbia, Crawford, Dane, Dunn, Eau Claire, Grant, Iowa, La Crosse, Pepin, Richland, Rusk, Sauk	Chippewa and Wisconsin Rivers
Snuffbox (*Epioblasma triquetra*)	Endangered	Outagamie, Pierce, Polk, St. Croix, Shawano, Waupaca, Waushara	St. Croix, Wolf, Embarrass, and Little Wolf Rivers and Willow Creek
Spectaclecase (*Cumberlandia monodonta*)	Endangered	Buffalo, Burnett, Chippewa, Crawford, Grant, Pierce, Polk, St. Croix **Note:** Occurance record for Grant and Crawford counties is historic - last observation 1982	Chippewa, Mississippi, and St. Croix Rivers
Winged mapleleaf *(Quadrula fragosa)*	Endangered	Polk, St. Croix	St. Croix River
Insects			
Hine's emerald dragonfly *(Somatochlora hineana)*	Endangered	Door, Iowa, Grant, Kewaunee, Ozaukee, Richland	Streams and associated wetlands overlying dolomite bedrock

Reference 28
Endangered Species
USACE Parcel J

Hine's emerald dragonfly *(Somatochlora hineana)*	Critical Habitat	Door and Ozaukee Critical Habitat Maps (8-page PDF)	
Karner blue butterfly *(Lycaeides melissa samuelis)*	Endangered	Adams, Burnett, Chippewa, Clark, Eau Claire, Green Lake, Jackson, Juneau, Marquette, Menominee, Monroe, Oconto, Portage, Shawano, Waupaca, Waushara, Wood	Prairie, oak savanna, and jack pine areas with wild lupine
Poweshiek skipperling *(Oarisma poweshiek)*	Endangered and Critical Habitat	Green Lake, Waukesha Map of Critical Habitat	Native prairie
Rusty patched bumble bee *Bombus affinis*	Endangered	Brown, Buffalo, Columbia, Crawford, Dane, Dodge, Eau Claire, Fond du Lac, Grant, Green, Iowa, Kenosha, La Crosse, Manitowoc, Milwaukee, Monroe, Polk, Racine, Rock, Sauk, Walworth, Washington, Waukesha **Note for project proponents**: this bee is not known to occur throughout the entire counties. To determine if your project or ongoing action is within an area that is likely to have the rusty patched bumble bee, use our online tool at https://ecos.fws.gov/ipac/	Grasslands with flowering plants from April through October, underground and abandoned rodent cavities or clumps of grasses above ground as nesting sites, and undisturbed soil for hibernating queens to overwinter.
Plants			
Dwarf lake iris *(Iris lacustris)*	Threatened	Brown, Door	Partially shaded sandy-gravelly soils on lakeshores
Eastern prairie fringed orchid *(Platanthera leucophaea)*	Threatened	Dane, Green Lake, Jefferson, Kenosha, Ozaukee, Rock, Walworth, Waukesha, Winnebago	Wet grasslands
Fassett's locoweed *(Oxytropis campestris var. chartaceae)*	Threatened	Bayfield, Douglas, Portage, Waushara	Open sandy lakeshores
Mead's milkweed *(Asclepias meadii)*	Threatened	Columbia, Dane, Grant, Green, Iowa	Upland tallgrass prairie or glade/barren habitat **Note:** all the Mead's milkweed sites in Wisconsin are reintroduction attempts and

Reference 28
Endangered Species
USACE Parcel J

			occur on protected conservation lands.
Northern monkshood *(Aconitum noveborancense)*	Threatened	Grant, Monroe, Richland, Sauk, Vernon	North facing slopes
Pitcher's thistle *(Cirsium pitcheri)*	Threatened	Door, Manitowoc, Sheboygan	Stabilized dunes and blowouts
Prairie bush-clover *(Lespedeza leptostachya)*	Threatened	Columbia, Dane, Grant, Green, Iowa, Lafayette, Pepin, Pierce, Rock, St. Croix, Sauk	Dry to mesic prairies with gravelly soil areas

****Whooping Crane -** On June 26, 2001, a nonessential experimental population of the whooping crane was designated in a 20-state area of the eastern United States. The first release of birds occurred in Wisconsin in 2001, and the counties listed are those where the species has been observed to date. It is unknown at this time which counties the species will occupy in the future, as the birds mature and begin to exhibit territorial behavior. For purposes of section 7 consultation, this species is considered as a proposed species, except where it occurs within the National Wildlife Refuge System or the National Park System, where it is treated as a threatened species.

Back to State and County Ranges of Listed Species
Midwest Endangered Species Home

Reference 28
Endangered Species
USACE Parcel J

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
2984 Shawano Avenue
Green Bay WI 54313-6727

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

August 11, 2020

U. S. Army Corps of Engineers
Benjamin J. O'Neil
231 S. LaSalle Street STE 1500
Chicago IL 60604

Subject: Reported Contamination at USACE – Parcel J (Kaukauna Power Canal), End of Bicentennial Ct, Kaukauna, WI
DNR BRRTS Activity # 02-45-548419

Dear Mr. O'Neil:

In February 2004 the Department of Natural Resources ("department") issued a Responsible Party Letter to the United States Army Corps of Engineers (USACE) for all releases discovered at USACE properties along the Fox River, identified in the 2003 Altech Phase II report, including parcel J (Kaukauna Power Canal). Parcel J had lead detected soil which was reported as part of the 2003 Phase II report. In November 2007 USACE submitted a case closure request for the Parcel J (Kaukauna Power Canal) Site (BRRTS #: 02-45-548419). Closure was denied March 2008, at the time the department recommended remedial action to address lead impacts in soil and evaluating if groundwater monitoring would be necessary following the remedial action. Since that letter was issued no additional action has been performed at the site by the USACE. In 2020, the department will be completing a Superfund Site Assessment at Parcel J.

Based on the information available to the DNR regarding ownership of this property, we believe that the USACE remains the landowner in possession of the above referenced property. As the landowner you are in possession or control of the hazardous substance discharge or other environmental pollution (hereafter referred to as "contamination") at the above-described site, and, as such, you are responsible under Wisconsin Statutes ("Wis. Stats.") ch. 292 for the investigation and cleanup of the contamination at the site. The term "site" includes the property where the contamination occurred and any other property it has migrated to, pursuant to Wisconsin Administrative Code ("Wis. Admin. Code") § NR 700.03(56).

This letter explains how to initiate the investigation and cleanup of contamination of the site, and how to access further information and assistance from the department. The longer contamination is left in the environment, the farther it can spread and the more it may cost to clean up. Quick action may lessen damage to your property and neighboring properties and reduce your costs in investigating and cleaning up the contamination.

Legal Responsibilities:

Persons meeting the definition of "responsible party" under § NR 700.03(51) must follow applicable law to address the discharge of a hazardous substance to the environment or other environmental pollution. Wisconsin Statutes ("Wis. Stats.") ch. 292 and Wis. Admin. Code chs. NR 700 through NR 754 provide

specific requirements for undertaking appropriate response actions to address contamination, including requirements for emergency and interim actions, public information, site investigations, remedy selection, design and operation of remedial action systems, and case closure.

General Recommendations for Responsible Parties:

The department recommends that you:

1. Hire a Qualified Environmental Consultant

To ensure response actions you plan to undertake comply with Wisconsin law, you should hire an environmental consultant within **30 days,** by September 11, 2020, to meet the regulatory deadlines listed below. A delay in hiring an environmental consultant could result in you missing key submittal deadlines.

Hiring a consulting firm with staff that have the appropriate State of Wisconsin qualifications to supervise and certify the submittals is a critical component and necessary to meet your requirements. Further, an environmental consultant should be knowledgeable of Wisconsin's technical procedures and laws, and be able to answer questions regarding cleanup requirements. Required qualifications for environmental consultants are specified in Wis. Admin. Code ch. NR 712. Program guidance is available, see *Wis. Admin. Code ch. NR 712 Qualifications and Certifications, RR-081*.

2. Properly Submit Reports on Time with Required Information Included

Wisconsin law includes timeframes for submitting technical documents and conducting work, as well as specifications for what should be included in those submittals. This letter provides a general overview of the timeframes and first steps to take for site investigation and cleanup. For an overview of timing requirements, please refer to *NR 700 Process and Timeline Overview, RR-967*, *enclosed.*

The department developed the publication *Guidance for Electronic Submittals for the Remediation and Redevelopment Program, RR-690,* to assist responsible parties and consultants in properly submitting documents. Wis. Admin. Code § NR 700.11(3g), and other specific provisions within Wis. Admin. Code ch. NR 700, outline the requirements for submittals, including electronic submittals. Consultants and representatives of responsible parties are required to submit one paper copy and one electronic copy of submittals, including case closure documents. The electronic version must be an exact duplicate of the paper version. Failure to submit both a paper copy and electronic copy delays acceptance of your submittals.

3. Consider the Benefits of a Fee-based Technical Review of your Submittals

In-depth department review of technical reports and submittals is available for a fee. The Remediation and Redevelopment (RR) Program project managers are available throughout the process to answer general questions and provide general input as the site moves toward closure. However, if you want a formal written response from the department, a meeting or both on a specific submittal, a review fee will be required in accordance with Wis. Admin. Code ch. NR 749. **Obtaining technical assistance from department project managers throughout the process is an effective way to prevent problems and delays at the end of the process when case closure is requested.** Forms, a fee schedule, and further information on technical assistance is available at dnr.wi.gov and searching "brownfield fees".

Required Steps to Take and Documents to Submit:

The steps listed below serve as a general overview only — all mandatory steps and submittals specified in state law must be met before the department can grant "case closure", which is a determination by the department that no further cleanup is necessary at a site, as defined in Wis. Admin. Code § NR 700.03(3m).

1. **Scoping and Work Plan Submittal – NR 716.07 and 716.09**: The law requires that you appropriately scope out your site investigation and submit a work plan within **60 days of this notification,** by October 10, 2020, for completing a site investigation. The work plan must comply with the requirements in Wis. Admin. Code, chs. NR 700 through NR 754. For additional assistance, the department has extensive guidance on its web page at dnr.wi.gov and search "brownfield publications".

   Prior to and during a site investigation, you must evaluate whether any interim actions are needed to contain or stabilize a hazardous substance discharge or environmental pollution, pursuant to Wis. Admin. Code § NR 708.11. If you undertake an interim action (*e.g.*, free product removal), you must submit documentation of the action per Wis. Admin. Code § NR 708.15.

   As you develop the site investigation work plan, you must include an assessment of the vapor intrusion pathway. Wis. Admin. Code § NR 716.11(5) outlines the requirements for when to evaluate for the presence of vapors in the sub-surface and in indoor air. The results and conclusions from the vapor assessment must be included in the Wis. Admin. Code § NR 716.15 site investigation report whether or not you elected to take vapor samples. *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin, RR-800,* is available to help responsible parties and their consultants comply with these requirements.

2. **Field Investigation – NR 716.11**: Following submission of the work plan, the site investigation must be started within the timeframe provided under law. The timeframe varies depending on whether you are requesting the department's fee-based review of the work plan. If you do not request a fee-based review of the work plan, you must initiate the field investigation within 90 days of submitting the work plan, and you may proceed with the field investigation upon department notification to proceed; however, if the department has not responded within 30 days, from submittal of the work plan, you may then proceed with the field investigation. If a fee and request for department review of the work plan is submitted, the field investigation must begin within 60 days after receiving department approval.

3. **Sample Results Notification Requirements – NR 716.14**: You must report sampling results to the department, owners, occupants, and various other parties within 10 business days after receiving the sampling results, unless a different timeframe is approved by the department, in accordance with Wis. Admin. Code § NR 716.14.

4. **Site Investigation Report – NR 716.15**: Within 60 days after completion of the field investigation and receipt of the laboratory data, the law requires you to submit a Site Investigation Report (SIR) to the department. As part of the SIR or in the Remedial Actions Options Report (RAOR), if there is soil contamination, the responsible party shall identify the current land use (*i.e.*, industrial or non-industrial) and zoning for the site or facility in accordance with Wis. Admin. Code § NR 720.05(5).

Also, as part of the SIR or in the RAOR, you must include any interim action report that may be required under Wis. Admin. Code § NR 708.15.

5. **Remedial Actions Options Report – NR 722**: Within 60 days after submitting the SIR, the law requires you to submit a RAOR. The selected remedy in the RAOR should include an evaluation of green and sustainable remediation criteria, as appropriate, as required by Wis. Admin. Code § NR 722.09(2m). This may be submitted as part of a broader SIR.

6. **Remedial and Interim Action Design, Implementation, Operation, Maintenance and Monitoring Reports – NR 724**: Unless otherwise directed by the department, the responsible party shall submit all plans and reports required in Wis. Admin. Code ch. NR 724.

7. **Notification of Residual Contamination or Continuing Obligations – NR 725**: In situations where notification is required, the responsible party must provide submittal(s) that confirms that continuing obligations have been identified and affected property owners have been notified by the responsible parties 30 days prior to case closure, as required by Wis. Admin. Code ch. NR 725.

8. **Semi-annual Reporting -- NR 700.11**: Wis. Admin. Code § NR 700.11(1)(a) requires responsible parties to submit semi-annual site progress reports to the department until final case closure is granted. The reports summarize the work completed over six months and additional work planned to adequately complete the response action at the site. Consultants may submit these reports on behalf of responsible parties. These reports are due in January and July of each year. Please refer to department publication *NR 700 Semi-Annual Site Progress Report, RR-082*, for more information.

Submittals required under Wis. Admin. Code chs. NR 700 - 726

These documents, as applicable, must be submitted to the department prior to the responsible party requesting case closure, unless otherwise directed by the department:

- Ch. NR 708 reports and documentation for any immediate or interim actions.
- Ch. NR 712 professional certifications and signatures are included with applicable submittals.
- Ch. NR 716 work plan(s) and site investigation report.
- Ch. NR 722 remedial action options report (exception is for Dry Cleaners Environmental Response Fund sites), with the selected remedial action identified.
- Ch. NR 724 design, construction documentation, operation, maintenance and monitoring plans and reports, including vapor mitigation commissioning.
- Ch. NR 725 submittal(s) that confirms that continuing obligations have been identified and affected property owners have been notified by the responsible parties 30 days prior to case closure.
- If requesting case closure, the Ch. NR 726 case closure form and documentation substantiating compliance with the NR 700 rule series.
- Ch. NR 749 fees have been paid, as applicable, including closure and database fees.
- Ch. NR 700 semi-annual site progress reports starting six months after notification.

Additional Information:

The department tracks information on all cleanup sites in a department database available at dnr.wi.gov and search "BOTW". The Bureau for Remediation and Redevelopment Tracking System (BRRTS) identification number for this site is listed at the top of this letter. You may view information related to your site on this database at any time.

All correspondence regarding this site should be directed to:

Sarah Krueger
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
2984 Shawano Avenue
Green Bay WI 54313-6727
sarah.krueger@wisconsin.gov

As previously noted, you are required to submit one paper copy and one electronic copy of plans and reports. To speed up processing, your correspondence should reference the BRRTS and Facility Identification (FID) numbers (if assigned) listed at the top of this letter.

Please visit the department's Remediation and Redevelopment Program website at dnr.wi.gov and search "Brownfields", for information on selecting a consultant, seeking financial assistance, and understanding the investigation and cleanup process. Information regarding review fees, liability clarification letters, post-cleanup liability and more is also available.

If you have questions, please call Sarah Krueger at 920-662-5443 for more information.

Thank you for your cooperation.

Sincerely,

Denise D. Danelski

Denise D. Danelski
Environmental Program Associate - Remediation & Redevelopment Program
Northeast Region

Enclosures:

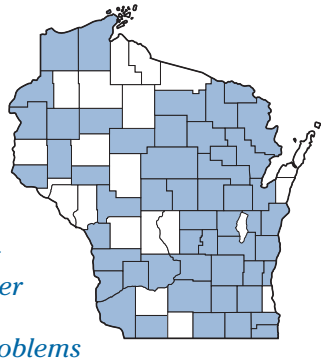
1. NR 700 Process and Timeline Overview, RR-967
2. Environmental Contamination Basics, RR674
3. Selecting a Consultant, RR502
4. Environmental Services Contractor List, RR024

cc: Sarah Krueger - NER



Arsenic in Drinking Water

Drinking Water Wells tested with Arsenic Levels Greater than 10 ppb.



Arsenic has been detected in every county in the State of Wisconsin. The shaded counties on the map represent areas with water wells that had arsenic levels exceeding the arsenic drinking water standard of 10 parts per billion (ppb). Serious problems with arsenic are however concentrated in specific regions within these counties.

Wisconsin Department of Natural Resources
Bureau of Drinking Water & Groundwater

What is arsenic?

Arsenic is an element that occurs naturally in soil and bedrock formations. Traces of arsenic are also found in groundwater, lakes, rivers and ocean water. Foods like fruits, vegetables, and seafood can also contain arsenic. Some fruits and vegetables absorb traces of arsenic from the soil they grow in. Ocean fish and seafoods naturally have high levels of an organic non-toxic form of arsenic.

High levels of inorganic arsenic, the most toxic form, have been found in over 1,200 private drinking water wells in Wisconsin. The map on the cover shows counties where wells have been tested and found to contain arsenic above 10 ppb.

How can I be exposed to arsenic?

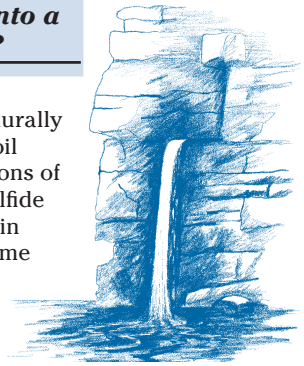


Since arsenic is a natural part of our environment, everyone is exposed to small amounts. The major source of arsenic exposure is drinking water that contains elevated levels of arsenic. Other sources of arsenic exposure include:

- foods containing traces of arsenic
- smoke from wood, coal, tobacco products
- dust from some industrial processes
- pesticides
- anti-parasitic veterinary medicines
- folk remedies
- some treated lumber

People who are exposed to arsenic over a period of years can experience a variety of health problems. Arsenic can be easily absorbed into the human system by drinking contaminated water or by breathing airborne particulates. In most cases, it is safe to use water that contains arsenic to bathe and for household chores. Arsenic is not easily absorbed through the skin and does not evaporate from the water into the air.

How does arsenic get into a drinking water supply?



Most of the arsenic found in Wisconsin groundwater is naturally occurring, deposited in the soil and bedrock layers over millions of years. Arsenic is tied up in sulfide minerals, which are common in bedrock formations and in some glacial deposits. Arsenic can be released from soil and rock into the groundwater and drawn into wells.

Scientists who have studied this problem believe arsenic is being released into groundwater at elevated levels in the Outagamie, Winnebago and Brown County area at least partly because people are now using more water than ever before due to rapid suburban development. During the past ten years, about 10,000 new wells have been constructed in this area. Water quality problems have increased as more new wells are being drilled and demands on groundwater continue to increase.

Studies have shown that increased water demands have lowered the water table in this area. This has allowed oxygen to get into the bedrock aquifers, creating chemical reactions that release arsenic into the water. In other areas of the State, different types of reactions can release arsenic that moved into Wisconsin, in the geologic past, from other geographic sources. Scientists are studying these and other possible factors to determine the best ways to avoid arsenic problems. The Department of Natural Resources staff continue to study arsenic contamination problems throughout the State to determine its geographical extent and severity.

How can arsenic affect my health?

Consumption of arsenic-contaminated water has been associated with the following possible health effects:

- Skin cancer
- Internal cancers (bladder, prostate, lung and other sites)
- Thick, rough skin on hands and feet
- Unusual skin pigmentation (dappling of dark brown or white splotches)
- Numbness in the hands and feet
- Circulatory disorders
- Tremors
- Stomach pain, nausea, diarrhea
- Diabetes
- Depression

Arsenic contamination of drinking water is a serious health concern. If you think you or someone in your family has symptoms from arsenic exposure talk to your doctor and have your water tested for arsenic.

How can I find out if my water is contaminated with arsenic?

You cannot smell, taste or see arsenic in your drinking water. The only way to know if your water contains arsenic is to have a water sample from your private well tested by a certified laboratory. A list of certified labs is available at **dnr.wi.gov**, Search: Arsenic

If you use water from a public water system, check the water system's Consumer Confidence Report (CCR). Public water systems distribute copies of their CCR to system users each summer. The section titled "Where can I get more information", found in this brochure contains instructions to help you find your CCR on the website.

If the arsenic level in your water is above the drinking water standard of 10 ppb, stop drinking your water. Obtain water from a known safe source for drinking and preparation of beverages or for foods like baby formula, soup, and coffee. Unless your arsenic level exceeds 100 ppb, it is safe to bathe in the water and use it for household purposes. If arsenic levels exceed 100 ppb, you should consult your local or County health department.

If the arsenic level in your water is just under 10 ppb and you consume 2 liters (about 68 ounces) or more of drinking water from this source per day, you may wish to try to reduce your exposure to arsenic. Contact your health care provider or local health department to determine your specific needs.



New well construction or reconstructions have been successful at reducing the arsenic concentrations in water supply systems. For levels of arsenic contamination exceeding 50 ppb, Department of Natural Resources *Well Compensation Program* funds may be available for replacement water systems for income eligible private well owners or lessees.

Everyone should have a sample of their water tested for arsenic at least once every five years, whenever a change in the color of your water or staining of fixtures is observed, or if water levels in your well have changed. If you are in the *"Special Well Casing Depth Area"* (Outagamie and Winnebago Counties) or an area where arsenic has been detected, the Department of Natural Resources recommends you retest your well water each year, regardless of previous test results because concentrations of arsenic can change over time. (See the map on the front of this brochure for counties in Wisconsin where arsenic levels are known to have exceeded 10ppb.) In a small percentage of wells that produce water with high levels of arsenic, the water is very acid and can corrode plumbing pipes and fixtures. Conversely, if you have corrosive water, i.e. your pipes and fixtures are corroding, there is a greater chance you have an arsenic problem.

Can water treatment systems remove arsenic?



Yes, special treatment systems can remove arsenic from well water. However, be aware that common treatment systems like water softeners, carbon filters and sediment filters do not adequately remove arsenic from water. Do not purchase a treatment system unless you have first checked with the Department of Safety and Professional Services (DSPS) approved treatment device list. (website below under Department of Safety and Professional Services)

There are two types of treatment systems currently available for arsenic removal. These treatment systems are "point-of-use" and "point-of-entry" systems. Point-of-use systems generally only treat one faucet that is used for drinking and cooking. Point-of-entry systems treat all the water entering the house. New treatment technologies that will reduce arsenic in your water supply are presently being developed. Once you have determined which treatment option is correct for your water supply, it is recommended that you use a licensed plumber for installation. After installation, follow the maintenance instructions provided by the manufacturer very closely and verify with sampling to make sure the system continues to operate as a viable arsenic reduction water treatment system.

Drilling a new well may be necessary for extremely high levels of arsenic. Talk to your well driller or your drinking water & groundwater specialist at your DNR regional office about special well construction guidelines.

Where can I get more information?

Health Departments



The Department of Health & Family Services has more information on the health effects of arsenic exposure at **dhs.wi.gov**, Search: Arsenic

State Department of Health Services, Division of Public Health..... 608-266-7480

Brown Co. Health Dept. 920-448-6400

Outagamie Co. Health Dept. 920-832-5100

Winnebago Co. Health Dept..... 920-232-3000

Department of Safety and Professional Services

The Department of Safety and Professional Services maintains a list of treatment devices approved for removing arsenic at **dsps.wi.gov/php/sb-ppalopp/contam_alpha_list.php**

Department of Natural Resources

The DNR maintains the following pages with information relating to labs, water quality and arsenic research.

Wisconsin's Arsenic Information Page

Visit the DNR Web site for arsenic information related to well drilling, water treatment options, recent news articles, research papers and more! Go to **dnr.wi.gov**, Search: Arsenic

Certified Laboratories

A list of certified labs is available on the Arsenic webpage mentioned above or check your local yellow pages and ask if they are state certified to test for arsenic.

Consumer Confidence Reports

Your local water supplier prints a special report on the quality of your public water system's drinking water. Contact your local water supplier or find your system's latest report on the Web! Go to **dnr.wi.gov**, Search: Consumer Confidence Report. A query, or search, can then be made by city or individual system.

Contact Us

Customer Service Staff are here to assist you.

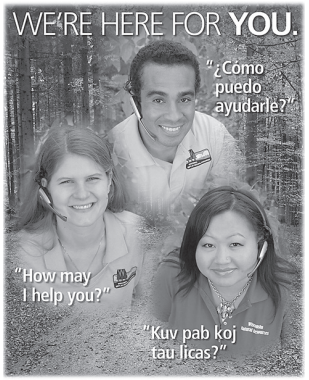
How may we help you?

Call Toll Free 1-888-WDNRINFO (1-888-936-7463)
Or, go to **dnr.wi.gov**, Search: Contact
Click on one of the following options:

Chat with customer service.

Call a representative.

Email your question.



Toll free hotlines

Violation Hotline:
1-800-TIP-WDNR or phone 1-800-847-9367
Confidentially report suspected wildlife, recreational and environmental violations.

Emergency Spill Hotline:
1-800-943-0003 phone

Bilingual Services are available

Drinking Water & Groundwater Program

101 S. Webster
P.O. Box 7921
Madison, WI 53707-7921
(608) 266-1054

For more information, go to **dnr.wi.gov**, Search: Drinking Water

The Wisconsin Department of Natural Resources provides equal opportunity in its employment, programs, services and functions under an Affirmative Action Plan. If you have any questions, please write to: Equal Opportunity Office, Department of the Interior, Washington, D.C. 20240.

This publication is available in alternative format (large print, Braille, audiotape, etc.) upon request. Please call (608) 266-1054 for more information.

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State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
2984 Shawano Avenue
Green Bay WI 54313-6727

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

May 10, 2022

Fox Investments LLC
Attn: Thomas Vandeyacht
2220 N Lynndale Drive
Appleton, WI 54914
Via Electronic Mail Only to tomv@vmi-vdi.com

Fox Shores LLC
Attn: Logan Rankin
518 Main Street #346
Wrightstown, WI 54180
Via Electronic Mail Only to logan@rentwithfocus.com

KEEP THIS LEGAL DOCUMENT WITH YOUR PROPERTY RECORDS

SUBJECT: Case Closure with Continuing Obligations
Fox Shores Apartments, 400 Fox Shores Drive, Kaukauna, WI 54130
BRRTS #: 02-45-582746, FID #: 445207290

Dear Mr. Vandeyacht and Mr. Rankin:

The Wisconsin Department of Natural Resources (DNR) is pleased to inform you that the Fox Shores Apartments case identified above met the requirements of Wisconsin Administrative (Wis. Admin.) Code chs. NR 700 to 799 for case closure with continuing obligations (COs). COs are legal requirements to address potential exposure to remaining contamination. No further investigation or remediation is required at this time for the reported hazardous substance discharge and/or environmental pollution.

However, you, future property owners and occupants of the property must comply with the COs as explained in this letter, which may include maintaining certain features and notifying the DNR and obtaining approval before taking specific actions. You must provide this letter and all enclosures to anyone who purchases, rents or leases this property from you. You may be required to make a real estate condition report disclosure under Wis. Stat. ch. 709.

This case closure decision is issued under Wis. Admin. Code chs. NR 700 to 799 and is based on information received by the DNR to date. The DNR reviewed the case closure request for compliance with state laws and standards and determined the case closure request met the notification requirements of Wis. Admin. Code ch. NR 725, the response action goals of Wis. Admin. Code § NR 726.05(4), the case closure criteria of Wis. Admin. Code §§ NR 726.05, 726.09, and 726.11, and Wis. Admin. Code ch. NR 140.

The Fox Shores Apartments site was investigated for a discharge of hazardous substances and/or environmental pollution from historic soil fill and historic property use. Case closure is granted for the volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and Resource Conservation Recovery Act metals (RCRA metals) sampled during the site investigation, as documented in the case file. The site investigation and/or remedial action addressed soil, and groundwater. The remedial action consisted of a one-foot excavation of

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landscaped areas with caping consisting of an engineered geotextile fabric underlying 12-inches of clean fill and/or topsoil. Excavated soils were placed in one of four designated fill locations creating landscape berms capped with engineered geotextile fabric underlying 12-inches of clean fil and/or topsoil. PAH, RCRA metals, and VOC contamination remain in soil and/or groundwater, across the site.

The case closure decision and COs required were based on the current use of the site for residential purposes. The site is currently zoned Commercial Core. Based on the land use and zoning, the site meets the non-industrial land use classification under Wis. Admin. Code § NR 720.05(5) for application of residual contaminant levels in soil.

SUMMARY OF CONTINUING OBLIGATIONS

COs are applied at the following location:

ADDRESS (City of Kaukauna, WI)	COS APPLIED	DATE OF MAINTENANCE PLAN(S)
400 Fox Shores Drive (Source Property)	• Residual Soil Contamination • Cover for Soil (Maintenance Required) • Residual Groundwater Contamination	Not applicable January 24, 2022 Not applicable

CLOSURE CONDITIONS

Closure conditions are legally required conditions which include both COs and other requirements for case closure (Wis. Stat. § 292.12(2)). Under Wis. Stat. § 292.12(5), you, any subsequent property owners and occupants of the property must comply with the closure conditions as explained in this letter. The property owner must notify occupants for any condition specified in this letter under Wis. Admin. Code §§ NR 726.15(1)(b) and NR 727.05(2). If an occupant is responsible for maintenance of any closure condition specified in this letter, you and any subsequent property owner must include the condition in the lease agreement under Wis. Admin. Code § NR 727.05(3) and provide the maintenance plan to any occupant that is responsible.

DNR staff may conduct periodic pre-arranged inspections to ensure that the conditions included in this letter and the maintenance plan dated, January 24, 2022, are met (Wis. Stat. § 292.11(8)). If these requirements are not followed, the DNR may take enforcement action under Wis. Stat. ch. 292 to ensure compliance with the closure conditions.

SOIL

Continuing Obligations to Address Soil Contamination

Residual Soil Contamination (Wis. Admin. Code chs. NR 718, NR 500 to 599, and § NR 726.15(2)(b) and Wis. Stat. ch. 289)

Soil contamination remains across the site as indicated on the enclosed map (Figure B.2.b., Residual Soil Contamination, dated April 24, 2020). If soil in the location(s) shown on the map is excavated in the future, the property owner or right of way holder at the time of excavation must sample and analyze the excavated soil. If sampling confirms that contamination is present, the property owner or right of way holder at the time of excavation will need to determine if the material is considered solid waste and ensure that any storage, treatment

or disposal complies with applicable standards and rules. Contaminated soil may be managed under Wis. Admin. Code ch. NR 718 with prior DNR approval.

In addition, all current and future property owners, occupants and right of way holders need to be aware that excavation of the contaminated soil may pose an inhalation and direct contact hazard; special precautions may be needed to prevent a threat to human health.

Cover for Soil (Maintenance Required) (Wis. Stat. § 292.12(2)(a), Wis. Admin. Code §§ NR 724.13(1) and (2), NR 726.15(2)(d) and/or (e), NR 727.07(1))
The cover consists of either building, gravel, concrete, asphalt, or landscape cap across the entire site, as shown on the enclosed map (Figure D.2, Cap Location Map, dated February 5, 2021) shall be maintained in compliance with the enclosed maintenance plan, dated January 24, 2022. The purpose of the cover is to prevent direct contact with residual soil contamination that might otherwise pose a threat to human health.

To modify or replace a cover, the property owner must submit a request to the DNR under Wis. Admin. Code ch. NR 727. The DNR approval must be obtained before implementation. The replacement or modified cover must be a structure of similar permeability or be protective of the revised use of the property until contaminant levels no longer exceed Wis. Admin. Code ch. NR 720 direct contact residual contaminant levels (RCLs).

GROUNDWATER

Continuing Obligations to Address Groundwater Contamination and/or Monitoring Wells

Residual Groundwater Contamination (Wis. Admin. Code ch. NR 140 and § NR 812.09(4)(w))
Groundwater contamination which equals or exceeds the enforcement standards for PAHs is present in temporary wells TW17 and B3 on the western portion of the site, as shown on the enclosed map (Figure B.3.b., Groundwater Isoconcentration, dated May 22, 2020). To construct a new well or reconstruct an existing well, the property owner must obtain prior DNR approval. Additional casing may be necessary to prevent contamination of the well.

OTHER CLOSURE REQUIREMENTS

Maintenance Plan and Inspection Log (Wis. Admin. Code §§ NR 726.11(2), NR 726.15(1)(d), NR 727.05(1)(b)3., Wis. Admin. Code § NR 716.14(2) for monitoring wells)
The property owner is required to comply with the enclosed maintenance plan dated January 24, 2022, for the cover, to conduct inspections annually, and to use the inspection log (DNR Form 4400-305) to document the required inspections. The maintenance plan and inspection log are to be kept up-to-date and on-site, or at the address of the property owner. The property owner shall submit the inspection log to the DNR only upon request, using the RR Program Submittal Portal. See the DNR Notification and Approval Requirements section below for more information on how to access the Submittal Portal.

The limitations on activities are identified in the enclosed maintenance plan(s). The following activities are prohibited on any portion of this property where the cover is required, without prior DNR approval.

- Removal of the existing barrier;
- Replacement with another barrier;
- Excavating or grading of the land surface;
- Filling on capped or paved areas;
- Plowing for agricultural cultivation;
- Construction or placement of a building or other structure; and
- Changing the use or occupancy of the property to single-family residential.

Pre-Approval Required for Well Construction (Wis. Admin. Code § NR 812.09(4)(w))
DNR approval is required before well construction or reconstruction for all sites identified as having residual contamination and/or COs. This requirement applies to private drinking water wells and high capacity wells. To obtain approval, the property owner is required to complete and submit Form 3300-254, Continuing Obligations/Residual Contamination Well Approval Application, to the DNR Drinking and Groundwater program's regional water supply specialist. A well driller can help complete this form. The form can be obtained online at dnr.wi.gov, search "3300-254." Additional casing may be necessary to help prevent contamination of the well.

General Wastewater Permits for Construction-related Dewatering Activities (Wis. Admin. Code ch. NR 200)
The DNR's Water Quality Program regulates point source discharges of contaminated water, including discharges to surface waters, storm sewers, pits, or to the ground surface. This includes discharges from construction-related dewatering activities, including utility work and building construction.

If the property owner or any other person plans to conduct such activities, that person must contact the Water Quality Program and, if necessary, apply for the required discharge permit. If residual soil or groundwater contamination is likely to affect water collected in a pit/trench that requires dewatering, a general permit for discharge of *Contaminated Groundwater from Remedial Action Operations* may be needed. If water collecting in a pit/trench that requires dewatering is expected to be free of pollutants other than suspended solids, oil and grease, a general permit for pit/trench *Dewatering Operations* may be needed. Additional information can be obtained by visiting the DNR website at "dnr.wi.gov," search "wastewater general permits."

DNR NOTIFICATION AND APPROVAL REQUIREMENTS

Certain activities are limited at closed sites to maintain protectiveness to human health and the environment. The property owner is required to notify the DNR at least 45 days before and obtain approval from the DNR prior to taking the following actions (Wis. Admin. Code §§ NR 727.07, NR 726.15 (2), Wis. Stat. § 292.12(6)).

- Before removing a cover or any portion of a cover

The DNR may require additional investigation and/or cleanup actions if necessary, to be protective of human health and the environment. The case may be reopened under Wis. Admin. Code § NR 727.13 if additional information indicates that contamination on or from the site poses a threat, or for a lack of compliance with a CO or closure requirement. Compliance with the maintenance plan is considered when evaluating the reopening criteria.

SUBMITTALS AND CONTACT INFORMATION

Site, case-related information and DNR contacts can be found online in the Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web (BOTW); go to dnr.wi.gov and search "BOTW." Use the BRRTS ID # found at the top of this letter. The site can also be found on the map view, Remediation and Redevelopment Sites Map (RRSM) by searching "RRSM."

Send written notifications and inspection logs to the DNR using the RR Program Submittal Portal at dnr.wi.gov, search "RR submittal portal" (https://dnr.wi.gov/topic/Brownfields/Submittal.html). Questions on using this portal can be directed to the DNR project manager, Sarah Krueger, below or to the environmental program associate (EPA) for the regional DNR office. Visit dnr.wi.gov, search "RR contacts" and select the EPA tab (https://dnr.wi.gov/topic/Brownfields/Contact.html).

CLOSING

The DNR appreciates your efforts to restore the environment at this site. If you have any questions regarding this this letter, please contact DNR project manager, Sarah Krueger at (920) 510-8277 or sarah.krueger@wisconsin.gov.

Sincerely,

Roxanne N. Chronert
Team Supervisor, Northeast Region
Remediation & Redevelopment Program

Attachments:

Figure B.2.b., Residual Soil Contamination, dated April 24, 2020
Attachment D, Maintenance Plan, dated January 24, 2022
Figure B.3.b, Groundwater Isoconcentration, dated May 22, 2020
Inspection Log (DNR Form 4400-305)

cc. Jeff Brand, Stantec Consulting Services, Inc. (jeff.brand@stantec.com)
Nathan Olson, Olson Legal Group LLC (nate@olsonlegalgroup.com)

Additional Resources:
The DNR fact sheets listed below can be obtained by visiting the DNR website at "dnr.wi.gov," search the DNR publication number.

- *Guidance for Electronic Submittals for the Remediation and Redevelopment Program* (RR-690)
- *Continuing Obligations for Environmental Protection* (RR-819)
- *Environmental Contamination and Your Real Estate* (RR-973)
- *Post-Closure Modifications: Changes to Property Conditions after a State-Approved Cleanup* (RR-987)
- *Using Natural Attenuation to Clean Up Contaminated Groundwater: What Landowners Should Know* (RR-671)



N

SCALE IN FEET

30 0 30 60

LEGEND

SB6 STANTEC SOIL BORING LOCATION

HA–1 STANTEC HAND AUGER SOIL BORING LOCATION

APPROXIMATE PROPERTY LINE

ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION (ASSUMED TO BE SITEWIDE)

Stantec

1165 Scheuring Road, Green Bay, Wisconsin 54115
Phone: 920-592-8400 Fax: 920-592-8444

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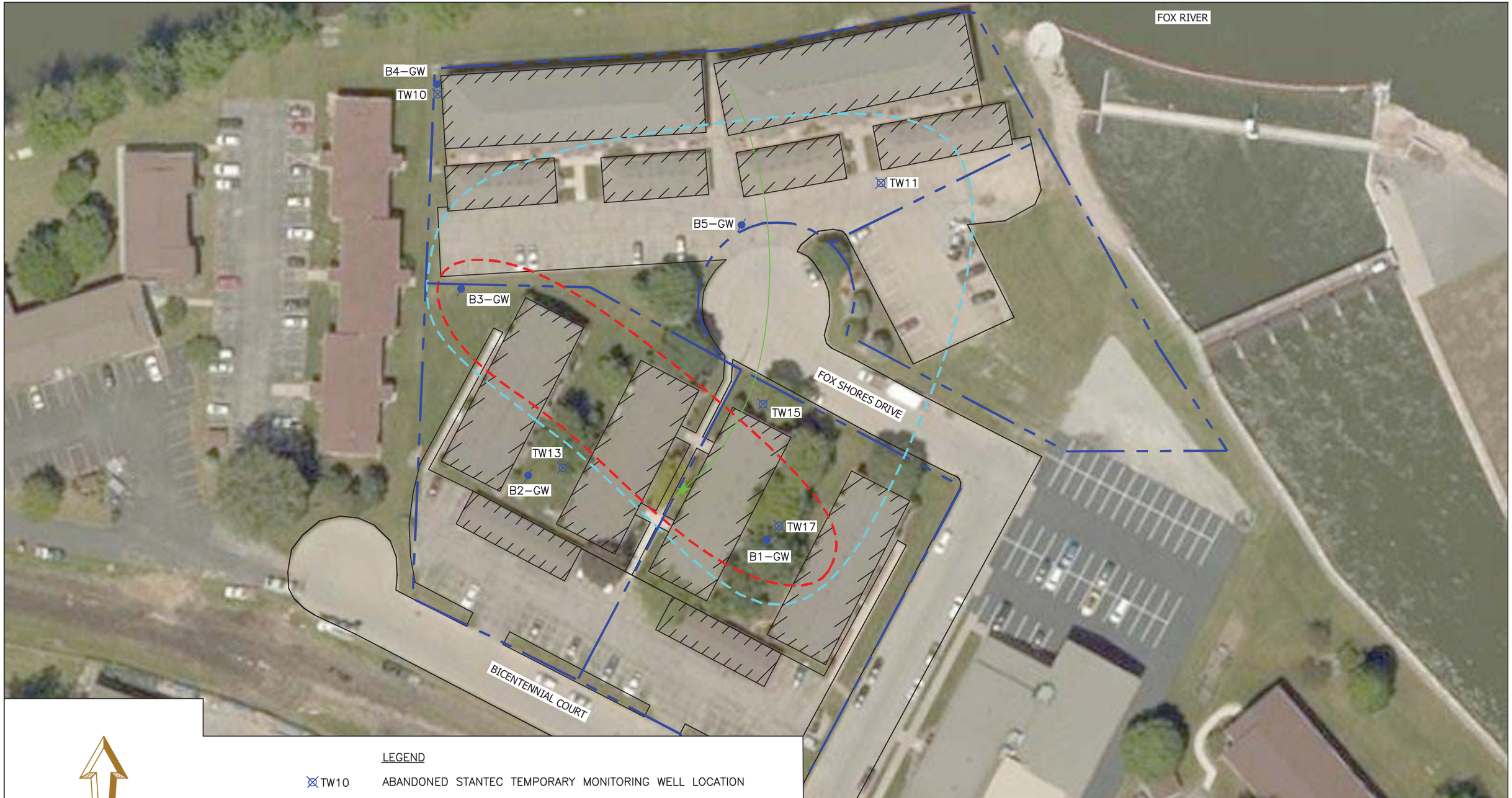
B.2.b. RESIDUAL SOIL CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
04/24/20	JRB	JRB	193706620	B.2.b



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10	ABANDONED STANTEC TEMPORARY MONITORING WELL LOCATION
B1–GW	ABANDONED PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION
	APPROXIMATE PROPERTY LINE
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES
	GROUNDWATER FLOW DIRECTION (8/28/19)

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B.3.b.GROUNDWATER ISOCONCENTRATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
05/22/20	JRB	JRB	193706620	B.3.b

COVER MAINTENANCE PLAN

January 24, 2022

Property Located at:

380/400 Bicentennial Court; 400/410 Fox Shores Drive; Lot 2 CSM 6200

DNR BRRTS # 02-45-582746

Parcel Identification Numbers #323040800, #323040801, #323040802, #323040804

Introduction

This document is the Maintenance Plan for building structures, asphalt, concrete, gravel, and soil cover at the above-referenced property in accordance with the requirements of s. NR 724.13 (2), Wis. Adm. Code. The maintenance activities relate to the existing pavement, structural, or soil covers which addresses or occupies the area over the contaminated soil and groundwater plume.

More site-specific information about this property/site may be found in:

- The case file in the DNR Northeast Regional office
- At http://dnr.wi.gov/topic/Brownfields/wrrd.html, which includes:
  - BRRTS on the Web (DNR's internet-based data base of contaminated sites) for the link to a PDF for site-specific information at the time of closure and on continuing obligations;
  - RR Sites Map for a map view of the site, and
- The DNR project manager for Outagamie County.

D.1. Descriptions:

Description of Contamination

Soil contaminated by polycyclic aromatic hydrocarbons (PAHs), resource conservation and recovery act (RCRA) metals, and/or volatile organic compounds (VOCs) has been identified at a depth of 0 to 4 feet across the property. Groundwater contaminated by arsenic and PAHs is located at a depth of 4 to 6 feet below ground surface. The extent of the soil and groundwater contamination is shown on the attached **Figure D.2**.

Description of the Cover to be Maintained

The cover consists of either building structures, 6-8 inches of gravel, impermeable surfaces such as concrete and asphalt, or a landscape cap made up of permeable filter fabric overlain with clean fill totaling 12 inches. The cap is located across the entire property as shown on the attached **Figure D.2**.

Cover Purpose

The buildings, gravel, paved surfaces, and landscaped soils in place cover the remaining contaminated soil and groundwater and serve as a barrier to prevent direct human contact with residual soil contamination that might otherwise pose a threat to human health. Based on the current use of the property as a residential apartment complex, the barrier should function as intended unless disturbed.

Annual Inspection

The cover overlying the contaminated soil and groundwater and as depicted in **Figure D.2.** will be inspected once a year, normally in the spring after all snow and ice is gone, for deterioration, cracks and other potential problems that can cause exposure to underlying soils. The inspections will be performed by the property owner or their designated representative. The inspections will be performed to evaluate damage due to settling, exposure to the weather, wear from traffic, increasing age and other factors. Any area where soils have become or are likely to become exposed will be documented.

A log of the inspections and any repairs will be maintained by the property owner and is included as D.4, Form 4400-305, Continuing Obligations Inspection and Maintenance Log. The log will include recommendations for necessary repair of any areas where underlying soils are exposed and where infiltration from the surface will not be effectively minimized. Once repairs are completed, they will be documented in the inspection log. A copy of the maintenance plan and inspection log will be kept at the site; or, if there is no acceptable place (for example, no building is present) to keep it at the site, at the address of the property owner and available for submittal or inspection by Wisconsin Department of Natural Resources (DNR) representatives upon their request.

Maintenance Activities

If problems are noted during the annual inspections or at any other time during the year, repairs will be scheduled as soon as practical. Repairs can include patching and filling or larger resurfacing or construction operations. In the event that necessary maintenance activities expose the underlying soil, the owner must inform maintenance workers of the direct contact exposure hazard and provide them with appropriate personal protection equipment (PPE). The owner must also sample any soil that is excavated from the site prior to disposal to ascertain if contamination remains. The soil must be treated, stored and disposed of by the owner in accordance with applicable local, state and federal law.

In the event the gravel, soil cover, and/or impervious surfaces overlying the contaminated soil and groundwater are removed or replaced, the replacement barrier must be equally impervious. Any replacement barrier will be subject to the same maintenance and inspection guidelines as outlined in this Maintenance Plan unless indicated otherwise by the DNR or its successor.

The property owner, in order to maintain the integrity of the gravel, soil cover, and impervious surfaces, will maintain a copy of this Maintenance Plan at the site; or, if there is no acceptable place to keep it at the site (for example, no building is present), at the address of the property owner and make it available to all interested parties (i.e. on-site employees, contractors, future property owners, etc.) for viewing.

Prohibition of Activities and Notification of DNR Prior to Actions Affecting a Cover

The following activities are prohibited on any portion of the property where [pavement, a building foundation, soil cover, engineered cap or other barrier] is required as shown on the attached map, unless prior written approval has been obtained from the Wisconsin Department of Natural Resources: 1) removal of the existing barrier; 2) replacement with another barrier; 3) excavating or grading of the land surface; 4) filling on capped or paved areas; 5) plowing for agricultural cultivation; 6) construction or placement of a building or other structure; 7) changing the use or occupancy of the property to single-family residential use.

If removal, replacement or other changes to a cover, or a building which is acting as a cover, are considered, the property owner will contact DNR at least 45 days before taking such an action, to determine whether further action may be necessary to protect human health, safety, or welfare or the environment, in accordance with s. NR 727.07, Wis. Adm. Code.

Amendment or Withdrawal of Maintenance Plan

This Maintenance Plan can be amended or withdrawn by the property owner and its successors with the written approval of DNR.

Contact Information

January 2022

Site Owner and Operator:	Fox Shores LLC Logan Rankin 518 Main Street #346 Wrightstown, WI 54180 (920) 255-3259
Signature:	_____
Consultant:	Stantec Consulting Services Inc. Jeffrey R. Brand 1165 Scheuring Road De Pere, WI 54115 (920) 592-8400
DNR:	Sarah Krueger 2984 Shawano Avenue Green Bay, WI 54313-6727 (920) 510-8277

D.2 Map(s)

D. 3 Photographs of Cover/Barrier

D.4 Continuing Obligations Inspection and Maintenance Log
Form 4400-305



**NOTE: CAP EXISTS ACROSS THE ENTIRE SITE FOR INDUSTRIAL AND NON-INDUSTRIAL DIRECT CONTACT EXCEEDANCES OF PAHs AND METALS.

N

SCALE IN FEET

30 0 30 60

LEGEND

- BRRTS CASE #02-45-582746 AND ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION. (ASSUMED TO BE SITEWIDE)
- APPROXIMATE PROPERTY LINE
- ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES
- ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
- PAVED CAP
- BUILDING CAP
- BERM LOCATION
- LANDSCAPE CAP
- GAVEL CAP

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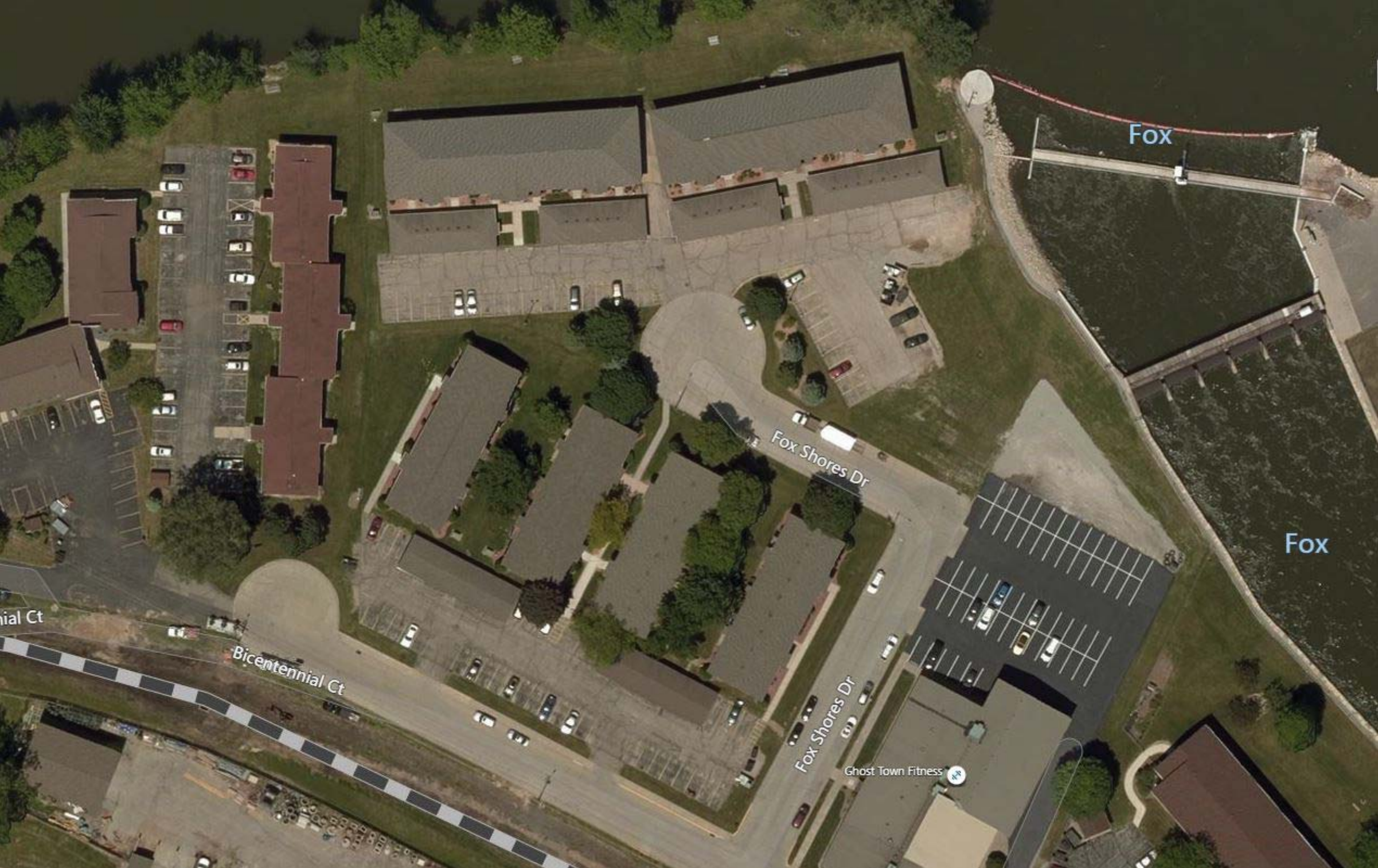
CAP LOCATION MAP

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
02/05/21	JRB	JRB	193706620	D.2.


Fox
Fox
Fox Shores Dr
Fox Shores Dr
Bicentennial Ct
Ghost Town Fitness

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 1

Photo Location:
Lot 2

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 2

Photo Location:
Lot 2

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Capped Berm



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 3 **Photo Location:** Lot 2 **Direction:** North **Survey Date:** 9/28/2021 **Comments:** Capped Berm	
Photograph ID: 4 **Photo Location:** 380/390 Bicentennial Court **Direction:** Southwest **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 5

Photo Location:
400 Bicentennial Court

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 6

Photo Location:
400/410 Bicentennial Court

Direction:
Southwest

Survey Date:
9/28/2021

Comments:
Capped Berm



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 7 **Photo Location:** 400/410 Bicentennial Court **Direction:** Northwest **Survey Date:** 9/28/2021 **Comments:** Soil Cap	
Photograph ID: 8 **Photo Location:** 410 Bicentennial Court **Direction:** Southwest **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 9

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 10

Photo Location:
410 Fox Shores Drive

Direction:
South

Survey Date:
9/28/2021

Comments:
Soil Cap



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 11 **Photo Location:** 410 Bicentennial Court **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Soil Cap With Added Mulch	
Photograph ID: 12 **Photo Location:** 390 Bicentennial Court **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Soil Cap With Added Mulch	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 13

Photo Location:
380 Bicentennial Court

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Soil cap



Photograph ID: 14

Photo Location:
380 Bicentennial Court

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Soil Cap



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 15 **Photo Location:** Lot 2 **Direction:** Northwest **Survey Date:** 9/28/2021 **Comments:** Soil Cap	
Photograph ID: 16 **Photo Location:** Lot 2 **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 17

Photo Location:
Lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 18

Photo Location:
Lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 19 **Photo Location:** lot 2 **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Capped Berm	
Photograph ID: 20 **Photo Location:** Lot 2 **Direction:** Northeast **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 21

Photo Location:
Lot 2

Direction:
North

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 22

Photo Location:
lot 2

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 23

Photo Location:
380/390 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 24

Photo Location:
390/400 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 25

Photo Location:
400 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 26

Photo Location:
400/410 Bicentennial Court

Direction:
South

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 27

Photo Location:
410 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 28

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 29

Photo Location:
410 Fox Shores Drive

Direction:
East

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 30

Photo Location:
390/400 Bicentennial Court

Direction:
Northwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 31

Photo Location:
380 Bicentennial Court

Direction:
Southeast

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 32

Photo Location:
380 Bicentennial Court

Direction:
Northeast

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 33 **Photo Location:** 410 Fox Shores Drive **Direction:** North **Survey Date:** 7/28/2021 **Comments:** Lanscaping With Gravel Cap	
Photograph ID: 34 **Photo Location:** 410 Fox Shores Drive **Direction:** Northeast **Survey Date:** 7/28/2021 **Comments:** Lanscaping With Gravel Cap	

State of Wisconsin
Department of Natural Resources
dnr.wi.gov

Continuing Obligations Inspection and Maintenance Log

Form 4400-305 (R 7/20)

Directions: In accordance with s. NR 727.05 (1) (b) 3., Wis. Adm. Code, use of this form for documenting the inspections and maintenance of certain continuing obligations is required. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Public Records law [ss. 19.31-19.39, Wis. Stats.]. When using this form, identify the condition that is being inspected. See the closure approval letter for this site for requirements regarding the submittal of this form to the Department of Natural Resources. A copy of this inspection log is required to be maintained either on the property, or at a location specified in the closure approval letter. Do NOT delete previous inspection results. This form was developed to provide a continuous history of site inspection results. The Department of Natural Resources project manager is identified in the closure letter. The project manager may also be identified from the database, BRRTS on the Web, at http://dnr.wi.gov/botw/SetUpBasicSearchForm.do, by searching for the site using the BRRTS ID number, and then looking in the "Who" section.

Activity (Site) Name	BRRTS No.
Fox Shores Apartments	02-45-582746

Inspections are required to be conducted (see closure approval letter):

- (•) annually
- ( ) semi-annually
- ( ) other – specify _____

When submittal of this form is required, submit the form electronically to the DNR project manager. An electronic version of this filled out form, or a scanned version may be sent to the following email address (see closure approval letter):

Inspection Date	Inspector Name	Item	Describe the condition of the item that is being inspected	Recommendations for repair or maintenance	Previous recommendations implemented?	Photographs taken and attached?
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N

{Click to Add/Edit Image}

Date added:

Title:

{Click to Add/Edit Image}

Date added:

Title:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Case Closure

SUBMIT AS UNBOUND PACKAGE IN THE ORDER SHOWN

Notice: Pursuant to ch. 292, Wis. Stats., and chs. NR 726 and 746, Wis. Adm. Code, this form is required to be completed for case closure requests. The closure of a case means that the Department of Natural Resources (DNR) has determined that no further response is required at that time based on the information that has been submitted to the DNR. All sections of this form must be completed unless otherwise directed by the Department. DNR will consider your request administratively complete when the form and all sections are completed, all attachments are included, and the applicable fees required under ch. NR 749, Wis. Adm. Code, are included, and sent to the proper destinations. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Open Records Law (ss. 19.31 - 19.39, Wis. Stats.). Incomplete forms will be considered "administratively incomplete" and processing of the request will stop until required information is provided.

Site Information

BRRTS No.	VPLE No.
02-45-582746	

Parcel ID No.

#323040800, #323040801, #323040802, #323040804

FID No.	WTM Coordinates X	WTM Coordinates Y
	657622.2	424528.6

BRRTS Activity (Site) Name

Fox Shores Apartments

WTM Coordinates Represent: ☐ Source Area ☒ Parcel Center

Site Address	City	State	ZIP Code
400/410 Fox Shores Dr.; 380/400 Bicentennial	Kaukauna	WI	54130

Acres Ready For Use

3.86

Responsible Party (RP) Name

Thomas Vandeyacht

Company Name

Fox Investments LLC

Mailing Address	City	State	ZIP Code
2220 N Lynndale Drive	Appleton	WI	54914

Phone Number	Email
(920) 213-7145	

☐ Check here if the RP is the owner of the source property.

Environmental Consultant Name

Jeffrey R. Brand

Consulting Firm

Stantec Consulting Services Inc.

Mailing Address	City	State	ZIP Code
1165 Scheuring Road	De Pere	WI	54115

Phone Number	Email
(920) 592-8400	jeff.brand@stantec.com

Fees and Mailing of Closure Request

1. **Send a copy of page one** of this form and the applicable ch. NR 749, Wis. Adm. Code, fee(s) to the DNR Regional EPA (Environmental Program Associate) at **http://dnr.wi.gov/topic/Brownfields/Contact.html#tabx3**. Check all fees that apply:

   ☒ $1,050 Closure Fee

   ☒ $350 Database Fee for Groundwater or Monitoring Wells (Not Abandoned)

   ☒ $300 Database Fee for Soil

   Total Amount of Payment $ $1,700.00

   ☐ Resubmittal, Fees Previously Paid

2. **Send one paper copy and one e-copy on compact disk of the entire closure package** to the Regional Project Manager assigned to your site. Submit as *unbound, separate documents* in the order and with the titles prescribed by this form. For electronic document submittal requirements, see **http://dnr.wi.gov/files/PDF/pubs/rr/RR690.pdf**.

Site Summary

If any portion of the Site Summary Section is not relevant to the case closure request, you must fully explain the reasons why in the relevant section of the form. All information submitted shall be legible. Providing illegible information will result in a submittal being considered incomplete until corrected.

1. General Site Information and Site History

A. Site Location: Describe the physical location of the site, both generally and specific to its immediate surroundings.
The Property consists of four parcels comprising approximately 3.86 acres to the north and west of Fox Shores Drive within the City of Kaukauna, Outagamie County, Wisconsin (SE 1/4 of the NE 1/4 of Section 23, T21N, R18E). Surrounding land uses consist of a mix of commercial and residential properties. The Property is currently occupied by River Ridge Apartments (formerly Fox Shores Apartments) for residential use. Current Property addresses consists of 400/410 Fox Shores Drive and 380/400 Bicentennial Court.

B. Prior and current site usage: Specifically describe the current and historic occupancy and types of use.
According to historical sources, the Property was developed as early as the 1890s. The Property and vicinity were developed as part of the Chicago and Northwest Railroad Shops. Areas of the Site were formerly utilized as a carpentry shop, machine shop, repair shop, engine room, coal room, blacksmith shop, supply warehouses, tin shop, and pipe shed. In 1983 the Property was redeveloped into multi-family residential apartments along Bicentennial Court. Additional apartments were later developed along Fox Shores Drive in 1992. The Property is currently occupied by River Ridge Apartments (formerly Fox Shores Apartments) and used for residential purposes.

C. Current zoning (e.g., industrial, commercial, residential) for the site and for neighboring properties, and how verified (Provide documentation in Attachment G).
Current zoning for the for the Site is Commercial Core (CCD) per October 1985 City of Kaukauna Zoning Map. Neighboring properties are denoted as Residential Multi-Family to the west, and Institutional to the south and east.

D. Describe how and when site contamination was discovered.
Partner Engineering and Science, Inc. (Partner) completed a Phase I Environmental Site Assessment (ESA) at the Property during July 2018. Several recognized environmental conditions (RECs) were identified during the Phase I ESA. To evaluate the RECs, a Phase II ESA was performed by Partner at the Property in November of 2018. As part of the Phase II ESA, five soil borings were completed for the collection of representative soil and groundwater samples along with the installation of three temporary sub-slab vapor sampling points. The Phase II ESA identified Resource Conservation and Recovery Act (RCRA) metals in soil at concentrations in excess of Wisconsin Administrative Code (Wis. Adm. Code) ch. NR720 residual contaminant levels (RCLs). Polynuclear aromatic hydrocarbons (PAHs) were also detected in the groundwater in excess of the Wis. Adm. Code ch. NR140 preventive action limit (PAL) and/or enforcement standards (ES) at the Site. Finally, dichlorodifluoromethane was detected above Wisconsin Department of Natural Resources (WDNR) residential sub-slab vapor risk screening levels.

E. Describe the type(s) and source(s) or suspected source(s) of contamination.
Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select volatile organic compounds (VOCs) exceeding Wis. Adm. Code ch. NR 720 RCLs for protection of groundwater. Various RCRA metals and PAHs were also detected in some samples above their respective industrial and non-industrial direct contact RCLs. Contaminants are believed to be the result of historical fill deposited across the site and the historic use of the site as a rail yard.

F. Other relevant site description information (or enter Not Applicable).
Not Applicable.

G. List BRRTS activity/site name and number for BRRTS activities at this source property, including closed cases.
02-45-582746 Fox Shores Apartments

H. List BRRTS activity/site name(s) and number(s) for all properties immediately adjacent to (abutting) this source property.
02-45-547911 Ghost Town Fitness Center; 02-45-589028 Chicago & Northwestern Railyard (Former); 02-45-548419 USACE - Parcel J (Kaukauna Power Canal)

2. General Site Conditions

A. Soil/Geology

i. Describe soil type(s) and relevant physical properties, thickness of soil column across the site, vertical and lateral variations in soil types.

Subsurface strata encountered in borings generally consisted of approximately three inches of asphalt or 1.5 to 2 feet of topsoil underlain by 0.5 to 2 feet of fine black sand and gravel underlain by 5 to 6 feet of silty clay.

ii. Describe the composition, location and lateral extent, and depth of fill or waste deposits on the site.

The results of the Phase II ESA and Site Investigation activities indicate that widespread historic fill consisting of sand and gravel is present across the entire Property at depths of up to 4 feet below ground surface (bgs). Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select VOCs exceeding Wis. Adm. Code ch. NR 720 RCLs for protection of groundwater. Various RCRA metals and PAHs were also detected in some samples above their respective industrial and non-industrial direct contact RCLs.

iii. Describe the depth to bedrock, bedrock type, competency and whether or not it was encountered during the investigation.

The bedrock in Outagamie County typically consists of dolomite, limestone, and shale of the Galena Formation of the Sinnipee Group (Luczaj, 2011). Depth to bedrock is estimated to exist between 5 and 50 feet bgs. Bedrock was not believed to be encountered during this investigation of the Property. Geoprobe drilling hit refusals at depths of 10 feet below grade. However, refusal was assumed to be within fractured bedrock or just above it as more competent bedrock is known to be present at depths of 13 to 18 feet below grade according to WDNR well construction records for wells constructed southeast of the Site.

iv. Describe the nature and locations of current surface cover(s) across the site (e.g., natural vegetation, landscaped areas, gravel, hard surfaces, and buildings).

Environmental actions associated with the presence of impacted soil/fill material at the Site are considered complete and are consistent with the 2021 Remedial Action Plan (RAP) and Material Management Plan (MMP). Select landscape areas across the Site were excavated to a maximum depth of one foot bgs. These areas were subsequently capped with an engineered geotextile fabric followed by 12 inches of clean soil and re-vegetated. Excavated impacted soils were redeposited back on-site as landscaped berms.

The berms were capped with engineered geotextile fabric followed by 12 inches of clean soil and re-vegetated. Remaining impacted soil areas are capped with gravel, or an impermeable surface such as building, sidewalk, or asphalt parking lot.

B. Groundwater

i. Discuss depth to groundwater and piezometric elevations. Describe and explain depth variations, including high and low water table elevation and whether free product affects measurement of water table elevation. Describe the stratigraphic unit(s) where water table was found or which were measured for piezometric levels.

The depth to groundwater was observed in temporary monitoring wells located on-site from approximately 3.5 to 6 feet bgs. No free product was detected in any of the temporary monitoring wells.

ii. Discuss groundwater flow direction(s), shallow and deep. Describe and explain flow variations, including fracture flow if present.

Regional shallow groundwater was determined to flow southeast along the Fox River, however, Site groundwater flow was found to follow a more southerly flow.

iii. Discuss groundwater flow characteristics: hydraulic conductivity, flow rate and permeability, or state why this information was not obtained.

While not calculated for the Site, hydraulic conductivity is considered to be low due to the silty clay substrate encountered during the Site Investigation.

iv. Identify and describe locations/distance of potable and/or municipal wells within 1200 feet of the site. Include general summary of well construction (geology, depth of casing, depth of screened or open interval).

Potable water at the Site is obtained from the City of Kaukauna municipal water system which is supplied by five groundwater wells located throughout the city. Depths of the wells range from 500 to 850 feet deep. None of the municipal wells are located within 1,200 feet of the Site.

3. Site Investigation Summary

A. General

i. Provide a brief summary of the site investigation history. Reference previous submittals by name and date. Describe site investigation activities undertaken since the last submittal for this project and attach the appropriate documentation in Attachment C, if not previously provided.

Partner completed a Phase I ESA at the Property during July 2018. Several RECs were identified during the Phase I ESA. To evaluate the RECs, a Phase II ESA was performed by Partner at the Property in November of 2018. As part of the Phase II ESA, five soil borings were completed for the collection of representative soil and groundwater samples along with the installation of three temporary sub-slab vapor sampling points. The Phase II ESA identified RCRA metals in soil at concentrations in excess of Wis. Adm. Code ch. NR720 RCLs. PAHs were also detected in the groundwater in excess of the Wis. Adm. Code ch. NR140 PAL and/or ES at the Site. Finally, dichlorodifluoromethane was detected above WDNR residential sub-slab vapor risk screening levels.

On December 3, 2018 Stantec was hired by Fox Investments, LLC to notify the WDNR of soil and groundwater contamination at the Site and possible vapor intrusion of dichlorodifluoromethane into Site buildings. On January 7, 2019, the WDNR opened BRRTS case #02-45-582746 for the Site and requested additional investigation to further characterize and define the extent of contamination at the Site and complete remedial actions needed for Site closure.

On February 25, 2019 Stantec conducted ambient air sampling within three apartment units. On February 26, 2019, Stantec personnel installed three sub-slab vapor points (VP-4, VP-5, and VP-6) within the same three apartment units where the ambient air samples were collected. An additional vapor point was also installed immediately adjacent to original vapor point (VP-2) from the November 2018 Phase II ESA completed by Partner.

On August 13, 2019, Stantec conducted additional sub-slab vapor sampling at vapor points VP-4, VP-5, and VP-6 within three apartment units at the Site. Samples were collected within the cooling months of summer to contrast earlier samples collected during the heating months of winter. Vapor samples were again sampled for dichlorodifluoromethane using EPA method TO-15.

With elevated dichlorodifluoromethane sub-slab concentrations at the Site, a source for the contamination was investigated. In order to determine a source for the sub-slab vapor issues at the Site, soil and groundwater investigation activities were conducted across the Site from May 2019 to April 2020. The results of these activities indicated the presence of widespread historic urban fill consisting of clay and sand/gravel across the Property at depths of up to three feet below ground surface. The sand and gravel fill were underlain by native silty clays. Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select VOCs exceeding Wis. Adm. Code ch. NR 720 RCLs for protection of groundwater. Various RCRA metals and PAHs were also detected in some samples above their respective industrial and non-industrial direct contact RCLs.

Due to the lack of dichlorodifluoromethane in soil samples collected at the Site, Stantec and the property owner continued to search for potential sources for the vapor intrusion issues. Upon further investigation, it was discovered that extruded polystyrene foam board was used as insulation on the interior foundation walls of the apartment buildings. It was further determined that dichlorodifluoromethane was a component that made up the extruded polystyrene foam insulation.

After determining that the extruded polystyrene foam board used on the apartment building's foundation walls could potentially be the source of the vapor intrusion issues at the Site, discussions were conducted with the WDNR. During those discussions, it was determined that construction/building materials are unregulated and that a subsequent release from these materials would not warrant further vapor assessment or require remedial action to be conducted.

During investigative activities, three rounds of groundwater sampling were completed. Groundwater analysis of water samples collected at the Property detected arsenic in three of the five temporary monitoring wells exceeding their respective Wis. Adm. Code ch. NR 140 PALs. Benzo(a)pyrene, benzo(b)fluoranthene, and/or chrysene were also identified within three temporary monitoring wells above the PAL with benzo(a)pyrene and benzo(b)fluoranthene above the ES during the most recent round of sampling at TW17. However, these were likely the result of colloidal material present in the sample from fine grained sediments surrounding the temporary well screen. No VOCs were detected in groundwater samples collected exceeding either the PAL or ES. Based on sampling results, it did not appear that contaminants in soil were significantly affecting groundwater quality at the Property. The results of the site investigation activities were submitted to the WDNR during June 2020. Based on the investigation activities completed to date, the WDNR indicated that the entire Property was impacted to some degree and required that contaminant concentrations in soil that exceed respective groundwater protection and/or direct contact RCLs be addressed.

On September 18, 2020, Stantec submitted a RAP to the WDNR proposing the excavation and capping of contaminated soil on the Site. Excavated soils unable to be reused on-site were proposed to be placed on the Adjacent Parcel under a low hazard exemption request. The low hazard exemption request was subsequently denied. As an alternative, the WDNR requested that soil investigation activities be completed on the Adjacent Parcel to determine if similar contaminants exist to those present on the Site. Laboratory analysis of shallow soil samples (0-4 feet bgs) collected from the Adjacent Parcel detected multiple RCRA metals, PAHs, and naphthalene exceeding the Wis. Adm. Code ch. NR720 RCLs for groundwater protection and/or non-industrial direct contact. Benzo(a)pyrene and arsenic were also detected in soil above the industrial direct contact RCL. Based on the sampling results, contaminants at the Adjacent Parcel were consistent with those generally observed in shallow soil at the Site. The Adjacent Parcel was subsequently added to the open BRRTS case for Fox Shores Apartments.

ii. Identify whether contamination extends beyond the source property boundary, and if so describe the media affected (e.g., soil, groundwater, vapors and/or sediment, etc.), and the vertical and horizontal extent of impacts.

Further investigation beyond the property lines was not warranted since contamination is likely related to the presence of historic fill which is widespread in this portion of the City and widespread throughout the area.

iii. Identify any structural impediments to the completion of site investigation and/or remediation and whether these impediments are on the source property or off the source property. Identify the type and location of any structural impediment (e.g., structure) that also serves as the performance standard barrier for protection of the direct contact or the groundwater pathway.

No structural impediments hindered investigation or remediation of the Site.

B. Soil

i. Describe degree and extent of soil contamination. Relate this to known or suspected sources and known or potential receptors/migration pathways.

Widespread historic urban fill consisting of clay and sand/gravel is present across the Property at depths of up to 3 feet bgs. The fill is underlain by native silty clay. Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select VOCs exceeding Wis. Adm. Code ch. NR 720 RCLs for protection of groundwater. Likewise, various RCRA metals and PAHs also were detected in samples above their respective industrial and non-industrial direct contact RCLs. Soil contamination is assumed to extend site-wide. Contaminants are believed to be the result of historical fill deposited across the site and the historic use of the site as a rail yard.

ii. Describe the concentration(s) and types of soil contaminants found in the upper four feet of the soil column.

Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select VOCs exceeding Wis. Adm. Code ch. NR 720 RCLs for protection of groundwater. Likewise, various RCRA metals and PAHs also were detected in samples above their respective industrial and non-industrial direct contact RCLs.

iii. Identify the ch. NR 720, Wis. Adm. Code, method used to establish the soil cleanup standards for this site. This includes a soil performance standard established in accordance with s. NR 720.08, a Residual Contaminant Level (RCL) established in accordance with s. NR 720.10 that is protective of groundwater quality, or an RCL established in accordance with s. NR 720.12 that is protective of human health from direct contact with contaminated soil. Identify the land use classification that was used to establish cleanup standards. Provide a copy of the supporting calculations/ information in Attachment C.

Stantec utilized the standard ch. NR 720, Wis. Adm. Code RCLs provided by the WDNR in spreadsheet form. The Wis. Adm. Code ch. NR 720, RCLs were most recently updated by the WDNR during December 2018.

C. Groundwater

i. Describe degree and extent of groundwater contamination. Relate this to known or suspected sources and known or potential receptors/migration pathways. Specifically address any potential or existing impacts to water supply wells or interception with building foundation drain systems.

Groundwater analysis of water samples collected at the Property detected arsenic in four of the five temporary monitoring wells (TW11, TW15, TW17) exceeding the respective Wis. Adm. Code ch. NR 140 PAL.

Groundwater sampling results also detected benzo(a)pyrene and benzo(b)fluoranthene exceeding their respective Wis. Adm. Code ch. NR 140 ES and chrysene above the respective Wis. Adm. Code ch. NR 140, PAL in temporary monitoring well TW17. No VOCs were detected exceeding either the PAL or ES. Based on sampling results, it does not appear that identified soil contamination is significantly affecting groundwater quality at the Property.

ii. Describe the presence of free product at the site, including the thickness, depth, and locations. Identify the depth and location of the smear zone.

No free product was observed during groundwater sampling.

D. Vapor

i. Describe how the vapor migration pathway was assessed, including locations where vapor, soil gas, or indoor air samples were collected. If the vapor pathway was not assessed, explain reasons why.

A Phase II ESA was performed by Partner at the Property in November of 2018. As part of the Phase II ESA, five soil borings were completed for the collection of representative soil and groundwater samples along with the installation of three temporary sub-slab vapor sampling points. Dichlorodifluoromethane was detected above WDNR residential sub-slab vapor risk screening levels.

On December 3, 2018 Stantec was hired by Fox Investments, LLC to notify the WDNR of soil and groundwater contamination at the Site and possible vapor intrusion of dichlorodifluoromethane into Site buildings. On January 7, 2019, the WDNR opened BRRTS case #02-45-582746 for the Site and requested additional investigation to further characterize and define the extent of contamination at the Site and complete remedial actions needed for Site closure. Due to the potential health threat of vapor intrusion, the WDNR requested that immediate actions be taken to investigate potential vapor intrusion impacts within the apartments at the Site.

On February 25, 2019 Stantec conducted ambient air sampling within three apartment units. On February 26, 2019, Stantec personnel installed three sub-slab vapor points (VP-4, VP-5, and VP-6) within the same three apartment units where the ambient air samples were collected. An additional vapor point was also installed immediately adjacent to original vapor point (VP-2) from the November 2018 Phase II ESA completed by Partner.

On August 13, 2019 Stantec conducted additional sub-slab vapor sampling at vapor points VP-4, VP-5, and VP-6 within three apartment units at the Site. Samples were collected within the cooling months of summer to contrast earlier samples collected during the heating months of winter. Vapor samples were again sampled for dichlorodifluoromethane using EPA method TO-15.

With elevated dichlorodifluoromethane sub-slab concentrations at the Site, a source for the contamination was investigated. In order to determine a source for the sub-slab vapor issues at the Site, soil and groundwater investigation activities were conducted across the Site from May 2019 to April 2020.

Due to the lack of dichlorodifluoromethane in soil samples collected at the Site, Stantec and the property owner continued to search for potential sources for the vapor intrusion issues. Upon further investigation, it was discovered that extruded polystyrene foam board was used as insulation on the interior foundation walls of the apartment buildings. It was further determined that dichlorodifluoromethane was a component that made up the extruded polystyrene foam insulation.

After determining that the extruded polystyrene foam board used on the apartment building's foundation walls could potentially be the source of the vapor intrusion issues at the Site, discussions were conducted with the WDNR. During those discussions, it was determined that construction/building materials are unregulated and that a subsequent release from these materials would not warrant further vapor assessment or require remedial action to be conducted.

ii. Identify the applicable DNR action levels and the land use classification used to establish them. Describe where the DNR action levels were reached or exceeded (e.g., sub slab, indoor air or both).

Not applicable. It was discovered that extruded polystyrene foam board was used as insulation on the interior foundation walls of the apartment buildings. It was further determined that dichlorodifluoromethane was a component that made up the extruded polystyrene foam insulation. Following this discovery, discussions were conducted with the WDNR which led to the determination that construction/building materials are unregulated and that a subsequent release from these materials would not warrant further vapor assessment or require remedial action to be conducted.

E. Surface Water and Sediment

i. Identify whether surface water and/or sediment was assessed and describe the impacts found. If this pathway was not assessed, explain why.

No surface water or sediment was assessed. No surface water or sediments exist on the Property. Site is covered by buildings, asphalt, concrete, gravel, and established grassy landscaped areas. Even though the site is adjacent to the Fox River, impacted soils are not likely to have migrated off-site to the river with the existing covers in place. In addition, adjacent areas of the Fox River are fast moving with little to no sediment existing in which to adequately sample.

ii. Identify any surface water and/or sediment action levels used to assess the impacts for this pathway and how these were derived. Describe where the DNR action levels were reached or exceeded.

Not Applicable. No surface water or sediments exist on the Property.

4. Remedial Actions Implemented and Residual Levels at Closure

A. General: Provide a brief summary of the remedial action history. List previous remedial action report submittals by name and date. Identify remedial actions undertaken since the last submittal for this project and provide the appropriate documentation in Attachment C.

On February 24, 2021, Stantec submitted a revised RAP and MMP to the WDNR to manage, redeposit, and cap excavated soil at the Site. The RAP and MMP was approved by the WDNR on June 2, 2021. The MMP outlined a strategy where all landscape areas across the Site were considered impacted and would either be excavated to a depth of 1-foot bgs and capped or have excavated soils redeposited on existing landscape areas and capped. The soil cap would consist of engineered geotextile fabric underlying twelve inches of clean fill and/or topsoil in the landscaped areas. Areas with an engineered cap (i.e., building, asphalt, concrete) would not be modified.

Prior to the start of remedial activities, all temporary monitoring wells (TW10, TW11, TW13, TW15, TW17) were located and abandoned in accordance with Wis. Adm. Code ch. NR 141. On June 30, 2021, Bartel Excavating, LLC and Versatile Lawn and Landscaping Inc. mobilized to the Site to begin remedial excavation activities. Silt fence and/or silt socks were installed along the eastern property boundary as well as areas surrounding the designated soil fill locations on-Site. Select landscape areas across the Site were excavated to a maximum depth of 1-foot bgs. Excavated soils were placed in one of four designated fill locations to create landscape berms. Excavated soils were generally placed within the closest fill area to prevent tracking of contaminated soils across the Site.

As excavation activities proceeded, several minor adjustments were made to the MMP. Upon visual inspection of the terrace area west of Fox Shores Drive, it was decided that no excavated soil would be deposited within it. Due to the narrow width of the area, a berm would not have been aesthetically pleasing nor have been practical to maintain as proposed. Therefore, the area was redesignated as an excavation area with contaminated soils being redeposited within the soil fill area located on the northeast portion of the Site.

In addition, the gravel area located north of the Ghost Town Fitness Center parking lot was not excavated. This area is

comprised of 8-10 inches of compacted gravel and has been used in the past as overflow parking for the fitness center. Due to the location and general use of the area, the gravel was left in place to act as a barrier to potentially contaminated soils beneath.

Likewise, the Fox Shores Apartment complex maintains several established landscape areas with mature plantings consisting of shrubs, bushes, and/or perennials. These locations were generally located immediately adjacent to the apartment buildings as well as near the garage units for the Fox Shores Drive apartments located on the northern portion of the Site. Because of the small size, accessibility, and established plantings within these landscape areas, no soil was excavated. The landscape areas, however, are currently capped with a minimum of 6 inches of decorative landscape gravel between the plantings.

Remedial excavation and redepositing of contaminated soils in landscape berms was completed on September 9, 2021. Remedial excavation activities generated approximately 1,230 cubic yards of RCRA metal, PAH, and VOC impacted soil which was redeposited on-site as landscaped berms. The depth of placed fill material ranged from six inches between the Bicentennial Court apartment buildings to a maximum depth of 2.5 feet above existing ground surface on the eastern portion of the Site. The soil fill areas were later capped with an engineered geotextile fabric followed by 12 inches of clean soil and reseeded.

On November 19, 2021, Stantec submitted a Remedial Actions Report documenting contaminated soil excavation, redeposition, and Site capping completed as a part of remedial actions. Remedial actions were completed according to the WDNR approved MMP. Remedial actions included documenting the excavation and redeposition of contaminated materials and placement of a cap existing of an engineered geotextile fabric followed by 12 inches of clean soil clean soil. Remaining soil contamination capped under BRRTS case (#02-45-582746) for the Fox Shores Apartments Site is the subject of this closure request.

B. Describe any immediate or interim actions taken at the site under ch NR 708, Wis. Adm. Code.
Not Applicable - No immediate or interim actions taken at the Property.

C. Describe the *active* remedial actions taken at the source property, including: type of remedial system(s) used for each media affected; the size and location of any excavation or in-situ treatment; the effectiveness of the systems to address the contaminated media and substances; operational history of the systems; and summarize the performance of the active remedial actions. Provide any system performance documentation in Attachment A.7.
Not Applicable - No active remediation systems utilized for the Property.

D. Describe the alternatives considered during the Green and Sustainable Remediation evaluation in accordance with NR 722.09 and any practices implemented as a result of the evaluation.
The remedial actions including the management of impacted materials on-site and capping the material in place which is considered a Green and Sustainable Remediation practice.

E. Describe the nature, degree and extent of residual contamination that will remain at the source property or on other affected properties after case closure.
VOC, RCRA metal, and PAH impacted soils remain across the entire Property. All landscape areas were either excavated to a depth of 1-foot bgs and capped or have excavated soils redeposited on existing landscape areas and capped. The soil cap consists of engineered geotextile fabric underlying twelve inches of clean fill and/or topsoil in the landscaped areas. Remaining areas across the Site without the soil cap are capped with an engineered cap (i.e., gravel, building, asphalt, concrete).

F. Describe the residual soil contamination within four feet of ground surface (direct contact zone) that attains or exceeds RCLs established under s. NR 720.12, Wis. Adm. Code, for protection of human health from direct contact.
Various RCRA metals and PAHs were detected in samples above their respective industrial and non-industrial direct contact RCLs. Soil contamination is assumed to extend site-wide. All landscape areas were either excavated to a depth of 1-foot bgs and capped or have excavated soils redeposited on existing landscape areas and capped. The soil cap consists of engineered geotextile fabric underlying twelve inches of clean fill and/or topsoil in the landscaped areas. Remaining areas without the soil cap are capped with an engineered cap (i.e., gravel, building, asphalt, concrete).

G. Describe the residual soil contamination that is above the observed low water table that attains or exceeds the soil standard(s) for the groundwater pathway.
Laboratory analysis of soil samples collected from the Site reported RCRA metals, PAHs, and select VOCs exceeding Wis. Adm. Code ch. NR 720 RCLs for protection of groundwater. Various RCRA metals and PAHs were also detected in some samples above their respective industrial and non-industrial direct contact RCLs. Soil contamination is assumed to extend site-wide. All landscape areas across the Site were either excavated to a depth of 1-foot bgs and capped or have excavated soils redeposited on existing landscape areas and capped. The soil cap consists of engineered geotextile fabric underlying twelve inches of clean fill and/or topsoil in the landscaped areas. Remaining areas across the Site without the soil cap are capped with an engineered cap (i.e., gravel, building, asphalt, concrete).

H. Describe how the residual contamination will be addressed, including but not limited to details concerning: covers, engineering controls or other barrier features; use of natural attenuation of groundwater; and vapor mitigation systems or measures.

Natural attenuation will be used to address remaining groundwater contamination.

I. If using natural attenuation as a groundwater remedy, describe how the data collected supports the conclusion that natural attenuation is effective in reducing contaminant mass and concentration (e.g., stable or receding groundwater plume).

As of the most recent round of quarterly groundwater sampling, benzo(a)pyrene and benzo(b)fluoranthene concentrations remain above the ES and chrysene concentrations remain above the PAL in TW17. Arsenic concentrations remain above the PAL in TW11, TW15, and TW17. PAH contamination in groundwater likely appears to be a product of fine sediment resulting from silty clay and sandy soils found at the Site along with the limitations of temporary monitoring wells.

In addition, elevated PAH concentrations in soil do not appear to translate to elevated concentrations in groundwater. For example, benzo(a)pyrene concentrations in soil samples collected from borings SB11 and SB17 were found to be in excess of industrial direct contact RCLs. However, no PAHs were detected in water samples collected from temporary monitoring well TW11 and concentrations of PAHs in TW17 were found to be just above the ES. This was also the case for benzo(b) fluoranthene concentrations found above non-industrial direct contact concentrations in borings SB11 and SB17. Therefore, based on sampling results, it does not appear that contaminants in soil are significantly affecting groundwater quality at the Property. No further groundwater monitoring appears to be necessary.

J. Identify how all exposure pathways (soil, groundwater, vapor) were removed and/or adequately addressed by immediate, interim and/or remedial action(s).

Environmental actions associated with the presence of impacted soil/fill material at the Site are considered complete and are consistent with the 2021 RAP and MMP. Select landscape areas across the Site were excavated to a maximum depth of one foot bgs. These areas were subsequently capped with an engineered geotextile fabric followed by 12 inches of clean soil and re-vegetated. Excavated impacted soils were redeposited back on-site as landscaped berms. The berms were capped with engineered geotextile fabric followed by 12 inches of clean soil and re-vegetated. Remaining impacted soil areas are capped with 6-8" of gravel, or an impermeable surface such as building, sidewalk, or asphalt parking lot.

K. Identify any system hardware anticipated to be left in place after site closure, and explain the reasons why it will remain.

Not applicable. No remediation system built for the Site.

L. Identify the need for a ch. NR 140, Wis. Adm. Code, groundwater Preventive Action Limit (PAL) or Enforcement Standard (ES) exemption, and identify the affected monitoring points and applicable substances.

As of the most recent round of quarterly groundwater sampling, benzo(a)pyrene and benzo(b)fluoranthene concentrations remain above the ES and chrysene concentrations remain above the PAL in TW17. Arsenic concentrations remain above the PAL in TW11, TW15, and TW17.

M. If a DNR action level for vapor intrusion was exceeded (for indoor air, sub slab, or both) describe where it was exceeded and how the pathway was addressed.

Not applicable. It was discovered that extruded polystyrene foam board was used as insulation on the interior foundation walls of the apartment buildings. It was further determined that dichlorodifluoromethane was a component that made up the extruded polystyrene foam insulation. After determining that the extruded polystyrene foam board used on the apartment building's foundation walls could potentially be the source of the vapor intrusion issues at the Site, discussions were conducted with the WDNR. During those discussions, it was determined that construction/building materials are unregulated and that a subsequent release from these materials would not warrant further vapor assessment or require remedial action to be conducted.

N. Describe the surface water and/or sediment contaminant concentrations and areas after remediation. If a DNR action level was exceeded, describe where it was exceeded and how the pathway was addressed.

Not applicable. No surface water or sediment existing on-site.

5. Continuing Obligations: Includes all affected properties and rights-of-way (ROWs). In certain situations, maintenance plans are also required, and must be included in Attachment D.

Directions: For each of the 3 property types below, check all situations that apply to this closure request.

(NOTE: Monitoring wells to be transferred to another site are addressed in Attachment E.)

	This situation applies to the following property or Right of Way (ROW): Property Type:			Case Closure Situation - Continuing Obligation (database fees will apply, ii. - xiv.)	Maintenance Plan Required
	Source Property	Affected Property (Off-Source)	ROW		
i.	☐	☒	☒	None of the following situations apply to this case closure request.	NA
ii.	☒	☐	☐	Residual groundwater contamination exceeds ch. NR 140 ESs.	NA
iii.	☒	☐	☐	Residual soil contamination exceeds ch. NR 720 RCLs.	NA
iv.				Monitoring Wells Remain:	
	☐	☐	☐	• Not Abandoned (filled and sealed)	NA
	☐	☐	☐	• Continued Monitoring (requested or required)	Yes
v.	☒	☐	☐	Cover/Barrier/Engineered Cover or Control for (soil) direct contact pathways (includes vapor barriers)	Yes
vi.	☐	☐	☐	Cover/Barrier/Engineered Cover or Control for (soil) groundwater infiltration pathway	Yes
vii.	☐	☐	☐	Structural Impediment: impedes completion of investigation or remedial action (not as a performance standard cover)	NA
viii.	☐	☐	☐	Residual soil contamination meets NR 720 industrial soil RCLs, land use is classified as industrial	NA
ix.	☐	☐	NA	Vapor Mitigation System (VMS) required due to exceedances of vapor risk screening levels or other health based concern	Yes
x.	☐	☐	NA	Vapor: Dewatering System needed for VMS to work effectively	Yes
xi.	☐	☐	NA	Vapor: Compounds of Concern in use: full vapor assessment could not be completed	NA
xii	☐	☐	NA	Vapor: Commercial/industrial exposure assumptions used.	NA
xiii.	☐	☐	☐	Vapor: Residual volatile contamination poses future risk of vapor intrusion	NA
xiv.	☐	☐	☐	Site-specific situation: (e. g., fencing, methane monitoring, other) (*discuss with project manager before submitting the closure request*)	Site specific

6. Underground Storage Tanks

A. Were any tanks, piping or other associated tank system components removed as part of the investigation or remedial action? ○ Yes ◉ No

B. Do any upgraded tanks meeting the requirements of ch. ATCP 93, Wis. Adm. Code, exist on the property? ○ Yes ◉ No

C. If the answer to question 6.B. is yes, is the leak detection system currently being monitored? ○ Yes ○ No

General Instructions

All information shall be legible. Providing illegible information will result in a submittal being considered incomplete until corrected. For each attachment (A-G), provide a Table of Contents page, listing all 'applicable' and 'not applicable' items by Closure Form titles (e.g., A.1. Groundwater Analytical Table, A.2. Soil Analytical Results Table, etc.). If any item is 'not applicable' to the case closure request, you must fully explain the reasons why.

Data Tables (Attachment A)

Directions for Data Tables:

- Use **bold** and italics font for information of importance on tables and figures. Use **bold** font for ch. NR 140, Wis. Adm. Code ES attainments or exceedances, and *italicized font* for ch. NR 140, Wis. Adm. Code, PAL attainments or exceedances.
- Use **bold** font to identify individual ch. NR 720 Wis. Adm. Code RCL exceedances. Tables should also include the corresponding groundwater pathway and direct contact pathway RCLs for comparison purposes. Cumulative hazard index and cumulative cancer risk exceedances should also be tabulated and identified on Tables A.2 and A.3.
- Do not use shading or highlighting on the analytical tables.
- Include on Data Tables the level of detection for results which are below the detection level (i.e., do not just list as no detect (ND)).
- Include the units on data tables.
- Summaries of all data must include information collected by previous consultants.
- Do not submit lab data sheets unless these have not been submitted in a previous report. Tabulate all data required in s. NR 716.15 (3)(c), Wis. Adm. Code, in the format required in s. NR 716.15(4)(e), Wis. Adm. Code.
- Include in Attachment A all of the following tables, in the order prescribed below, with the specific Closure Form titles noted on the separate attachments (e.g., Title: A.1. Groundwater Analytical Table; A.2. Soil Analytical Results Table, etc.).
- For required documents, each table (e.g., A.1., A.2., etc.) should be a separate Portable Document Format (PDF).

A. Data Tables

A.1. **Groundwater Analytical Table(s):** Table(s) showing the analytical results and collection dates for all groundwater sampling points (e.g., monitoring wells, temporary wells, sumps, extraction wells, potable wells) for which samples have been collected.

A.2. **Soil Analytical Results Table(s):** Table(s) showing **all** soil analytical results and collection dates. Indicate if sample was collected above or below the observed low water table (unsaturated versus saturated).

A.3. **Residual Soil Contamination Table(s):** Table(s) showing the analytical results of only the residual soil contamination at the time of closure. This table shall be a subset of table A.2 and should include only the soil sample locations that exceed an RCL. Indicate if sample was collected above or below the observed low water table (unsaturated versus saturated). Table A.3 is optional only if a total of fewer than 15 soil samples have been collected at the site.

A.4. **Vapor Analytical Table(s)**: Table(s) showing type(s) of samples, sample collection methods, analytical method, sample results, date of sample collection, time period for sample collection, method and results of leak detection, and date, method and results of communication testing.

A.5. **Other Media of Concern (e.g., sediment or surface water)**: Table(s) showing type(s) of sample, sample collection method, analytical method, sample results, date of sample collection, and time period for sample collection.

A.6. **Water Level Elevations:** Table(s) showing all water level elevation measurements and dates from all monitoring wells. If present, free product should be noted on the table.

A.7. **Other:** This attachment should include: 1) any available tabulated natural attenuation data; 2) data tables pertaining to engineered remedial systems that document operational history, demonstrate system performance and effectiveness, and display emissions data; and (3) any other data tables relevant to case closure not otherwise noted above. If this section is not applicable, please explain the reasons why.

Maps, Figures and Photos (Attachment B)

Directions for Maps, Figures and Photos:

- Provide on paper no larger than 11 x 17 inches, unless otherwise directed by the Department. Maps and figures may be submitted in a larger electronic size than 11 x 17 inches, in a PDF readable by the Adobe Acrobat Reader. However, those larger-size documents must be legible when printed.
- Prepare visual aids, including maps, plans, drawings, fence diagrams, tables and photographs according to the applicable portions of ss. NR 716.15(4), 726.09(2) and 726.11(3), (5) and (6), Wis. Adm. Code.
- Include all sample locations.
- Contour lines should be clearly labeled and defined.
- Include in Attachment B all of the following maps and figures, in the order prescribed below, with the specific Closure Form titles noted on the separate attachments (e.g., Title: B.1. Location Map; B.2. Detailed Site Map, etc).
- For the electronic copies that are required, each map (e.g., B.1.a., B.2.a, etc.,) should be a separate PDF.
- Maps, figures and photos should be dated to reflect the most recent revision.

B.1. Location Maps

B.1.a. **Location Map:** A map outlining all properties within the contaminated site boundaries on a United States Geological Survey (U.S.G.S.) topographic map or plat map in sufficient detail to permit easy location of all affected and/or adjacent parcels. If groundwater standards are exceeded, include the location of all potable wells, including municipal wells, within 1200 feet of the area of contamination.

B.1.b. **Detailed Site Map:** A map that shows all relevant features (buildings, roads, current ground surface cover, individual property boundaries for all affected properties, contaminant sources, utility lines, monitoring wells and potable wells) within the contaminated area. This map is to show the location of all contaminated public streets, and highway and railroad rights-of-way in relation to the source property and in relation to the boundaries of groundwater contamination attaining or exceeding a ch. NR 140 ES, and/or in relation to the boundaries of soil contamination attaining or exceeding a RCL. Provide parcel identification numbers for all affected properties.

B.1.c. **RR Sites Map:** From RR Sites Map (http://dnrmaps.wi.gov/sl/?Viewer=RR Sites) attach a map depicting the source property, and all open and closed BRRTS sites within a half-mile radius or less of the property.

B.2. Soil Figures

B.2.a. **Soil Contamination:** Figure(s) showing the location of **all** identified unsaturated soil contamination. Use a single contour to show the horizontal extent of each area of contiguous soil contamination that exceeds a soil to groundwater pathway RCL as determined under ch. NR 720.Wis. Adm. Code. A separate contour line should be used to indicate the horizontal extent of each area of contiguous soil contamination that exceeds a direct contact RCL exceedances (0-4 foot depth).

B.2.b. **Residual Soil Contamination:** Figure(s) showing only the locations of soil samples where unsaturated soil contamination remains at the time of closure (locations represented in Table A.3). Use a single contour to show the horizontal extent of each area of contiguous soil contamination that exceeds a soil to groundwater pathway RCL as determined under ch. NR 720 Wis. Adm. Code. A separate contour line should be used to indicate the horizontal extent of each area of contiguous soil contamination that exceeds a direct contact RCL exceedence (0-4 foot depth).

B.3. Groundwater Figures

B.3.a. **Geologic Cross-Section Figure(s):** One or more cross-section diagrams showing soil types and correlations across the site, water table and piezometric elevations, and locations and elevations of geologic rock units, if encountered. Display on one or more figures all of the following:

- Source location(s) and vertical extent of residual soil contamination exceeding an RCL. Distinguish between direct contact and the groundwater pathway RCLs.
- Source location(s) and lateral and vertical extent if groundwater contamination exceeds ch. NR 140 ES.
- Surface features, including buildings and basements, and show surface elevation changes.
- Any areas of active remediation within the cross section path, such as excavations or treatment zones.
- Include a map displaying the cross-section location(s), if they are not displayed on the Detailed Site Map (Map B.1.b.)

B.3.b. **Groundwater Isoconcentration:** Figure(s) showing the horizontal extent of the post-remedial groundwater contamination exceeding a ch. NR 140, Wis. Adm. Code, PAL and/or an ES. Indicate the date and direction of groundwater flow based on the most recent sampling data.

B.3.c. **Groundwater Flow Direction:** Figure(s) representing groundwater movement at the site. If the flow direction varies by more than 20° over the history of the site, submit two groundwater flow maps showing the maximum variation in flow direction.

B.3.d. **Monitoring Wells:** Figure(s) showing all monitoring wells, with well identification number. Clearly designate any wells that: (1) are proposed to be abandoned; (2) cannot be located; (3) are being transferred; (4) will be retained for further sampling, or (5) have been abandoned.

B.4. Vapor Maps and Other Media

B.4.a. **Vapor Intrusion Map:** Map(s) showing all locations and results for samples taken to investigate the vapor intrusion pathway in relation to residual soil and groundwater contamination, including sub-slab, indoor air, soil vapor, soil gas, ambient air, and communication testing. Show locations and footprints of affected structures and utility corridors, and/or where residual contamination poses a future risk of vapor intrusion.

B.4.b. **Other media of concern (e.g., sediment or surface water):** Map(s) showing all sampling locations and results for other media investigation. Include the date of sample collection and identify where any standards are exceeded.

B.4.c. **Other:** Include any other relevant maps and figures not otherwise noted above. (This section may remain blank).

B.5. Structural Impediment Photos: One or more photographs documenting the structural impediment feature(s) which precluded a complete site investigation or remediation at the time of the closure request. The photographs should document the area that could not be investigated or remediated due to a structural impediment. The structural impediment should be indicated on Figures B.2.a and B.2.b.

Documentation of Remedial Action (Attachment C)

Directions for Documentation of Remedial Action:

- Include in Attachment C all of the following documentation, in the order prescribed below, with the specific Closure Form titles noted on the separate attachments (e.g., Title: C.1. Site Investigation Documentation; C.2. Investigative Waste, etc.).
- If the documentation requested below has already been submitted to the DNR, please note the title and date of the report for that particular document requested.

C.1. **Site investigation documentation,** that has not otherwise been submitted with the Site Investigation Report.

C.2. **Investigative waste** disposal documentation.

C.3. Provide a **description of the methodology** used along with all supporting documentation if the RCLs are different than those contained in the Department's RCL Spreadsheet available at: http://dnr.wi.gov/topic/Brownfields/Professionals.html.

C.4. **Construction documentation** or as-built report for any constructed remedial action or portion of, or interim action specified in s. NR 724.02(1), Wis. Adm. Code.

C.5. **Decommissioning of Remedial Systems.** Include plans to properly abandon any systems or equipment.

C.6. **Other**. Include any other relevant documentation not otherwise noted above (This section may remain blank).

Maintenance Plan(s) and Photographs (Attachment D)

Directions for Maintenance Plans and Photographs:

Attach a maintenance plan for each affected property (source property, each off-source affected property) with continuing obligations requiring future maintenance (e.g., direct contact, groundwater protection, vapor intrusion). See Site Summary section 5 for all affected property(s) requiring a maintenance plan. Maintenance plan guidance and/or templates for: 1) Cover/barrier systems; 2) Vapor intrusion; and 3) Monitoring wells, can be found at: http://dnr.wi.gov/topic/Brownfields/Professionals.html#tabx3

D.1. **Descriptions of maintenance action(s) required for maximizing effectiveness of the engineered control, vapor mitigation system, feature or other action for which maintenance is required:**

- Provide brief descriptions of the type, depth and location of residual contamination.

- Provide a description of the system/cover/barrier/monitoring well(s) to be maintained.
- Provide a description of the maintenance actions required for maximizing effectiveness of the engineered control, vapor mitigation system, feature or other action for which maintenance is required.
- Provide contact information, including the name, address and phone number of the individual or facility who will be conducting the maintenance.

D.2. **Location map(s) which show(s):** (1) the feature that requires maintenance; (2) the location of the feature(s) that require(s) maintenance - on and off the source property; (3) the extent of the structure or feature(s) to be maintained, in relation to other structures or features on the site; (4) the extent and type of residual contamination; and (5) all property boundaries.

D.3. **Photographs** for site or facilities with a cover or other performance standard, a structural impediment or a vapor mitigation system, include one or more photographs documenting the condition and extent of the feature at the time of the closure request. Pertinent features shall be visible and discernible. Photographs shall be submitted with a title related to the site name and location, and the date on which it was taken.

D.4. **Inspection log**, to be maintained on site, or at a location specified in the maintenance plan or approval letter. The inspection and maintenance log is found at: http://dnr.wi.gov/files/PDF/forms/4400/4400-305.pdf.

Monitoring Well Information (Attachment E)

Directions for Monitoring Well Information:
For all wells that will remain in use, be transferred to another party, or that could not be located; attach monitoring well construction and development forms (DNR Form 4400-113 A and B: http://dnr.wi.gov/topic/groundwater/documents/forms/4400_113_1_2.pdf)

Select One:

◯ No monitoring wells were installed as part of this response action.

◉ All monitoring wells have been located and will be properly abandoned upon the DNR granting conditional closure to the site

◯ ***Select One or More:***

☐ Not all monitoring wells can be located, despite good faith efforts. Attachment E must include a description of efforts made to locate the wells.

☐ One or more wells will remain in use at the site after this closure. Attachment E must include documentation as to the reason (s) the well(s) will remain in use. When one or more monitoring wells will remain in use this is considered a continuing obligation and a maintenance plan will be required and must be included in Attachment D.

☐ One or more monitoring wells will be transferred to another owner upon case closure being granted. Attachment E should include documentation identifying the name, address and email for the new owner(s). Provide documentation from the party accepting future responsibility for monitoring well(s).

Source Legal Documents (Attachment F)

Directions for Source Legal Documents:
Label documents with the specific closure form titles (e.g., F.1. Deed, F.2. Certified Survey Map, etc.). Include all of the following documents, in the order listed:

F.1. **Deed:** The most recent deed with legal description clearly listed.

Note: *If a property has been purchased with a land contract and the purchaser has not yet received a deed, a copy of the land contract which includes the legal description shall be submitted instead of the most recent deed. If the property has been inherited, written documentation of the property transfer should be submitted along with the most recent deed.*

F.2. **Certified Survey Map:** A copy of the certified survey map or the relevant section of the recorded plat map for those properties where the legal description in the most recent deed refers to a certified survey map or a recorded plat map. In cases where the certified survey map or recorded plat map are not legible or are unavailable, a copy of a parcel map from a county land information office may be substituted. A copy of a parcel map from a county land information office shall be legible, and the parcels identified in the legal description shall be clearly identified and labeled with the applicable parcel identification number.

F.3. **Verification of Zoning**: Documentation (e.g., official zoning map or letter from municipality) of the property's or properties' current zoning status.

F.4. **Signed Statement:** A statement signed by the Responsible Party (RP), which states that he or she believes that the attached legal description(s) accurately describe(s) the correct contaminated property or properties. This section applies to the source property only. Signed statements for Other Affected Properties should be included in Attachment G.

Notifications to Owners of Affected Properties (Attachment G)

Directions for Notifications to Owners of Affected Properties:

Complete the table on the following page for sites which require notification to owners of affected properties pursuant to ch. 292, Wis. Stats. and ch. NR 725 and 726, Wis. Adm. Code. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Open Records law [ss. 19.31- 19.39,Wis. Stats.]. The DNR's "Guidance on Case Closure and the Requirements for Managing Continuing Obligations" (PUB-RR-606) lists specific notification requirements http://dnr.wi.gov/files/PDF/pubs/rr/RR606.pdf.

State law requires that the responsible party provide a 30-day, written advance notification to certain persons prior to applying for case closure. This requirement applies if: (1) the person conducting the response action does not own the source property; (2) the contamination has migrated onto another property; and/or (3) one or more monitoring wells will not be abandoned. Use form 4400-286, Notification of Continuing Obligations and Residual Contamination, at http://dnr.wi.gov/files/PDF/forms/4400/4400-286.pdf

Include a copy of each notification sent and accompanying proof of delivery, i.e., return receipt or signature confirmation.

Include the following documents for each property, keeping each property's documents grouped together and labeled with the letter G and the corresponding ID number from the table on the following page. (Source Property documents should only be included in Attachment F):

- **Deed:** The most recent deed with legal descriptions clearly listed for all affected properties.
  Note: If a property has been purchased with a land contract and the purchaser has not yet received a deed, a copy of the land contract which includes the legal description shall be submitted instead of the most recent deed. If the property has been inherited, written documentation of the property transfer should be submitted along with the most recent deed.
- **Certified Survey Map:** A copy of the certified survey map or the relevant section of the recorded plat map for those properties where the legal description in the most recent deed refers to a certified survey map or a recorded plat map. In cases where the certified survey map or recorded plat map are not legible or are unavailable, a copy of a parcel map from a county land information office may be substituted. A copy of a parcel map from a county land information office shall be legible, and the parcels identified in the legal description shall be clearly identified and labeled with the applicable parcel identification number.
- **Verification of Zoning:** Documentation (e.g., official zoning map or letter from municipality) of the property's or properties' current zoning status.
- **Signed Statement:** A statement signed by the Responsible Party (RP), which states that he or she believes the attached legal description(s) accurately describe(s) the correct contaminated property or properties.

Notifications to Owners of Affected Properties (Attachment G)

ID	Address of Affected Property	Parcel ID No.	Date of Receipt of Letter	Type of Property Owner	WTMX	WTMY	Reasons Notification Letter Sent: Residual Groundwater Contamination = or > ES	Residual Soil Contamination Exceeds RCLs	Monitoring Wells: Not Abandoned	Monitoring Wells: Continued Monitoring	Cover/Barrier/Engineered Control	Structural Impediment	Industrial RCLs Met/Applied	Vapor Mitigation System(VMS)	Dewatering System Needed for VMS	Compounds of Concern in Use	Commercial/Industrial Vapor Exposure Assumptions Applied	Residual Volatile Contamination Poses Future Risk of Vapor Intrusion	Site Specification Situation
A	400/410 Fox Shores Drive, Kaukauna, WI	323040800	03/04/2022	SPO	657632	424564	X	X			X								
B	400 Bicentennial Court, Kaukauna, WI	323040801	03/04/2022	SPO	657607	424504	X	X			X								
C	380 Bicentennial Court, Kaukauna, WI	323040802	03/04/2022	SPO	657648	424484	X	X			X								
D	Lot 2 CSM 6200	323040804	03/04/2022	SPO	657698	424526	X	X			X								

Signatures and Findings for Closure Determination

This page has been updated as of February 2019 to comply with the requirements of Wis. Admin. Code ch. NR 712.

Check the correct box for this case closure request and complete the corresponding certification statement(s) listed below to demonstrate that the requirements of Wis. Admin. Code ch. NR 712 have been met. The responsibility for signing the certification may not be delegated per Wis. Admin. Code § NR 712.09 (1). Per Wis. Admin. Code § 712.05 (1), the work must be conducted or supervised by the person certifying.

- (●) The investigation and/or response action(s) for this site evaluated and/or addressed groundwater (including natural attenuation remedies). Both a professional engineer and a hydrogeologist must sign this document per Wis. Admin. Code ch. NR 712.
- ( ) The investigation and the response action(s) for this site did not evaluate or address groundwater. A professional engineer must sign this document per Wis. Admin. Code ch. NR 712.

Engineering Certification

I, Hiedi Waller, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Signature Hiedi Ann Waller P. E. # E-33741

Title Senior Engineer P.E. Stamp



Hydrogeologist Certification

I, Stu Gross, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, am registered in accordance with the requirements of ch. GHSS 2, Wis. Adm. Code, or licensed in accordance with the requirements of ch. GHSS 3, Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Signature Stuart Gross

Title Principal Date 02/25/2022

ATTACHMENT A – DATA TABLES

TABLE OF CONTENTS

A.1. Groundwater Analytical Table(s)…….3 pages

A.2. Soil Analytical Results Table(s) ...……4 pages

A.3. Residual Soil Contamination Table(s)……4 pages

A.4. Vapor Analytical Table(s)……..……...1 pages

A.5. Other Media of Concern……..NA

A.6. Water Level Elevations…….……1 pages

A.7. Other…….NA

Table **A.1.** Groundwater **Analytical Table(s)**, RCRA Metals Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Well Number	Date Collected	Laboratory Results (µg/L)							
		RCRA Metals							
		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
NR 140 Preventive Action Limit		1	400	0.5	10	1.5	0.2	10	10
NR 140 Enforcement Standard		10	2000	5	100	15	2	50	50
TW10	8/28/2019	0.49 J	45	<0.17	<1.1	<0.19	<0.098	1.3 J	<0.12
	4/16/2020	0.56 J	29	<0.17	<1.1	<0.19	<0.098	1.3 J	<0.12
TW11	8/28/2019	***8.5***	***420***	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
	4/16/2020	***5.2***	330	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
TW13	8/28/2019	0.82 J	190	<0.17	<1.1	<0.19	<0.098	1.1 J	<0.12
	4/16/2020	0.77 J	91	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
TW15	8/28/2019	17	240	<0.17	1.3 J	0.31 J	<0.098	1.8 J	<0.12
	4/16/2020	***2.0***	47	<0.17	<1.1	<0.19	<0.098	7.9	<0.12
TW17	8/28/2019	***1.6***	100	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12
	4/16/2020	***1.3***	67	<0.17	<1.1	<0.19	<0.098	<0.98	<0.12

Key:

RCRA	= Resource Conservation and Recovery Act
<X	= analyte not detected above method detection limit
"J"	= Analyte detected between Limit of Detection and Limit of Quantitation
µg/L	= microgram per liter
X	= concentration detected above Chapter NR 140, Wisconsin Administrative Code(NR 140, Wis. Adm. Code) preventive action limit (PAL)
X	= concentration detected above NR 140, Wis. Adm. Code enforcement standard (ES)

Table **A.1.** Groundwater **Analytical Table(s)**, Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Well Number	Date Collected	Polynuclear Aromatic Hydrocarbons (µg/L)																
		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g, h, i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a, h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
NR 140 Preventive Action Limit		NE	NE	600	NE	0.02	0.02	NE	NE	0.02	NE	80	80	NE	NE	NE	10	NE	50
NR 140 Enforcement Standard		NE	NE	3,000	NE	0.2	0.2	NE	NE	0.2	NE	400	400	NE	NE	NE	100	NE	250
B1-GW	10/3/2018	<0.0590	<0.0590	0.16	0.0151 J	<0.0590	0.0099 J	0.00654 J	<0.0590	<0.0590	<0.0590	0.0353 J	<0.0590	<0.0590	0.0257 J	0.0250 J	0.0557 J	0.0293 J	0.0175 J
B2-GW	10/3/2018	<0.0715	<0.0715	<0.0715	0.00715 J	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	<0.0715	0.0180 J	0.0185 J	0.0566 J	<0.0715	<0.0715
B3-GW	10/3/2018	0.107 J	<0.500	0.67	0.341 J	0.225 J	0.156 J	0.326 J	<0.500	0.454 J	<0.500	0.243 J	<0.500	<0.500	<2.50	<2.50	0.243 J	0.33	2.22
B4-GW	10/3/2018	<0.0525	<0.0525	<0.0525	0.00583 J	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	<0.0525	0.0152 J	0.0156 J	0.0338 J	<0.0525	<0.0525
B5-GW	10/3/2018	0.0155 J	<0.0590	0.0292 J	0.0698	0.0766	0.116 J	0.0991	0.0328 J	0.118 J	0.0143 J	0.203	<0.0590	0.0610 J	0.0335 J	0.0418 J	0.0452 J	0.205	0.152
TW10	8/28/2019	<0.23	<0.20	<0.25	<0.043	<0.075	<0.061	<0.29	<0.049	<0.052	<0.039	<0.35	<0.19	<0.057	<0.23	<0.050	<0.23	<0.23	<0.32
	4/16/2020	<0.26	<0.22	<0.28	<0.047	<0.083	<0.067	<0.31	<0.054	<0.057	<0.042	<0.38	<0.20	<0.063	<0.25	<0.054	<0.26	<0.25	<0.36
TW11	8/28/2019	<0.25	<0.22	<0.27	<0.047	<0.081	<0.066	<0.31	<0.053	<0.056	<0.042	<0.37	<0.20	<0.062	<0.25	<0.054	<0.25	<0.25	<0.35
	4/16/2020	<0.27	<0.24	<0.30	<0.050	<0.088	<0.072	<0.33	<0.057	<0.061	<0.045	<0.40	<0.22	<0.067	<0.27	<0.058	<0.27	<0.27	<0.38
TW13	8/28/2019	<0.25	<0.22	<0.27	<0.047	<0.081	<0.066	<0.31	<0.053	<0.056	<0.042	<0.37	<0.20	<0.061	<0.25	<0.054	<0.25	<0.25	<0.35
	4/16/2020	<0.27	<0.23	<0.29	<0.050	<0.087	<0.071	<0.33	<0.056	<0.060	<0.044	<0.40	<0.21	<0.065	<0.26	<0.057	<0.27	<0.26	<0.37
TW15	8/28/2019	<2.4	<2.1	<2.6	<0.45	<0.78	<0.64	<3.0	<0.51	***1.5 J***	<0.40	<3.6	<1.9	<0.59	4.0 J	<0.52	<2.4	2.8 J	<3.4
	4/16/2020	<0.27	<0.23	<0.29	<0.049	<0.086	<0.070	<0.33	<0.056	<0.059	<0.044	<0.39	<0.21	<0.065	<0.26	<0.057	<0.27	<0.26	<0.37
TW17	8/28/2019	<0.24	<0.21	<0.26	<0.045	<0.078	<0.064	<0.30	<0.051	<0.054	<0.040	<0.36	<0.19	<0.059	<0.24	<0.052	<0.24	<0.24	<0.34
	4/16/2020	<0.27	<0.24	<0.29	0.21	***0.36***	***0.29***	<0.33	0.23	0.17 J	<0.045	<0.40	<0.21	0.23	<0.27	<0.057	<0.27	0.29 J	<0.38

Key:

<X	= analyte not detected above method detection limit
"J"	= Analyte detected between Limit of Detection and Limit of Quantitation
µg/L	= micrograms per liter
NE	= not established
X	= Concentration detected above Chapter NR 140, Wisconsin Administrative Code (NR 140, Wis. Adm. Code) preventive action limit (PAL)
X	= Concentration detected above NR 140, Wis. Adm. Code enforcement standard (ES)
	= Sample collected by Partner Engineering and Science Inc.

Table **A.1.** Groundwater **Analytical Table(s)**, Volatile Organic Compound Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Well Number	Date Collected	Volatile Organic Compounds (µg/L)																				
		Benzene	Chloroform	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene	Methylene Chloride	MTBE	Naphthalene	n-Butylbenzene	N-Propylbenzene	sec-Butylbenzene	Tetrachloroethene (PCE)	Toluene	1,1,1-Trichloroethane (1,1,1-TCA)	Trichloroethene (TCE)	Total Trimethylbenzene	Vinyl Chloride	Total Xylenes
NR 140 Preventive Action Limit		0.5	0.6	0.5	85	7	20	140	NE	NE	0.5	12	10	NE	NE	NE	0.5	160	40	0.5	96	0.02	400
NR 140 Enforcement Standard		5	6	5	850	70	100	700	NE	NE	5	60	100	NE	NE	NE	5	800	200	5	480	0.2	2,000
B1-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.56	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
B2-GW	10/3/2018	<5.00	<25.0	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<25.0	<5.00	<25.0	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<10.0	<5.00	<15.0
B3-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
B4-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
B5-GW	10/3/2018	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<5.00	<1.00	<5.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<2.00	<1.00	<3.00
TW10	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
TW11	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
TW13	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
TW15	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	1.6	1.1	<1.6	<0.39	0.76 J	<0.39	2.0	0.63 J	<0.37	<0.15	<0.38	<0.16	3.5	<0.20	1.3
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	0.21 J	2.9	2.1	<1.6	<0.39	---	9.2	4.6	3.6	<0.37	<0.15	<0.38	<0.16	6.3	<0.20	1.6
TW17	8/28/2019	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	<0.34	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22
	4/16/2020	<0.15	<0.37	<0.39	<0.41	<0.41	<0.35	<0.18	<0.39	<0.36	<1.6	<0.39	---	<0.39	<0.41	<0.40	<0.37	<0.15	<0.38	<0.16	<0.61	<0.20	<0.22

Key:

"J" = Analyte detected between Limit of Detection and Limit of Quantitation
µg/L = microgram per liter
NE = not established
X = Concentration detected above Chapter NR 140, Wisconsin Administrative Code (NR 140, Wis. Adm. Code) preventive action limit (PAL)
X = Concentration detected above NR 140, Wis. Adm. Code enforcement standard (ES)
= Sample collected by Partner Engineering and Science Inc.

Table **A.2.** Soil**Analytical Results Table(s),** RCRA Metals Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample					Laboratory Result (mg/kg)							
					RCRA Metals							
Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	Arsenic (total)	Barium	Cadmium	Chromium	Lead (total)	Mercury	Selenium	Silver
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	8* [0.677]	15,300	71.1	NE	400	3.13	391	391
				Industrial	8* [3.00]	100,000	985	NE	800	3.13	5,840	5,840
WDNR RCL for Protection of Groundwater					8* [0.584]	364* [164.8]	1* [0.752]	360,000	52* [27]	0.208	0.52	0.849
Background Threshold Value (BTV)					8	364	1	44	52	NE	NE	NE
B1	B1 (0.5-1)	0.5-1	Topsoil	10/3/2018	17.7	81.8	2.8	22.6	940	0.492	2.58	<0.616
B2	B2 (0.5-1)	0.5-1	Topsoil	10/3/2018	0.732 J	42.4	<0.230	15.7	5.1	0.0466	<2.30	<0.575
B3	B3 (0.5-1)	0.5-1	Topsoil	10/3/2018	3.07	76.1	0.335	17.9	209	0.0259	<2.28	<0.569
B4	B4 (0.5-1)	0.5-1	Topsoil	10/3/2018	116	58.9	2.01	14	272	0.0467	0.932 J	<0.645
B5	B5 (0.5-1)	0.5-1	Topsoil	10/3/2018	7.55	49.3	0.753	11.5	205	0.11	0.873 J	<0.550
SB10-1	SB10-1 (0-2)	0-2	Silty Sand	5/14/2019	2.8	19	0.35	7.1	48	0.066	0.91 J	1.0
	SB10-1 (4-5)	4-5	Silty Sand	5/14/2019	1.5	17	0.21 J	7.3	3.4	0.013 J	<0.64	1.5
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	08/21/19	41	55	1.7 B	14	390	0.23	0.84 J	1.6
SB11	SB11 (2-4)	2-4	Sand	08/21/19	9.3	54	1.2 B	14	440	0.41	1.5	1.5
SB12	SB12 (2-4)	2-4	Fill / Silty Clay	08/21/19	11	64	1.6 B	16	480	0.54	2.0	1.8
SB13	SB13 (2-4)	2-4	Sand	08/21/19	34	60	1.7 B	18	570	0.60	1.5	1.7
SB14	SB14 (0-2)	0-2	Silty Clay	08/21/19	2.7	45	0.13 JB	15	25	0.067	0.73 J	2.5
SB15	SB15 (2-4)	2-4	Sand	08/21/19	240	49	25 B	13	97,000	12	4.4	7.4
SB16	SB16 (2-4)	2-4	Silty Clay	08/21/19	11	40	0.44 B	16	84	0.10	0.75 J	1.5
SB17	SB17 (2-4)	2-4	Sand	08/21/19	15	79	1.7 B	14	560	0.45	2.2	1.6
HA-1	HA-1	0-2	Fill / Silty Clay	04/15/20	3.5	79	0.24	26	73	0.070	<0.67	0.45 J
HA-2	HA-2	0-2	Fill / Silty Clay	04/15/20	11	61	2.6	15	470	0.19	1.0 J	0.97
HA-3	HA-3	0-2	Fill / Silty Clay	04/15/20	11	56	0.92	16	220	0.32	0.74 J	0.56 J
HA-4	HA-4	0-2	Fill / Silty Clay	04/15/20	6.7	59	1.1	13	140	0.12	1.1	0.78
HA-5	HA-5	0-2	Fill / Silty Clay	04/15/20	8.1	55	0.64	16	160	0.15	<0.64	0.45 J
HA-6	HA-6	0-2	Fill / Silty Sand	04/15/20	6.8	37	0.36	12	91	0.053	<0.61	0.27 J
HA-7	HA-7	0-2	Fill / Silty Clay	04/15/20	5.0	44	0.43	16	86	0.041	<0.64	0.53 J
HA-8	HA-8	0-2	Fill / Silty Clay	04/15/20	6.2	54	0.58	16	150	0.080	<0.64	0.51 J
HA-9	HA-9	0-2	Fill / Silty Sand	04/15/20	3.0	37	0.18 J	13	53	0.16	<0.65	0.23 J
HA-10	HA-10	0-2	Fill / Silty Clay	04/15/20	5.0	41	0.44	16	190	0.22	<0.64	0.36 J
HA-11	HA-11	0-2	Fill / Silty Clay	04/15/20	7.9	70	0.83	19	250	0.19	1.1	0.82
HA-12	HA-12	0-2	Fill / Silty Sand	04/15/20	2.0	31	0.040 J	14	7.2	0.0083 J	<0.57	0.13 J
HA-15	HA-15	0-2	Sand and Gravel Fill	12/03/20	3.0	8.0	0.31	5.1	20	0.0081 J	<0.59	0.31 J
HA-15	HA-15	2-4	Sand and Gravel Fill	12/03/20	3.2	9.3	0.29	5.9	28	0.0089 J	<0.62	0.26 J
HA-16	HA-16	0-2	Silty Clay	12/03/20	3.5	81	0.29	30	20	0.027	<0.71	<0.16
HA-16	HA-16	2-4	Silty Clay w/ Black Fill	12/03/20	5.7	75	0.53	25	150	0.14	<0.62	<0.14
HA-17	HA-17	0-2	Silty Black Fill	12/03/20	6.0	44	0.79	14	260	0.17	<0.62	<0.14
HA-17	HA-17	2-4	Silty Black Fill	12/03/20	8.3	73	1.3	17	330	0.42	<0.69	0.16 J
HA-18	HA-18	0-2	Silty Black Fill w/ Gravel	12/03/20	4.9	68	0.65	16	82	0.12	<0.67	0.16 J
HA-18	HA-18	2-4	Silty Black Fill w/ Gravel and Debris	12/03/20	5.6	36	0.57	12	120	0.12	<0.65	<0.14
HA-19	HA-19	0-2	Silty Clay w/ Gravel	12/03/20	3.1	73	0.28	22	19	0.015 J	<0.63	<0.14
HA-19	HA-19	2-4	Silty Clay w/ Gravel and Black Fill	12/03/20	3.9	72	0.38	22	32	0.057	<0.59	<0.13

Key:

RCRA = Resource Conservation and Recovery Act
<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
mg/kg = milligram per kilogram
NE = not established by WAC (Wis. Adm. Code) or WDNR Soil RCL Summary Table
"J" = analyte detected between the limit of detection and limit of quantification
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes:
WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.
For the purpose of this evaluation under ch. NR 700, background threshold values are being considered as representative of background conditions.
However, constituent concentrations less than background threshold values may represent a potential health risk if concentrations are greater than health-based standards.

Table **A.2.** Soil **Analytical Results Table(s),** Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	PAH Compound Laboratory Result (µg/kg)																
					Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthrancene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	3,590,000	NE	17,900,000	1,140	115	1,150	NE	11,500	115,000	115	2,390,000	2,390,000	1,150	17,600	239,000	5,520	NE	1,790,000
				Industrial	45,200,000	NE	100,000,000	20,800	2,110	21,100	NE	211,000	2,110,000	2,110	30,100,000	30,100,000	21,100	72,700	3,010,000	24,100	NE	22,600,000
WDNR RCL for Protection of Groundwater					NE	NE	196,949.2	NE	470	478	NE	NE	144	NE	88,877.8	14,829.9	NE	NE	NE	658.2	NE	54,545
B1	B1 (6-7)	6-7	Clay	10/3/2018	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	<6.89	0.821 J	6.89	<6.89	<23.0	<23.0	<23.0	0.704 J	<6.89
B2	B2(7-8)	7-8	Clay	10/3/2018	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<6.68	<22.3	<22.3	<22.3	<6.68	<6.89
B3	B3 (3-4)	3-4	Clay	10/3/2018	2.31 J	<7.02	4.25 J	18	20	26.5	15.8	10.2	26.8	3.1 J	52.1	2.53 J	12.5	5.81 J	7.86 J	7.23 J	35.1	34.9
B4	B4 (6-7)	6-7	Clay	10/3/2018	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	<7.06	0.857 J	<7.06	<7.06	<23.5	<23.5	<23.5	<7.06	<7.06
B5	B5 (3.5-4.5)	3.5-4.5	Clay	10/3/2018	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<7.39	<24.6	<24.6	<24.6	<7.39	<7.39
SB6	SB6 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	32 J	39	160	410	480	940	210	<11	580	58	660	29 J	190	180	250	150	610	800
SB7	SB7 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	9.8 J	31 J	39	180	220	300	140	150	240	52	210	7.1 J	120	52 J	86	47	210	280
SB8	SB8 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	<7.0	<5.1	<6.5	23 J	25 J	37 J	23 J	13 J	30 J	<7.5	38	<5.4	18 J	<9.5	15 J	6.4 J	28 J	34 J
SB9	SB9 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	1,200	1,900	3,500	9,100	14,000	16,000	2,800	10,000	11,000	2,100	19,000	1,600	4,700	870	770 J	1,000	22,000	32,000
SB10-1	SB10 (0-2)	0-2	Silty Sand	5/14/2019	7.2 J	6.5 J	22 J	100	120	180	100	38	170	38	130	<4.9	85	29 J	38 J	29 J	150	170
	SB10 (4-5)	4-5	Silty Sand	5/14/2019	<7.2	<5.3	<6.7	<5.4	<7.8	<8.7	<13	<12	<11	<7.8	<7.5	<5.7	<10	<9.8	<7.4	<6.2	<5.6	<8.0
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	8/21/2019	22 J	28 J	84	290	280	480	210	160	390	52	480	21 J	150	220	260	200	450	470
SB11	SB11 (2-4)	2-4	Sand	8/21/2019	810	240	2,000	5,200	5,200	6,900	1,700	2,800	5,900	440	15,000	650	1,500	400	510	520	11,000	13,000
SB12	SB12 (2-4)	2-4	Fill / Silty Clay	8/21/2019	47 J	65 J	120 J	650	630	990	300	300	920	92 J	1,100	59 J	240	260 J	310 J	200	950	1,300
SB13	SB13 (2-4)	2-4	Sand	8/21/2019	85	29 J	260	790	840	1,300	320	520	1,000	79	2,100	68	270	150	200	130	1,300	1,600
SB14	SB14 (0-2)	0-2	Silty Clay	8/21/2019	<6.4	<4.7	6.4 J	33 J	35	52	40	23 J	61	8.2 J	65	<5.0	26 J	<8.7	11 J	8.5 J	46	60
SB15	SB15 (2-4)	2-4	Sand	8/21/2019	26 J	22 J	95	310	310	660	220	180	850	62	600	40	160	180	410	240	1,000	580
SB16	SB16 (2-4)	2-4	Silty Clay	8/21/2019	1,700	420	4,000	11,000	9,000	11,000	2,500	3,700	13,000	890	25,000	1,500	2,100	1,100	830	600	28,000	32,000
SB17	SB17 (2-4)	2-4	Sand	8/21/2019	1,100	550	2,300	5,900	5,800	8,600	2,000	3,800	6,800	520	16,000	930	1,800	940	1,100	1,100	13,000	14,000
HA-1	HA-1	0-2	Fill / Silty Clay	04/15/20	<7.2	9.5 J	18 J	92	110	150	74	65	130	<7.8	190	<5.6	63	24 J	30 J	17 J	100	190

Table **A.2.** Soil **Analytical Results Table(s),** Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	PAH Compound Laboratory Result (µg/kg)																
					Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthrancene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	3,590,000	NE	17,900,000	1,140	115	1,150	NE	11,500	115,000	115	2,390,000	2,390,000	1,150	17,600	239,000	5,520	NE	1,790,000
				Industrial	45,200,000	NE	100,000,000	20,800	2,110	21,100	NE	211,000	2,110,000	2,110	30,100,000	30,100,000	21,100	72,700	3,010,000	24,100	NE	22,600,000
WDNR RCL for Protection of Groundwater					NE	NE	196,949.2	NE	470	478	NE	NE	144	NE	88,877.8	14,829	NE	NE	NE	658.2	NE	54,545
HA-2	HA-2	0-2	Fill / Silty Clay	04/15/20	52 J	<26	160 J	950	1,200	1,800	460	730	1,300	120 J	2,300	55 J	420	390 J	410	240	1,400	2,000
HA-3	HA-3	0-2	Fill / Silty Clay	04/15/20	56 J	41 J	180 J	1,200	1,400	2,000	820	780	1,600	140 J	2,500	61 J	710	340 J	410	260	1,500	2,300
HA-4	HA-4	0-2	Fill / Silty Clay	04/15/20	190 J	150 J	540	2,400	2,700	3,600	890	1,200	2,800	250	4,800	160 J	870	420	460	410	3,100	4,900
HA-5	HA-5	0-2	Fill / Silty Clay	04/15/20	80 J	64 J	200	1,100	1,400	2,200	510	730	1,400	180 J	2,100	51 J	480	220 J	300 J	290	1,200	2,100
HA-6	HA-6	0-2	Fill / Silty Sand	04/15/20	190	39 J	400	1,300	1,400	1,900	440	570	1,300	100 J	2,400	160 J	320	120 J	120 J	150 J	1,900	2,300
HA-7	HA-7	0-2	Fill / Silty Clay	04/15/20	49	41	100	440	450	580	180	260	480	41	760	43	170	86	100	81	630	800
HA-8	HA-8	0-2	Fill / Silty Clay	04/15/20	100	140	310	1,100	1,200	1,600	340	630	1,200	100	2,300	96	330	100	140	160	1,600	2,600
HA-9	HA-9	0-2	Fill / Silty Sand	04/15/20	14 J	14 J	48	180	170	210	100	55	190	24 J	300	12 J	93	21 J	35 J	25 J	240	300
HA-10	HA-10	0-2	Fill / Silty Clay	04/15/20	40 J	44 J	150 J	530	620	1,000	150 J	250	720	<36	980	35 J	220	120 J	160 J	150 J	600	970
HA-11	HA-11	0-2	Fill / Silty Clay	04/15/20	<36	33 J	140 J	350	370	350	<65	120 J	460	<39	530	59 J	<52	230 J	390 J	130 J	650	690
HA-12	HA-12	0-2	Fill / Silty Sand	04/15/20	<6.7	<4.9	<6.2	36 J	37	46	22 J	18 J	43	<7.2	57	<5.2	23 J	<9.1	<6.9	<5.7	17 J	59
HA-15	HA-15	0-2	Sand and Gravel Fill	12/03/20	<6.2	<4.6	<5.8	14 J	18 J	25 J	16 J	<10	25 J	<6.7	37	<4.9	9.7 J	<8.5	<6.4	<5.3	35	37
HA-15	HA-15	2-4	Sand and Gravel Fill	12/03/20	<6.4	<4.7	<6.0	13 J	16 J	30 J	<12	<11	26 J	<6.9	45	<5.0	<9.3	<8.8	<6.6	<5.5	27 J	44
HA-16	HA-16	0-2	Silty Clay	12/03/20	31 J	6.7 J	78	150	170	200	110	73	160	28 J	330	28 J	89	15 J	13 J	9.8 J	280	320
HA-16	HA-16	2-4	Silty Clay w/ Black Fill	12/03/20	140	47	320	830	910	1,200	270	470	850	79	2,000	110	260	65 J	83	69	1,400	1,800
HA-17	HA-17	0-2	Silty Black Fill	12/03/20	320	180 J	790	2,800	3,200	4,300	1,000	1,300	3,000	280	6,500	270	980	160 J	160 J	250	4,000	6,000
HA-17	HA-17	2-4	Silty Black Fill	12/03/20	460	130 J	980	2,800	3,100	4,200	980	1,500	3,000	270	6,700	380	930	200 J	200 J	300	4,900	6,300
HA-18	HA-18	0-2	Silty Black Fill w/ Gravel	12/03/20	24 J	28 J	76	490	830	1,600	340	540	900	84	1,400	18 J	360	390	1,100	2,500	860	1,200
HA-18	HA-18	2-4	Silty Black Fill w/ Gravel and Debris	12/03/20	1,100	230	1,500	2,400	1,800	3,200	600	980	2,600	180 J	6,700	1,000	500	860	1,600	2,900	5,700	6,400
HA-19	HA-19	0-2	Silty Clay w/ Gravel	12/03/20	<7.0	<5.2	<6.5	14 J	24 J	24 J	17 J	<12	17 J	<7.6	21 J	<5.5	13 J	<9.5	7.3 J	<6.0	13 J	24 J
HA-19	HA-19	2-4	Silty Clay w/ Gravel and Black Fill	12/03/20	63	24 J	160	280	300	320	120	140	280	38	590	69	110	50 J	49 J	53	710	540

Key:

<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
µg/kg = milligram per kilogram
NE = not established by WAC (Wis. Adm. Code) or WDNR Soil RCL Summary Table
"J" = analyte detected between the limit of detection and limit of quantification
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

Table **A.2.** Soil **Analytical Results Table(s)**, Volatile Organic Compound Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample						VOC Compound Laboratory Result (µg/kg)																
Boring Number	Sample Number	Depth (fbg)	Description	PID Response (iui)	Date Collected	Acetone	1,2,4-Trimethyl benzene	1,3,5-Trimethyl benzene	1,2,3-Trimethyl benzene	Benzene	2-Butanone	Ethylbenzene	Isopropylbenzene	Methylene Chloride	Methyl tert-butyl ether	Naphthalene	Total Xylenes	n-Butylbenzene	n-Propylbenzene	p-Isopropyltoluene	sec-Butylbenzene	Toluene
WDNR NR 720 Direct Contact RCL					Non-Industrial	63,400,000	219,000	182,000	293000	1,600	28,400,000	8,020	NE	61,800	63,800	5,520	260,000	108,000	NE	162,000	145,000	818,000
					Industrial	100,000,000	219,000	182,000	293,000	7,070	28,400,000	35,400	NE	1,150,000	282,000	24,100	260,000	108,000	NE	162,000	145,000	818,000
WDNR NR 720 Groundwater Protection RCL						3,676.6	1378.7 combined		NE	5.1	1,666.1	1,570	NE	2.6	27	658.2	3,960	NE	NE	NE	NE	1,107.2
B1	B1 (6-7)	6-7	Clay	0	10/3/2018	<28.7	<5.74	<5.74	<5.74	<1.15	19.3 J	<2.87	<2.87	---	<1.15	<14.4	<7.46	<14.4	<5.74	---	---	<5.74
B2	B2 (7-8)	7-8	Clay	0.1	10/3/2018	<27.8	<5.57	<5.57	<5.57	<1.11	28	<2.78	<2.78	---	<1.11	<13.9	<7.24	<13.9	<5.57	---	---	1.49 J
B3	B3 (3-4)	3-4	Clay	0	10/3/2018	<29.3	<5.85	<5.85	<5.85	<1.17	29.7	<2.93	<2.93	---	<1.17	<14.6	<7.61	<14.6	<5.85	---	---	1.54 J
B4	B4 (6-7)	6-7	Clay	0.1	10/3/2018	36.3	2.42 J	<5.88	1.62 J	0.791 J	27.4 J	0.998 J	<2.94	---	<1.18	4.48 J	<7.64	<14.7	<5.88	---	---	5.69 J
B5	B5 (3.5-4.5)	3.5-4.5	Clay	0	10/3/2018	39.4	<6.16	<6.16	<6.16	<1.23	34.9	<3.08	<3.08	---	<1.23	<15.4	<8.00	<15.4	<6.16	---	---	<6.16
SB6	SB6 (0-2)	0-2	Topsoil/Silty Clay	1.3	5/14/2019	---	66 J	<26	---	22	---	<13	<26	<110	<27	---	170	<27	<29	<25	<27	110
SB7	SB7 (0-2)	0-2	Topsoil/Silty Clay	3.7	5/14/2019	---	<23	<24	---	<9.3	---	<12	<25	<100	<25	---	<14	<25	<26	<23	<25	<9.4
SB8	SB8 (0-2)	0-2	Topsoil/Silty Clay	0.8	5/14/2019	---	<24	<26	---	<9.8	---	<12	<26	<110	<27	---	<15	<26	<28	<24	<27	<9.9
SB9	SB9 (0-2)	0-2	Topsoil/Silty Clay	1.0	5/14/2019	---	<25	<27	---	<10	---	<13	<27	<110	<28	---	<15	<27	<29	<25	<28	41
SB10-1	SB10-1 (0-2)	0-2	Silty Sand	1.2	5/14/2019	---	<21	<22	---	<8.4	---	<11	<22	<94	<23	---	<13	<22	<24	<21	<23	<8.4
	SB10-1 (4-5)	4-5	Silty Sand	1.2	5/14/2019	---	<25	<27	---	<10	---	<13	<27	<120	<28	---	<16	<27	<29	<26	<28	<10
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	2.0	08/21/19	---	<25	<27	---	<10	---	<13	<27	<110	<28	---	<15	<27	<29	<25	<28	<10
SB11	SB11 (2-4)	2-4	Sand	4.3	08/21/19	---	<25	<26	---	<10	---	<13	<26	110 J	<27	---	<15	<27	<28	<25	<27	43
SB12	SB12 (2-4)	2-4	Fill/Silty Clay	5.9	08/21/19	---	<25	<28	---	<11	---	<13	<28	<120	<29	---	<16	<28	<30	<27	<29	<11
SB13	SB13 (2-4)	2-4	Sand	2.7	08/21/19	---	<25	<26	---	<10	---	<13	<27	120 J	<27	---	<15	<27	<29	<25	<28	<10
SB14	SB14 (0-2)	0-2	Silty Clay	1.5	08/21/19	---	<21	<23	---	<8.7	---	<11	<23	110 J	<23	---	<13	<23	<25	<22	<24	<8.7
SB15	SB15 (4-6)	4-6	Silty Clay	>300	08/21/19	---	1900	540	---	<10	---	<13	98	130 J	<27	---	72	<27	200	510	200	<8.7
SB16	SB16 (2-4)	2-4	Silty Clay	3.5	08/21/19	---	150	62 J	---	<9.9	---	<12	<26	<110	<27	---	68	<26	<28	<25	<27	41
SB17	SB17 (2-4)	2-4	Sand	2.2	08/21/19	---	2700	1200	---	<9.1	---	<11	<24	110 J	<25	---	320	<24	370	170	250	<9.2
HA-1	HA-1	0-2	Fill / Silty Clay	---	04/15/20	---	<26	<28	---	<11	---	<13	<28	<120	<29	---	<16	<28	<30	<26	<29	<11
HA-2	HA-2	0-2	Fill / Silty Clay	---	04/15/20	---	<26	<28	---	<11	---	<13	<28	<120	<29	---	64	<28	<30	<27	<29	28
HA-3	HA-3	0-2	Fill / Silty Clay	---	04/15/20	---	42 J	<26	---	<10	---	24	<27	<110	<27	---	130	<27	<29	<25	<28	74
HA-4	HA-4	0-2	Fill / Silty Clay	---	04/15/20	---	56 J	<25	---	18	---	26	<25	<110	<26	---	160	<25	<27	<24	<26	77
HA-5	HA-5	0-2	Fill / Silty Clay	---	04/15/20	---	77	<26	---	140	---	49	<26	<110	<27	---	270	<27	<28	<25	<27	260
HA-6	HA-6	0-2	Fill / Silty Sand	---	04/15/20	---	<24	<25	---	<9.7	---	<12	<26	<110	<26	---	25 J	<26	<28	<24	<26	13 J
HA-7	HA-7	0-2	Fill / Silty Clay	---	04/15/20	---	<24	<25	---	<9.8	---	<12	<26	<110	<26	---	53	<26	<28	<24	<27	<9.8
HA-8	HA-8	0-2	Fill / Silty Clay	---	04/15/20	---	23 J	<25	---	19	---	18	<25	<110	<25	---	67	<25	<27	<23	<26	49
HA-9	HA-9	0-2	Fill / Silty Sand	---	04/15/20	---	<23	<24	---	<9.3	---	<12	<24	<100	<25	---	<14	<25	<26	<23	<25	<9.4
HA-10	HA-10	0-2	Fill / Silty Clay	---	04/15/20	---	<23	<25	---	<9.6	---	<12	<25	<110	<26	---	46	<26	<27	<24	<26	23
HA-11	HA-11	0-2	Fill / Silty Clay	---	04/15/20	---	<25	<27	---	<11	---	<13	<28	<120	<29	---	<16	<28	<30	<26	<29	<11
HA-12	HA-12	0-2	Fill / Silty Sand	---	04/15/20	---	<22	<25	---	<9.4	---	<12	<25	<110	<25	---	<14	<25	<27	<23	<26	<9.5
HA-15	HA-15	0-2	Sand and Gravel Fill	0.5	12/03/20	---	<19	<20	---	<7.6	---	<9.5	<20	<85	<21	<17	17 J	<20	<22	<19	<21	<7.7
HA-16	HA-16	2-4	Silty Clay w/ Black Fill	0.4	12/03/20	---	<26	<27	---	<10	---	<13	---	---	<28	<24	<16	---	---	---	---	<11
HA-17	HA-17	0-2	Silty Black Fill	0.9	12/03/20	---	25 J	<20	---	<7.8	---	<9.8	---	---	<21	74	69	---	---	---	---	27
HA-18	HA-18	2-4	Silty Black Fill w/ Gravel & Debris	3.3	12/03/20	---	39 J	31 J	---	<8.8	---	<11	---	---	<24	4,300	47	---	---	---	---	15
HA-19	HA-19	2-4	Silty Clay w/ Gravel & Black Fill	0.1	12/03/20	---	<25	<26	---	<10	---	<13	---	---	<27	41 J	46	---	---	---	---	36

Key:

<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
µg/kg = microgram per kilogram
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

Table A.3. Residual Soil Contamination Table(s), RCRA Metals Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample					Laboratory Result (mg/kg)							
					RCRA Metals							
Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	Arsenic (total)	Barium	Cadmium	Chromium	Lead (total)	Mercury	Selenium	Silver
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	8* [0.677]	15,300	71.1	NE	400	3.13	391	391
				Industrial	8* [3.00]	100,000	985	NE	800	3.13	5,840	5,840
WDNR RCL for Protection of Groundwater					8* [0.584]	364* [164.8]	1* [0.752]	360,000	52* [27]	0.208	0.52	0.849
Background Threshold Value (BTV)					8	364	1	44	52	NE	NE	NE
SB10-1	SB10-1 (0-2)	0-2	Silty Sand	5/14/2019	2.8	19	0.35	7.1	48	0.066	0.91 J	1.0
	SB10-1 (4-5)	4-5	Silty Sand	5/14/2019	1.5	17	0.21 J	7.3	3.4	0.013 J	<0.64	1.5
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	08/21/19	41	55	1.7 B	14	390	0.23	0.84 J	1.6
SB11	SB11 (2-4)	2-4	Sand	08/21/19	9.3	54	1.2 B	14	440	0.41	1.5	1.5
SB12	SB12 (2-4)	2-4	Fill / Silty Clay	08/21/19	11	64	1.6 B	16	480	0.54	2.0	1.8
SB13	SB13 (2-4)	2-4	Sand	08/21/19	34	60	1.7 B	18	570	0.60	1.5	1.7
SB14	SB14 (0-2)	0-2	Silty Clay	08/21/19	2.7	45	0.13 JB	15	25	0.067	0.73 J	2.5
SB15	SB15 (2-4)	2-4	Sand	08/21/19	240	49	25 B	13	97,000	12	4.4	7.4
SB16	SB16 (2-4)	2-4	Silty Clay	08/21/19	11	40	0.44 B	16	84	0.10	0.75 J	1.5
SB17	SB17 (2-4)	2-4	Sand	08/21/19	15	79	1.7 B	14	560	0.45	2.2	1.6
HA-1	HA-1	0-2	Fill / Silty Clay	04/15/20	3.5	79	0.24	26	73	0.070	<0.67	0.45 J
HA-2	HA-2	0-2	Fill / Silty Clay	04/15/20	11	61	2.6	15	470	0.19	1.0 J	0.97
HA-3	HA-3	0-2	Fill / Silty Clay	04/15/20	11	56	0.92	16	220	0.32	0.74 J	0.56 J
HA-4	HA-4	0-2	Fill / Silty Clay	04/15/20	6.7	59	1.1	13	140	0.12	1.1	0.78
HA-5	HA-5	0-2	Fill / Silty Clay	04/15/20	8.1	55	0.64	16	160	0.15	<0.64	0.45 J
HA-6	HA-6	0-2	Fill / Silty Sand	04/15/20	6.8	37	0.36	12	91	0.053	<0.61	0.27 J
HA-7	HA-7	0-2	Fill / Silty Clay	04/15/20	5.0	44	0.43	16	86	0.041	<0.64	0.53 J
HA-8	HA-8	0-2	Fill / Silty Clay	04/15/20	6.2	54	0.58	16	150	0.080	<0.64	0.51 J
HA-9	HA-9	0-2	Fill / Silty Sand	04/15/20	3.0	37	0.18 J	13	53	0.16	<0.65	0.23 J
HA-10	HA-10	0-2	Fill / Silty Clay	04/15/20	5.0	41	0.44	16	190	0.22	<0.64	0.36 J
HA-11	HA-11	0-2	Fill / Silty Clay	04/15/20	7.9	70	0.83	19	250	0.19	1.1	0.82
HA-16	HA-16	2-4	Silty Clay w/ Black Fill	12/03/20	5.7	75	0.53	25	150	0.14	<0.62	<0.14
HA-17	HA-17	0-2	Silty Black Fill	12/03/20	6.0	44	0.79	14	260	0.17	<0.62	<0.14
HA-17	HA-17	2-4	Silty Black Fill	12/03/20	8.3	73	1.3	17	330	0.42	<0.69	0.16 J
HA-18	HA-18	0-2	Silty Black Fill w/ Gravel	12/03/20	4.9	68	0.65	16	82	0.12	<0.67	0.16 J
HA-18	HA-18	2-4	Silty Black Fill w/ Gravel and Debris	12/03/20	5.6	36	0.57	12	120	0.12	<0.65	<0.14

Key:

RCRA = Resource Conservation and Recovery Act

<x = compound not detected to a detection limit of x

XXX = exceeds WDNR Non-Industrial RCL for direct contact risk

XXX = exceeds WDNR Industrial RCL for direct contact risk

XXX = exceeds WDNR RCL for protection of groundwater

mg/kg = milligram per kilogram

NE = not established by WAC (Wis. Adm. Code) or WDNR Soil RCL Summary Table

"J" = analyte detected between the limit of detection and limit of quantification

RCL = residual contaminant level

fbg = feet below ground

= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes:

WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

For the purpose of this evaluation under ch. NR 700, background threshold values are being considered as representative of background conditions.

However, constituent concentrations less than background threshold values may represent a potential health risk if concentrations are greater than health-based standards.

Table A.3. Residual Soil Contamination Table(s), Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

					PAH Compound Laboratory Result (µg/kg)																
Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthrancene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	3,590,000	NE	17,900,000	1,140	115	1,150	NE	11,500	115,000	115	2,390,000	2,390,000	1,150	17,600	239,000	5,520	NE	1,790,000
				Industrial	45,200,000	NE	100,000,000	20,800	2,110	21,100	NE	211,000	2,110,000	2,110	30,100,000	30,100,000	21,100	72,700	3,010,000	24,100	NE	22,600,000
WDNR RCL for Protection of Groundwater					NE	NE	196,949.2	NE	470	478	NE	NE	144	NE	88,877.8	14,829.9	NE	NE	NE	658.2	NE	54,545
SB6	SB6 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	32 J	39	160	410	480	940	210	<11	580	58	660	29 J	190	180	250	150	610	800
SB7	SB7 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	9.8 J	31 J	39	180	220	300	140	150	240	52	210	7.1 J	120	52 J	86	47	210	280
SB9	SB9 (0-2)	0-2	Topsoil/Silty Clay	5/14/2019	1,200	1,900	3,500	9,100	14,000	16,000	2,800	10,000	11,000	2,100	19,000	1,600	4,700	870	770 J	1,000	22,000	32,000
SB10-1	SB10 (0-2)	0-2	Silty Sand	5/14/2019	7.2 J	6.5 J	22 J	100	120	180	100	38	170	38	130	<4.9	85	29 J	38 J	29 J	150	170
SB10-2	SB10-2 (2-4)	2-4	Silty Clay	8/21/2019	22 J	28 J	84	290	280	480	210	160	390	52	480	21 J	150	220	260	200	450	470
SB11	SB11 (2-4)	2-4	Sand	8/21/2019	810	240	2,000	5,200	5,200	6,900	1,700	2,800	5,900	440	15,000	650	1,500	400	510	520	11,000	13,000
SB12	SB12 (2-4)	2-4	Fill / Silty Clay	8/21/2019	47 J	65 J	120 J	650	630	990	300	300	920	92 J	1,100	59 J	240	260 J	310 J	200	950	1,300
SB13	SB13 (2-4)	2-4	Sand	8/21/2019	85	29 J	260	790	840	1,300	320	520	1,000	79	2,100	68	270	150	200	130	1,300	1,600
SB15	SB15 (2-4)	2-4	Sand	8/21/2019	26 J	22 J	95	310	310	660	220	180	850	62	600	40	160	180	410	240	1,000	580
SB16	SB16 (2-4)	2-4	Silty Clay	8/21/2019	1,700	420	4,000	11,000	9,000	11,000	2,500	3,700	13,000	890	25,000	1,500	2,100	1,100	830	600	28,000	32,000
SB17	SB17 (2-4)	2-4	Sand	8/21/2019	1,100	550	2,300	5,900	5,800	8,600	2,000	3,800	6,800	520	16,000	930	1,800	940	1,100	1,100	13,000	14,000

Table A.3. Residual Soil Contamination Table(s), Polynuclear Aromatic Hydrocarbon Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Boring Number	Sample Number	Depth (fbg)	Soil Description	Date Collected	PAH Compound Laboratory Result (µg/kg)																
					Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthrancene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Pyrene
WDNR RCL for Protection from Direct Contact Risk				Non-Industrial	3,590,000	NE	17,900,000	1,140	115	1,150	NE	11,500	115,000	115	2,390,000	2,390,000	1,150	17,600	239,000	5,520	NE	1,790,000
				Industrial	45,200,000	NE	100,000,000	20,800	2,110	21,100	NE	211,000	2,110,000	2,110	30,100,000	30,100,000	21,100	72,700	3,010,000	24,100	NE	22,600,000
WDNR RCL for Protection of Groundwater					NE	NE	196,949.2	NE	470	478	NE	NE	144	NE	88,877.8	14,829.9	NE	NE	NE	658.2	NE	54,545
HA-2	HA-2	0-2	Fill / Silty Clay	04/15/20	52 J	<26	160 J	950	1,200	1,800	460	730	1,300	120 J	2,300	55 J	420	390 J	410	240	1,400	2,000
HA-3	HA-3	0-2	Fill / Silty Clay	04/15/20	56 J	41 J	180 J	1,200	1,400	2,000	820	780	1,600	140 J	2,500	61 J	710	340 J	410	260	1,500	2,300
HA-4	HA-4	0-2	Fill / Silty Clay	04/15/20	190 J	150 J	540	2,400	2,700	3,600	890	1,200	2,800	250	4,800	160 J	870	420	460	410	3,100	4,900
HA-5	HA-5	0-2	Fill / Silty Clay	04/15/20	80 J	64 J	200	1,100	1,400	2,200	510	730	1,400	180 J	2,100	51 J	480	220 J	300 J	290	1,200	2,100
HA-6	HA-6	0-2	Fill / Silty Sand	04/15/20	190	39 J	400	1,300	1,400	1,900	440	570	1,300	100 J	2,400	160 J	320	120 J	120 J	150 J	1,900	2,300
HA-7	HA-7	0-2	Fill / Silty Clay	04/15/20	49	41	100	440	450	580	180	260	480	41	760	43	170	86	100	81	630	800
HA-8	HA-8	0-2	Fill / Silty Clay	04/15/20	100	140	310	1,100	1,200	1,600	340	630	1,200	100	2,300	96	330	100	140	160	1,600	2,600
HA-9	HA-9	0-2	Fill / Silty Sand	04/15/20	14 J	14 J	48	180	170	210	100	55	190	24 J	300	12 J	93	21 J	35 J	25 J	240	300
HA-10	HA-10	0-2	Fill / Silty Clay	04/15/20	40 J	44 J	150 J	530	620	1,000	150 J	250	720	<36	980	35 J	220	120 J	160 J	150 J	600	970
HA-11	HA-11	0-2	Fill / Silty Clay	04/15/20	<36	33 J	140 J	350	370	350	<65	120 J	460	<39	530	59 J	<52	230 J	390 J	130 J	650	690
HA-16	HA-16	0-2	Silty Clay	12/03/20	31 J	6.7 J	78	150	170	200	110	73	160	28 J	330	28 J	89	15 J	13 J	9.8 J	280	320
HA-16	HA-16	2-4	Silty Clay w/ Black Fill	12/03/20	140	47	320	830	910	1,200	270	470	850	79	2,000	110	260	65 J	83	69	1,400	1,800
HA-17	HA-17	0-2	Silty Black Fill	12/03/20	320	180 J	790	2,800	3,200	4,300	1,000	1,300	3,000	280	6,500	270	980	160 J	160 J	250	4,000	6,000
HA-17	HA-17	2-4	Silty Black Fill	12/03/20	460	130 J	980	2,800	3,100	4,200	980	1,500	3,000	270	6,700	380	930	200 J	200 J	300	4,900	6,300
HA-18	HA-18	0-2	Silty Black Fill w/ Gravel	12/03/20	24 J	28 J	76	490	830	1,600	340	540	900	84	1,400	18 J	360	390	1,100	2,500	860	1,200
HA-18	HA-18	2-4	Silty Black Fill w/ Gravel and Debris	12/03/20	1,100	230	1,500	2,400	1,800	3,200	600	980	2,600	180 J	6,700	1,000	500	860	1,600	2,900	5,700	6,400
HA-19	HA-19	2-4	Silty Clay w/ Gravel and Black Fill	12/03/20	63	24 J	160	280	300	320	120	140	280	38	590	69	110	50 J	49 J	53	710	540

Key:

<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
µg/kg = milligram per kilogram
NE = not established by WAC (Wis. Adm. Code) or WDNR Soil RCL Summary Table
"J" = analyte detected between the limit of detection and limit of quantification
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

Table A.3. Residual Soil Contamination Table(s), Volatile Organic Compound Laboratory Results, Fox Shores Apartments, Kaukauna, Wisconsin

Sample						VOC Compound Laboratory Result (µg/kg)																
Boring Number	Sample Number	Depth (fbg)	Description	PID Response (iui)	Date Collected	Acetone	1,2,4-Trimethyl benzene	1,3,5-Trimethyl benzene	1,2,3-Trimethyl benzene	Benzene	2-Butanone	Ethylbenzene	Isopropylbenzene	Methylene Chloride	Methyl tert-butyl ether	Naphthalene	Total Xylenes	n-Butylbenzene	n-Propylbenzene	p-Isopropyltoluene	sec-Butylbenzene	Toluene
WDNR NR 720 Direct Contact RCL					Non-Industrial	63,400,000	219,000	182,000	293000	1,600	28,400,000	8,020	NE	61,800	63,800	5,520	260,000	108,000	NE	162,000	145,000	818,000
					Industrial	100,000,000	219,000	182,000	293,000	7,070	28,400,000	35,400	NE	1,150,000	282,000	24,100	260,000	108,000	NE	162,000	145,000	818,000
WDNR NR 720 Groundwater Protection RCL						3,676.6	1378.7 combined		NE	5.1	1,666.1	1,570	NE	2.6	27	658.2	3,960	NE	NE	NE	NE	1,107.2
SB6	SB6 (0-2)	0-2	Topsoil/Silty Clay	1.3	5/14/2019	---	66 J	<26	---	22	---	<13	<26	<110	<27	---	170	<27	<29	<25	<27	110
SB11	SB11 (2-4)	2-4	Sand	4.3	08/21/19	---	<25	<26	---	<10	---	<13	<26	110 J	<27	---	<15	<27	<28	<25	<27	43
SB13	SB13 (2-4)	2-4	Sand	2.7	08/21/19	---	<25	<26	---	<10	---	<13	<27	120 J	<27	---	<15	<27	<29	<25	<28	<10
SB14	SB14 (0-2)	0-2	Silty Clay	1.5	08/21/19	---	<21	<23	---	<8.7	---	<11	<23	110 J	<23	---	<13	<23	<25	<22	<24	<8.7
SB15	SB15 (4-6)	4-6	Silty Clay	>300	08/21/19	---	1900	540	---	<10	---	<13	98	130 J	<27	---	72	<27	200	510	200	<8.7
SB17	SB17 (2-4)	2-4	Sand	2.2	08/21/19	---	2700	1200	---	<9.1	---	<11	<24	110 J	<25	---	320	<24	370	170	250	<9.2
HA-4	HA-4	0-2	Fill / Silty Clay	---	04/15/20	---	56 J	<25	---	18	---	26	<25	<110	<26	---	160	<25	<27	<24	<26	77
HA-5	HA-5	0-2	Fill / Silty Clay	---	04/15/20	---	77	<26	---	140	---	49	<26	<110	<27	---	270	<27	<28	<25	<27	260
HA-8	HA-8	0-2	Fill / Silty Clay	---	04/15/20	---	23 J	<25	---	19	---	18	<25	<110	<25	---	67	<25	<27	<23	<26	49
HA-18	HA-18	2-4	Silty Black Fill w/ Gravel & Debris	3.3	12/03/20	---	39 J	31 J	---	<8.8	---	<11	---	---	<24	4,300	47	---	---	---	---	15

Key:

<x = compound not detected to a detection limit of x
XXX = exceeds WDNR Non-Industrial RCL for direct contact risk
XXX = exceeds WDNR Industrial RCL for direct contact risk
XXX = exceeds WDNR RCL for protection of groundwater
µg/kg = microgram per kilogram
RCL = residual contaminant level
fbg = feet below ground
= Boring completed and sample collected by Partner Engineering and Science, Inc.

Notes: WDNR soil RCL Summary table (December 2018) used to establish RCLs for groundwater protection and direct contact.

Table A.4. Vapor Analytical Table(s), Fox Shores Apartments, Kaukauna, Wisconsin

Sample Location Building Address	Sample Point	Date Sampled	Date Analyzed	Sample Location	Sample Duration	Detected Volatile Organic Compounds (micrograms per cubic meter)
						Dichlorodifluoro-methane
Target Indoor Air Concentration (micrograms per cubic meter) *				Residential		100
				Small Commercial		440
Target Sub-Slab Air Concentration (micrograms per cubic meter)				Residential		3,300
				Small Commercial		15,000
400 Fox Shores Drive	VP-1	10/03/18	10/05/18	Water softner room sub-slab	30 Minutes	7,060
400 Fox Shores Drive	VP-2	10/03/18	10/06/18	Water softner room sub-slab	30 Minutes	126,000
400 Fox Shores Drive	VP-3	10/03/18	10/06/18	Water softner room sub-slab	30 Minutes	79,000
400 Fox Shores Drive	VP-4 Ambient	02/25/19	03/01/19	Apartment indoor air	24 Hour	19
400 Fox Shores Drive	VP-5 Ambient	02/25/29	03/01/19	Apartment indoor air	24 Hour	6.0
400 Fox Shores Drive	VP-6 Ambient	02/25/19	03/01/19	Apartment indoor air	24 Hour	5.3
400 Fox Shores Drive	VP-4	02/26/19	03/01/19	Apartment sub-slab	30 Minutes	1,800
		08/13/19	08/16/19	Apartment sub-slab	30 Minutes	9,100
400 Fox Shores Drive	VP-5	02/26/19	03/01/19	Apartment sub-slab	30 Minutes	2,700
		08/13/19	08/21/19	Apartment sub-slab	30 Minutes	11,000
400 Fox Shores Drive	VP-6	02/26/19	03/02/19	Apartment sub-slab	30 Minutes	4,700
		08/13/19	08/21/19	Apartment sub-slab	30 Minutes	5,100
400 Fox Shores Drive	VP-2R	02/26/19	03/02/19	Water softner room sub-slab	30 Minutes	35,000

Note:
NSL = no screening level assigned from EPA Region 3 Screening Level Table - Residential Air, November 2017
* = screening levels from USEPA Region 3 Screening Level Table - November 2017 and, if applicable, representing 1 in 100,000 cancer risk
x = analyte exceeds applicable target air concentration
= Sample collected by Partner Engineering and Science Inc.

A.5. - Other Media of Concern

No other media was of concern at the Site.

Table **A.6.** Water Level Elevations, Fox Shores Apartments, 400 Fox Shores Drive, Kaukauna, Wisconsin

Well I.D.	Ground Surface Elevation (site datum)	Reference Point Elevation (site datum)	Top / Bottom Well Screen Elevation (fbg)	Date	Depth to Water (feet)		Water Table Elevation (feet)
					Below Grade	Below Riser	
TW10	98.59	98.46	3-10	8/21/2019	4.20	4.07	94.39
				8/28/2019	4.02	3.89	94.57
				4/16/2020	3.86	3.73	94.73
TW11	98.61	98.44	4-9	8/21/2019	4.79	4.62	93.82
				8/28/2019	4.72	4.55	93.89
				4/16/2020	4.50	4.33	94.11
TW13	97.93	97.74	3.5-8.5	8/21/2019	5.55	5.36	92.38
				8/28/2019	5.12	4.93	92.81
				4/16/2020	4.87	4.68	93.06
TW15	98.15	97.96	3.5-8.5	8/21/2019	6.14	5.95	92.01
				8/28/2019	4.88	4.69	93.27
				4/16/2020	4.06	3.87	94.09
TW17	97.86	97.66	3-8	8/21/2019	4.90	4.70	92.96
				8/28/2019	4.73	4.53	93.13
				4/16/2020	4.26	4.06	93.60

Key:

fbg = Feet Below Grade

--- = Not Collected

A.7. - Other

Not applicable.

ATTACHMENT B – MAPS, FIGURES, AND PHOTOS

TABLE OF CONTENTS

B.1. Location Maps

B.1.a. Location Map……..……..1 page

B.1.b. Detailed Site Map……..……..……..1 page

B.1.c. RR Sites Map……..……..……..1 page

B.2. Soil Figures

B.2.a. Soil Contamination.……..……1 page

B.2.b. Residual Soil Contamination……..……1 page

B.3. Groundwater Figures

B.3.a-1. Geological Cross-Section Figure(s)……..……1 page

B.3.a-2. Geological Cross-Section Figure(s)……..……1 page

B.3.b. Groundwater Isoconcentration……..……1 page

B.3.c. Groundwater Flow Direction……..……1 page

B.3.d. Monitoring Wells……..……..……1 page

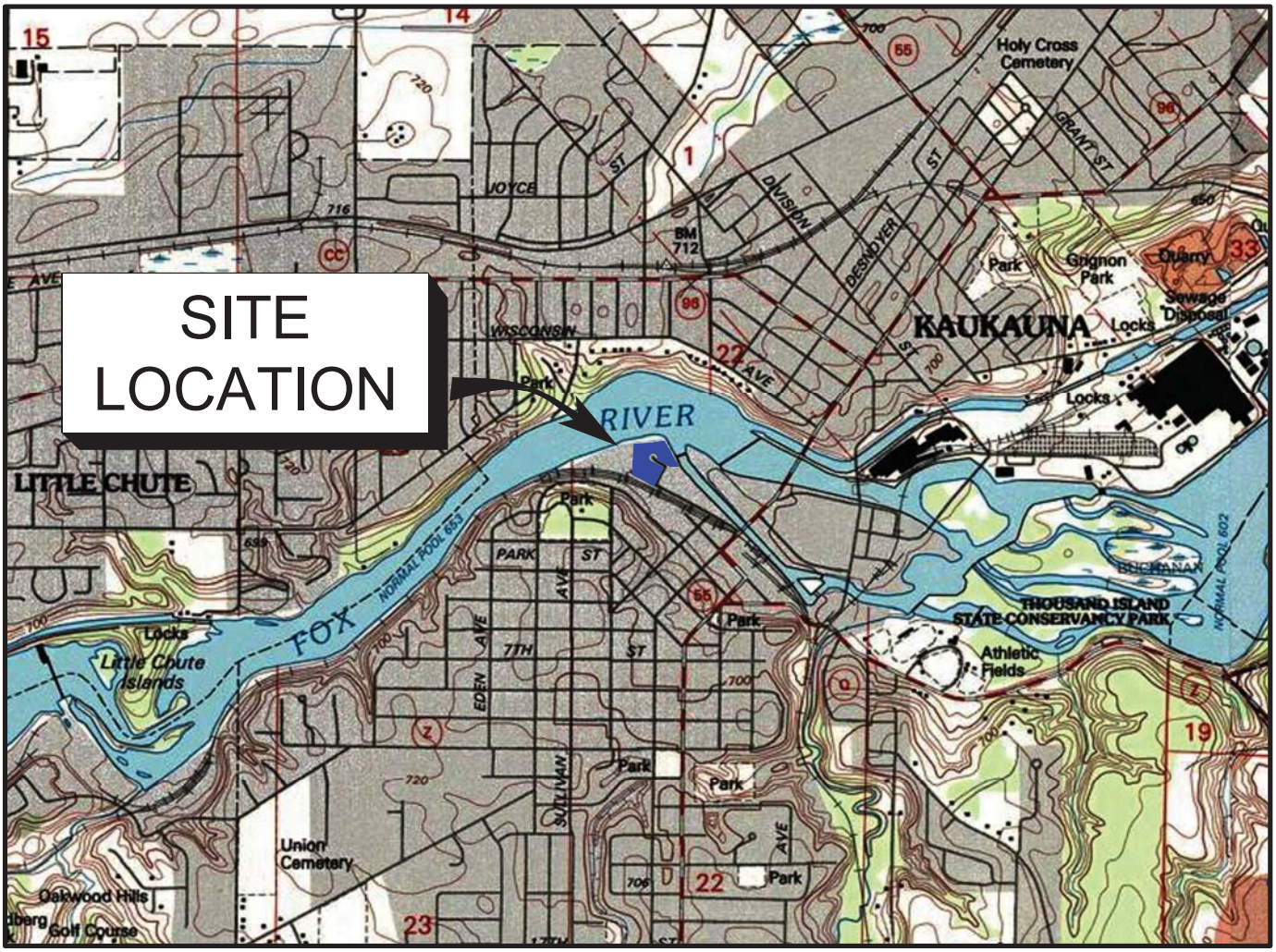
B.4. Vapor Maps and Other Media

B.4.a. Vapor Intrusion Map…..……..……..1 page

B.4.b. Other Media of Concern.……..……..……..NA

B.4.c. Other……...……..……..NA

B.5. Structural Impediment Photos……..NA



SCALE IN FEET

1" = 2000'

0 1000 2000 3000 4000 5000 6000 7000 8000

N

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929



QUADRANGLE LOCATION

BASE MAP SOURCE: USGS 7.5 MINUTE QUADRANGLE, KAUKAUNA, WISCONSIN, 1982 (NATIONAL GEOGRAPHIC HOLDINGS, INC.)

Stantec

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B.1.a. LOCATION MAP

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 02/05/21	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE B.1.a.



N

SCALE IN FEET

30 0 30 60

LEGEND

	APPROXIMATE PROPERTY LINE
TW10	ABANDONED STANTEC TEMPORARY MONITORING WELL LOCATION
B1–GW	ABANDONED PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION
B1	PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
SB6	STANTEC SOIL BORING LOCATION
HA–1	STANTEC HAND AUGER SOIL BORING LOCATION

Stantec

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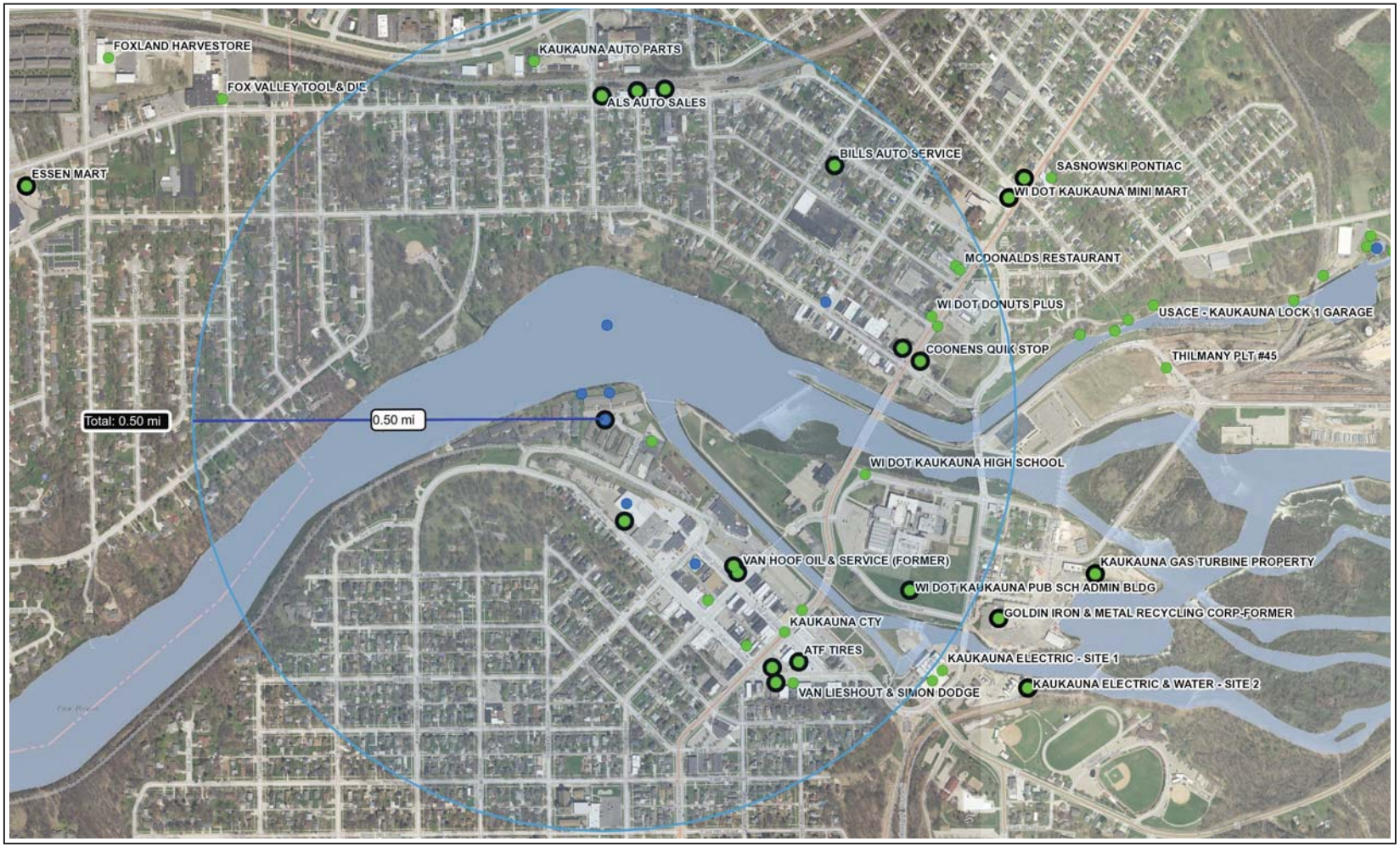
B.1.b. DETAILED SITE MAP

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
02/05/21	JRB	JRB	193706620	B.1.b.

B.1.c. RR Sites Map





Legend

- Open Site
- Closed Site
- Continuing Obligations Apply
- Facility-wide Site

0.3 0 0.13 0.3 Miles

NAD_1983_HARN_Wisconsin_TM

1: 7,920

© Latitude Geographics Group Ltd.

DISCLAIMER: The information shown on these maps has been obtained from various sources, and are of varying age, reliability and resolution. These maps are not intended to be used for navigation, nor are these maps an authoritative source of information about legal land ownership or public access. No warranty, expressed or implied, is made aregarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map. For more information, see the DNR Legal Notices web page: http://dnr.wi.gov/org/legal/

Note: Not all sites are mapped.

Notes



N

SCALE IN FEET

30 0 30 60

LEGEND

- B1 — PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
- SB6 — STANTEC SOIL BORING LOCATION
- HA–1 — STANTEC HAND AUGER SOIL BORING LOCATION
- APPROXIMATE PROPERTY LINE
- ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION (ASSUMED TO BE SITEWIDE)

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B.2.a. SOIL CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
04/24/20	JRB	JRB	193706620	B.2.a.



N

SCALE IN FEET

30 0 30 60

LEGEND

SB6 STANTEC SOIL BORING LOCATION

HA–1 STANTEC HAND AUGER SOIL BORING LOCATION

APPROXIMATE PROPERTY LINE

ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION (ASSUMED TO BE SITEWIDE)

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B.2.b. RESIDUAL SOIL CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
04/24/20	JRB	JRB	193706620	B.2.b



N

SCALE IN FEET

30 0 30 60

LEGEND

B1	PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
SB6	STANTEC SOIL BORING LOCATION
HA–1	STANTEC HAND AUGER SOIL BORING LOCATION
VP–4	PARTNER ENGINEERING AND SCIENCE INC. SOIL GAS SAMPLE LOCATION (SAMPLE LOCATIONS ADJUSTED BASED ON FIELD OBSERVATIONS OF LOCATIONS)
VP–4	STANTEC AMBIENT AIR AND SOIL GAS SAMPLE LOCATION
	APPROXIMATE PROPERTY LINE

Stantec

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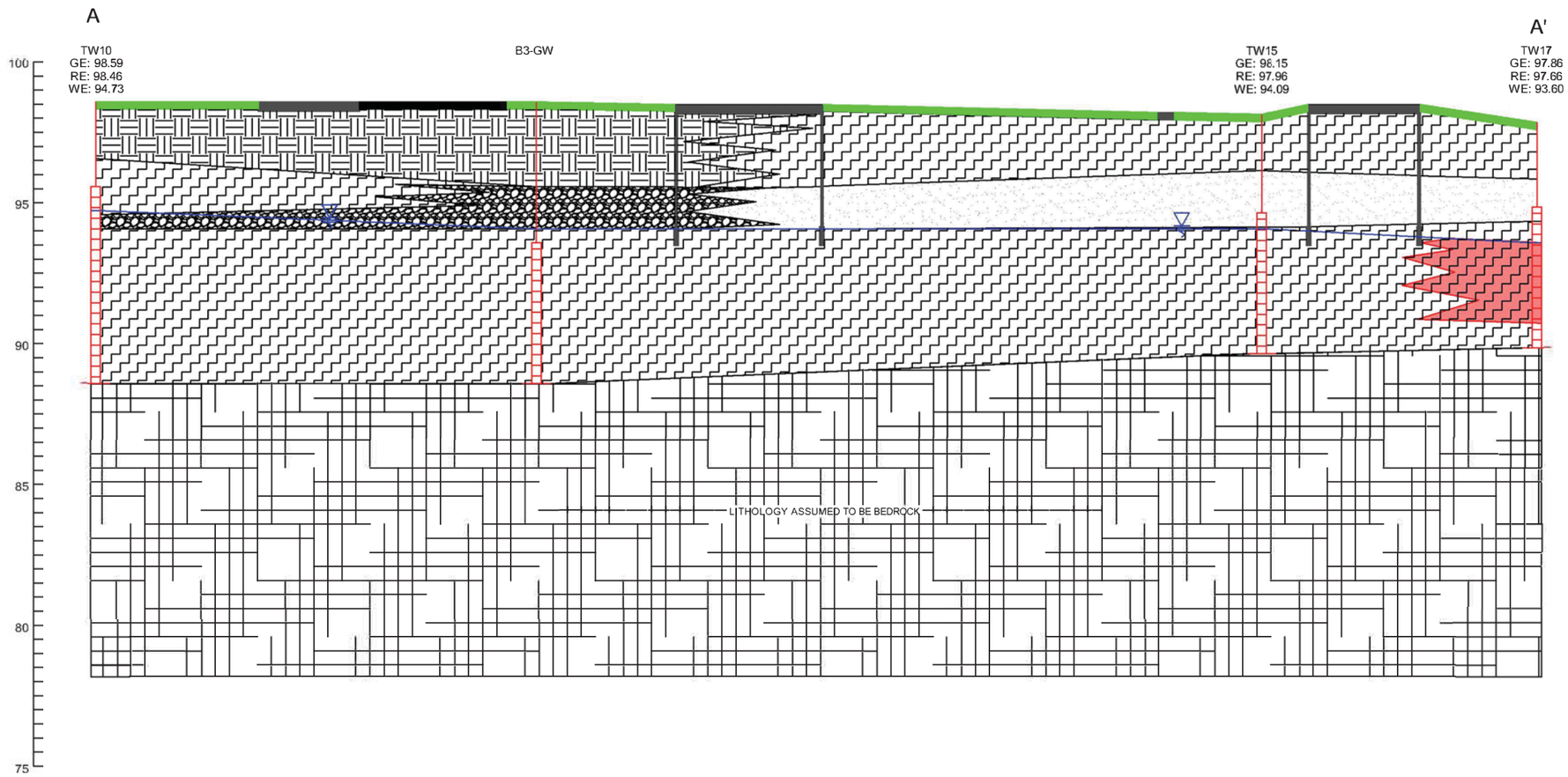
B.3.a-1.GEOLOGIC CROSS-SECTION FIGURE(S)

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIG.
05/22/20	JRB	JRB	193706620	B.3.a-1

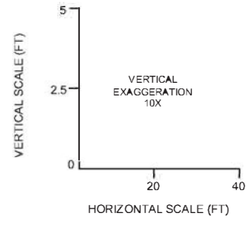


LEGEND

- ESTIMATED GROUNDWATER CONTAMINATION >ES
- TOPSOIL / GRASS
- ASPHALT
- CONCRETE
- CLAY
- BEDROCK
- SAND
- SILTY CLAY
- SAND AND GRAVEL
- = SOIL BORING/ GEOPROBE LOCATION
- = MONITORING WELL SCREEN LOCATION
- = GROUNDWATER TABLE 04-16-20

MW = MONITORING WELL
GE = GROUND ELEVATION (FEET)
RE= RISER ELEVATION (FEET)
WE= WATER ELEVATION (FEET)

NOTE: ENTIRE SITE ASSUMED TO BE IMPACTED WITH SOIL CONTAMINATION EXCEEDING RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION



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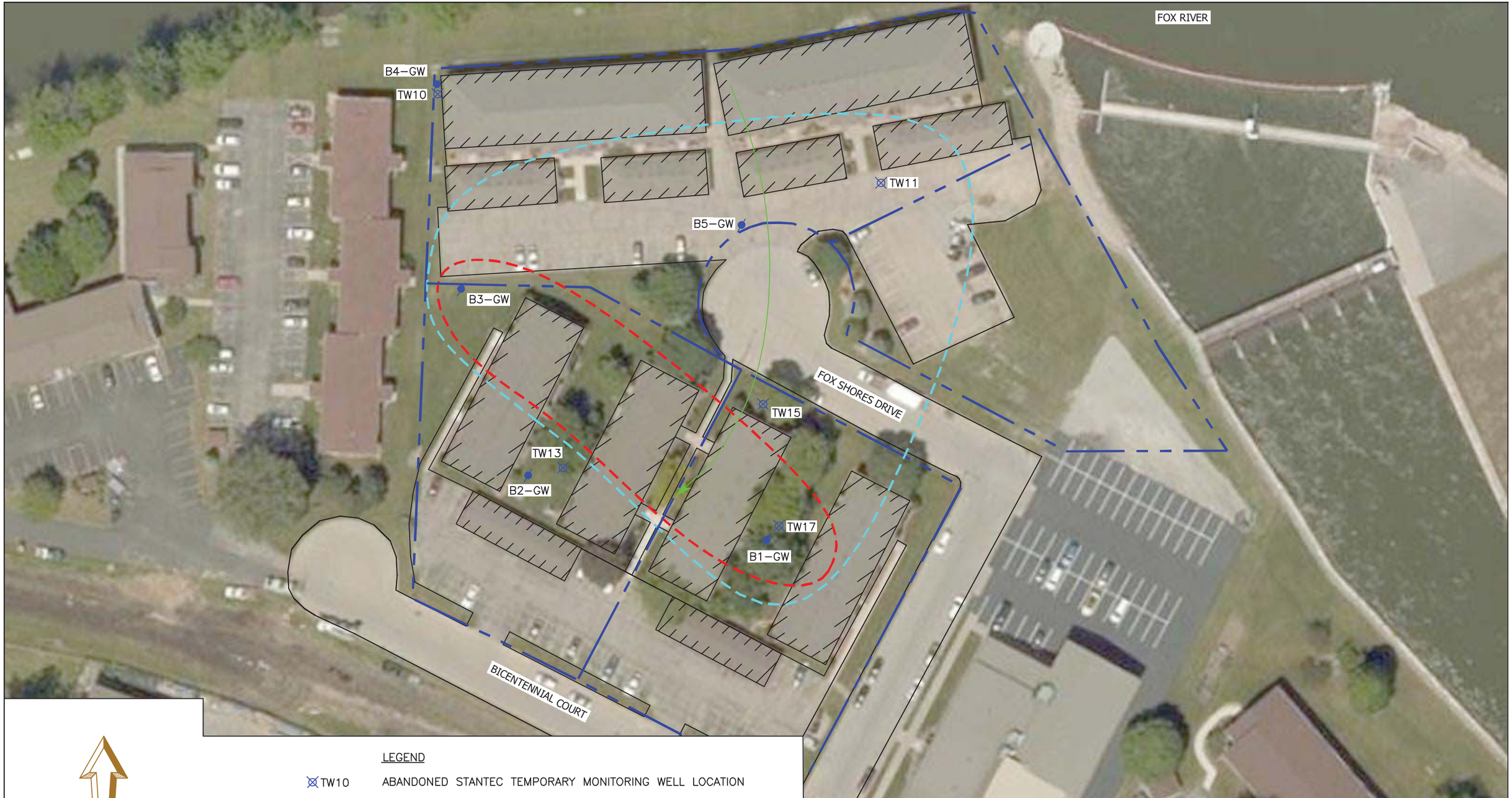
GEOLOGIC CROSS SECTION FIGURE(S)

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	TASK NUMBER:	PROJECT NUMBER:	FIG.
05/26/20	JRB	600	193706620	B.3.a-2.



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10	ABANDONED STANTEC TEMPORARY MONITORING WELL LOCATION
B1–GW	ABANDONED PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION
	APPROXIMATE PROPERTY LINE
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES
	GROUNDWATER FLOW DIRECTION (8/28/19)

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B.3.b.GROUNDWATER ISOCONCENTRATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
05/22/20	JRB	JRB	193706620	B.3.b



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10 94.57 — TEMPORARY MONITORING WELL LOCATION AND GROUNDWATER ELEVATION ON 08/28/19

—93.60— — GROUNDWATER CONTOUR LINE: DASHED WHERE INFERRED CONTOUR LINE INTERVAL = 0.1 FEET

GROUNDWATER FLOW DIRECTION

APPROXIMATE PROPERTY LINE

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B.3.c. GROUNDWATER FLOW DIRECTION (08/28/19)

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 09/10/19	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE B.3.c.



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10	ABANDONED STANTEC TEMPORARY MONITORING WELL LOCATION
B1–GW	ABANDONED PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION
	APPROXIMATE PROPERTY LINE

Stantec

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B.3.d. MONITORING WELLS

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
08/22/19	JRB	JRB	193706620	B.3.d



N

SCALE IN FEET

30 0 30 60

LEGEND

⊙VP–4 PARTNER ENGINEERING AND SCIENCE INC. SOIL GAS SAMPLE LOCATION (SAMPLE LOCATIONS ADJUSTED BASED ON FIELD OBSERVATIONS OF LOCATIONS)

⊙VP–4 STANTEC AMBIENT AIR AND SOIL GAS SAMPLE LOCATION

APPROXIMATE PROPERTY LINES ASSOCIATED WITH BRRTS #02–45–582746

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B.4.a. VAPOR INTRUSION MAP

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE: 12/08/20	DRAWN BY: JRB	PROJECT MANAGER: JRB	PROJECT NUMBER: 193706620	FIGURE B.4.a.

B.4.b. Other Media of Concern

No other media was of concern at the Site.

B.4.c. Other

No other relevant maps or figures.

B.5. Structural Impediment Photos

No structural impediments hindered investigation or remedial action activities of the Site.

ATTACHMENT C – DOCUMENTATION OF REMEDIAL ACTION

TABLE OF CONTENTS

C.1. Site Investigation Documentation……1 page

C.2. Investigative Waste……...1 page

C.3. Description of Methodology……...1 page

C.4. Construction Documentation…….NA

C.5. Decommissioning of Remedial Systems……..NA

C.6. Other……..……..NA

C.1. Site Investigation Documentation

All site investigation and remedial action documentation has been submitted prior.

C.2. Investigative Waste

Investigative soil wastes were redeposited within the soil berms at the Property and capped during remediation of the Site.

C.3 Description of Methodology

Methodology used and residual contaminant levels determined using departmental RCL spreadsheets last updated on December 2018.

C.4 Construction Documentation

Not Applicable.

C.5 Decommissioning of Remedial Systems

No remediation system built for Site.

ATTACHMENT D – MAINTENANCE PLAN(S) AND PHOTOGRAPHS

TABLE OF CONTENTS

D.1. Descriptions of Maintenance Actions……..3 pages

D.2. Location Maps……..……3 pages

D.3. Photographs……...18 pages

D.4. Inspection Log……..……...2 pages

COVER MAINTENANCE PLAN

January 24, 2022

Property Located at:

380/400 Bicentennial Court; 400/410 Fox Shores Drive; Lot 2 CSM 6200

DNR BRRTS # 02-45-582746

Parcel Identification Numbers #323040800, #323040801, #323040802, #323040804

Introduction

This document is the Maintenance Plan for building structures, asphalt, concrete, gravel, and soil cover at the above-referenced property in accordance with the requirements of s. NR 724.13 (2), Wis. Adm. Code. The maintenance activities relate to the existing pavement, structural, or soil covers which addresses or occupies the area over the contaminated soil and groundwater plume.

More site-specific information about this property/site may be found in:

- The case file in the DNR Northeast Regional office
- At http://dnr.wi.gov/topic/Brownfields/wrrd.html, which includes:
  - BRRTS on the Web (DNR's internet-based data base of contaminated sites) for the link to a PDF for site-specific information at the time of closure and on continuing obligations;
  - RR Sites Map for a map view of the site, and
- The DNR project manager for Outagamie County.

D.1. Descriptions:

Description of Contamination

Soil contaminated by polycyclic aromatic hydrocarbons (PAHs), resource conservation and recovery act (RCRA) metals, and/or volatile organic compounds (VOCs) has been identified at a depth of 0 to 4 feet across the property. Groundwater contaminated by arsenic and PAHs is located at a depth of 4 to 6 feet below ground surface. The extent of the soil and groundwater contamination is shown on the attached **Figure D.2**.

Description of the Cover to be Maintained

The cover consists of either building structures, 6-8 inches of gravel, impermeable surfaces such as concrete and asphalt, or a landscape cap made up of permeable filter fabric overlain with clean fill totaling 12 inches. The cap is located across the entire property as shown on the attached **Figure D.2**.

Cover Purpose

The buildings, gravel, paved surfaces, and landscaped soils in place cover the remaining contaminated soil and groundwater and serve as a barrier to prevent direct human contact with residual soil contamination that might otherwise pose a threat to human health. Based on the current use of the property as a residential apartment complex, the barrier should function as intended unless disturbed.

Annual Inspection

The cover overlying the contaminated soil and groundwater and as depicted in **Figure D.2.** will be inspected once a year, normally in the spring after all snow and ice is gone, for deterioration, cracks and other potential problems that can cause exposure to underlying soils. The inspections will be performed by the property owner or their designated representative. The inspections will be performed to evaluate damage due to settling, exposure to the weather, wear from traffic, increasing age and other factors. Any area where soils have become or are likely to become exposed will be documented.

A log of the inspections and any repairs will be maintained by the property owner and is included as D.4, Form 4400-305, Continuing Obligations Inspection and Maintenance Log. The log will include recommendations for necessary repair of any areas where underlying soils are exposed and where infiltration from the surface will not be effectively minimized. Once repairs are completed, they will be documented in the inspection log. A copy of the maintenance plan and inspection log will be kept at the site; or, if there is no acceptable place (for example, no building is present) to keep it at the site, at the address of the property owner and available for submittal or inspection by Wisconsin Department of Natural Resources (DNR) representatives upon their request.

Maintenance Activities

If problems are noted during the annual inspections or at any other time during the year, repairs will be scheduled as soon as practical. Repairs can include patching and filling or larger resurfacing or construction operations. In the event that necessary maintenance activities expose the underlying soil, the owner must inform maintenance workers of the direct contact exposure hazard and provide them with appropriate personal protection equipment (PPE). The owner must also sample any soil that is excavated from the site prior to disposal to ascertain if contamination remains. The soil must be treated, stored and disposed of by the owner in accordance with applicable local, state and federal law.

In the event the gravel, soil cover, and/or impervious surfaces overlying the contaminated soil and groundwater are removed or replaced, the replacement barrier must be equally impervious. Any replacement barrier will be subject to the same maintenance and inspection guidelines as outlined in this Maintenance Plan unless indicated otherwise by the DNR or its successor.

The property owner, in order to maintain the integrity of the gravel, soil cover, and impervious surfaces, will maintain a copy of this Maintenance Plan at the site; or, if there is no acceptable place to keep it at the site (for example, no building is present), at the address of the property owner and make it available to all interested parties (i.e. on-site employees, contractors, future property owners, etc.) for viewing.

Prohibition of Activities and Notification of DNR Prior to Actions Affecting a Cover

The following activities are prohibited on any portion of the property where [pavement, a building foundation, soil cover, engineered cap or other barrier] is required as shown on the attached map, unless prior written approval has been obtained from the Wisconsin Department of Natural Resources: 1) removal of the existing barrier; 2) replacement with another barrier; 3) excavating or grading of the land surface; 4) filling on capped or paved areas; 5) plowing for agricultural cultivation; 6) construction or placement of a building or other structure; 7) changing the use or occupancy of the property to single-family residential use.

If removal, replacement or other changes to a cover, or a building which is acting as a cover, are considered, the property owner will contact DNR at least 45 days before taking such an action, to determine whether further action may be necessary to protect human health, safety, or welfare or the environment, in accordance with s. NR 727.07, Wis. Adm. Code.

Amendment or Withdrawal of Maintenance Plan

This Maintenance Plan can be amended or withdrawn by the property owner and its successors with the written approval of DNR.

Contact Information

January 2022

Site Owner and Operator:	Fox Shores LLC Logan Rankin 518 Main Street #346 Wrightstown, WI 54180 (920) 255-3259
Signature:	_____
Consultant:	Stantec Consulting Services Inc. Jeffrey R. Brand 1165 Scheuring Road De Pere, WI 54115 (920) 592-8400
DNR:	Sarah Krueger 2984 Shawano Avenue Green Bay, WI 54313-6727 (920) 510-8277

D.2 Map(s)

D. 3 Photographs of Cover/Barrier

D.4 Continuing Obligations Inspection and Maintenance Log
Form 4400-305



**NOTE: CAP EXISTS ACROSS THE ENTIRE SITE FOR INDUSTRIAL AND NON-INDUSTRIAL DIRECT CONTACT EXCEEDANCES OF PAHs AND METALS.

N

SCALE IN FEET

30 0 30 60

LEGEND

- BRRTS CASE #02-45-582746 AND ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION. (ASSUMED TO BE SITEWIDE)
- APPROXIMATE PROPERTY LINE
- ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES
- ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
- PAVED CAP
- BUILDING CAP
- BERM LOCATION
- LANDSCAPE CAP
- GAVEL CAP

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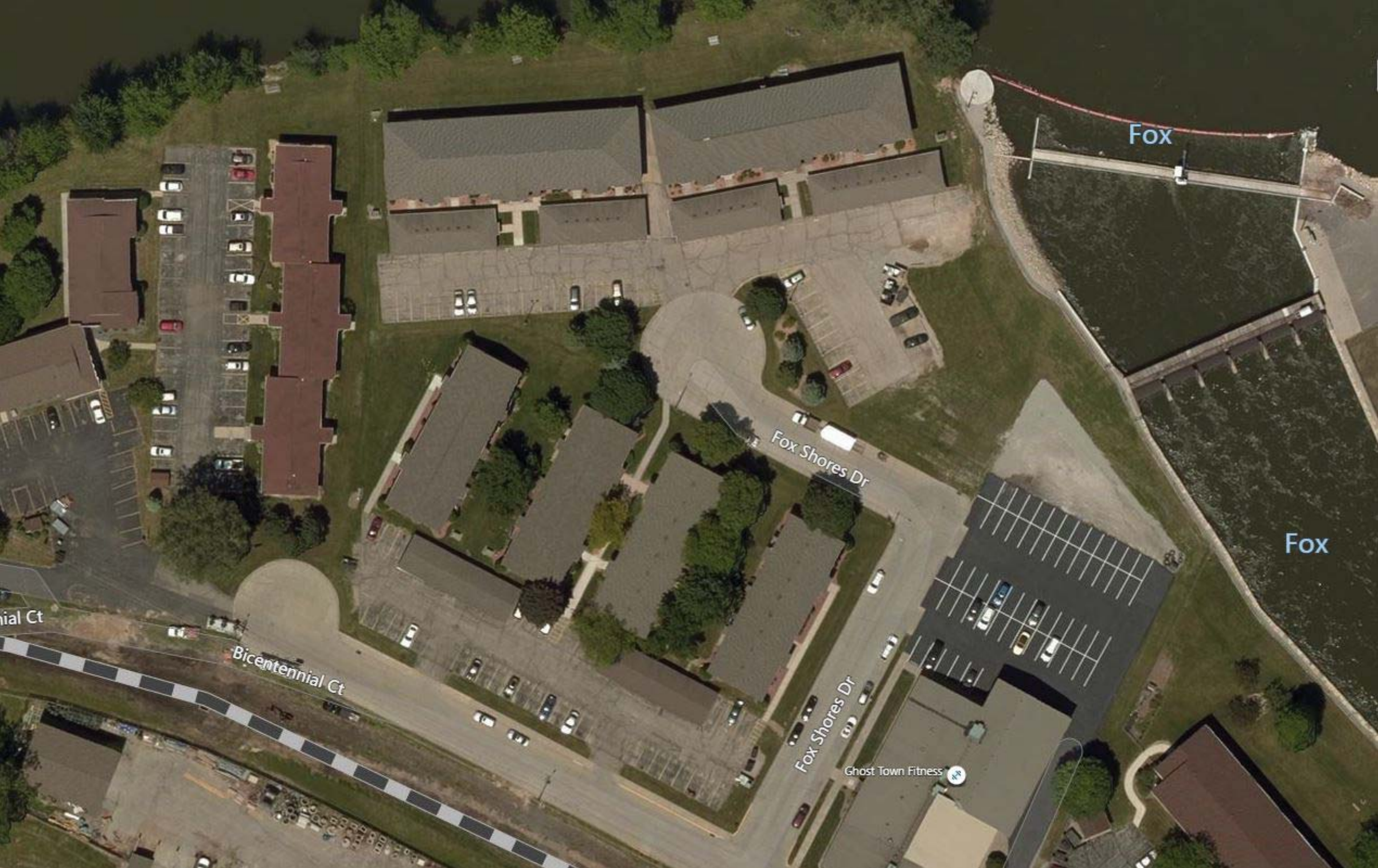
CAP LOCATION MAP

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
02/05/21	JRB	JRB	193706620	D.2.


Fox
Fox
Fox Shores Dr
Fox Shores Dr
Bicentennial Ct
Ghost Town Fitness

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 1

Photo Location:
Lot 2

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 2

Photo Location:
Lot 2

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Capped Berm



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 3

Photo Location:
Lot 2

Direction:
North

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 4

Photo Location:
380/390 Bicentennial Court

Direction:
Southwest

Survey Date:
9/28/2021

Comments:
Capped Berm



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 5	
Photo Location: 400 Bicentennial Court	
Direction: Northwest	
Survey Date: 9/28/2021	
Comments: Soil Cap	

Photograph ID: 6	
Photo Location: 400/410 Bicentennial Court	
Direction: Southwest	
Survey Date: 9/28/2021	
Comments: Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 7 **Photo Location:** 400/410 Bicentennial Court **Direction:** Northwest **Survey Date:** 9/28/2021 **Comments:** Soil Cap	
Photograph ID: 8 **Photo Location:** 410 Bicentennial Court **Direction:** Southwest **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 9

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 10

Photo Location:
410 Fox Shores Drive

Direction:
South

Survey Date:
9/28/2021

Comments:
Soil Cap



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 11 **Photo Location:** 410 Bicentennial Court **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Soil Cap With Added Mulch	
Photograph ID: 12 **Photo Location:** 390 Bicentennial Court **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Soil Cap With Added Mulch	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 13

Photo Location:
380 Bicentennial Court

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Soil cap



Photograph ID: 14

Photo Location:
380 Bicentennial Court

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Soil Cap



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 15 **Photo Location:** Lot 2 **Direction:** Northwest **Survey Date:** 9/28/2021 **Comments:** Soil Cap	
Photograph ID: 16 **Photo Location:** Lot 2 **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 17 **Photo Location:** Lot 2 **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Capped Berm	
Photograph ID: 18 **Photo Location:** Lot 2 **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Capped Berm	

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 19

Photo Location:
lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 20

Photo Location:
Lot 2

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 21

Photo Location:
Lot 2

Direction:
North

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 22

Photo Location:
lot 2

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 23

Photo Location:
380/390 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 24

Photo Location:
390/400 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 25

Photo Location:
400 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 26

Photo Location:
400/410 Bicentennial Court

Direction:
South

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 27

Photo Location:
410 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 28

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 29

Photo Location:
410 Fox Shores Drive

Direction:
East

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 30

Photo Location:
390/400 Bicentennial Court

Direction:
Northwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 31

Photo Location:
380 Bicentennial Court

Direction:
Southeast

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 32

Photo Location:
380 Bicentennial Court

Direction:
Northeast

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 33 **Photo Location:** 410 Fox Shores Drive **Direction:** North **Survey Date:** 7/28/2021 **Comments:** Lanscaping With Gravel Cap	
Photograph ID: 34 **Photo Location:** 410 Fox Shores Drive **Direction:** Northeast **Survey Date:** 7/28/2021 **Comments:** Lanscaping With Gravel Cap	

State of Wisconsin
Department of Natural Resources
dnr.wi.gov

Continuing Obligations Inspection and Maintenance Log

Form 4400-305 (R 7/20)

Directions: In accordance with s. NR 727.05 (1) (b) 3., Wis. Adm. Code, use of this form for documenting the inspections and maintenance of certain continuing obligations is required. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Public Records law [ss. 19.31-19.39, Wis. Stats.]. When using this form, identify the condition that is being inspected. See the closure approval letter for this site for requirements regarding the submittal of this form to the Department of Natural Resources. A copy of this inspection log is required to be maintained either on the property, or at a location specified in the closure approval letter. Do NOT delete previous inspection results. This form was developed to provide a continuous history of site inspection results. The Department of Natural Resources project manager is identified in the closure letter. The project manager may also be identified from the database, BRRTS on the Web, at http://dnr.wi.gov/botw/SetUpBasicSearchForm.do, by searching for the site using the BRRTS ID number, and then looking in the "Who" section.

Activity (Site) Name	BRRTS No.
Fox Shores Apartments	02-45-582746

Inspections are required to be conducted (see closure approval letter):

- (•) annually
- ( ) semi-annually
- ( ) other – specify _____

When submittal of this form is required, submit the form electronically to the DNR project manager. An electronic version of this filled out form, or a scanned version may be sent to the following email address (see closure approval letter):

Inspection Date	Inspector Name	Item	Describe the condition of the item that is being inspected	Recommendations for repair or maintenance	Previous recommendations implemented?	Photographs taken and attached?
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N

{Click to Add/Edit Image}

Date added:

Title:

{Click to Add/Edit Image}

Date added:

Title:

ATTACHMENT E – MONITORING WELL INFORMATION

TABLE OF CONTENTS

E.1. Monitoring Well Information……..……..1 page

E. Monitoring Well Information

All monitoring wells were located and have been properly abandoned.

ATTACHMENT F – SOURCE LEGAL DOCUMENTS

TABLE OF CONTENTS

F.1. Deed……..…….2 pages

F.2. Certified Survey Map……..……..5 pages

F.3. Verification of Zoning……...1 pages

F.4. Signed Statement……..……..1 pages

Document #: **2199610**
Date: **07-17-2020** Time: **12:27 PM**
Pages: **2** Fee: **$30.00**
County: **OUTAGAMIE COUNTY** State: **WI**
Transfer Fee: **$15300.00**

Sarah R Van Camp

SARAH R VAN CAMP, REGISTER OF DEEDS
Return via MAIL (REGULAR)
FOX SHORES LLC

State Bar of Wisconsin Form 1-2003

WARRANTY DEED

Document Number | Document Name

THIS DEED, made between GTFC Investments, LLC, a Wisconsin limited liability company, as to Parcels 1, 2, 3, 4 and Clay J. Eiting, as to Parcel 5 ("Grantor," whether one or more), and Fox Shores, LLC, a Wisconsin limited liability company ("Grantee," whether one or more).

Grantor for a valuable consideration, conveys to Grantee the following described real estate, together with the rents, profits, fixtures and other appurtenant interests, in Outagamie County, State of Wisconsin ("Property") (if more space is needed, please attach addendum):

SEE ATTACHED LEGAL DESCRIPTION

Recording Area

Name and Return Address
Fox Shores, LLC
Attn: Logan Rankin
109 E 8th Street
Kaukauna, WI 54130

(2)

See attached PINs
Parcel Identification Number (PIN)

This is not homestead property.
~~(is)~~ (is not)

Grantor warrants that the title to the Property is good, indefeasible, in fee simple and free and clear of encumbrances except:

municipal and zoning ordinances, recorded easements for public utilities serving the property, recorded building and use restrictions and covenants, and general taxes levied in the year of closing and will warrant and defend the same.

Dated July 15, 2020.

(SEAL)
* Clay J. Eiting, Individually

(SEAL)
*

GTFC INVESTMENTS, LLC

(SEAL)
* Clay J. Eiting, Member

(SEAL)
*

AUTHENTICATION

Signature(s) _____
_____
authenticated on _____
_____
*
TITLE: MEMBER STATE BAR OF WISCONSIN
(If not, _____
authorized by Wis. Stat. § 706.06)

JOSHUA J. SCHAEFER NOTARY PUBLIC STATE OF WISCONSIN

THIS INSTRUMENT DRAFTED BY:
Attorney Steven J. Frassetto
Appleton, WI 54912-0785

ACKNOWLEDGMENT

STATE OF WISCONSIN)
) ss.
OUTAGAMIE COUNTY)

Personally came before me on July 15, 2020,
the above-named Clay J. Eiting
to me known to be the person(s) who executed the foregoing instrument and acknowledged the same.

* Joshua J Schaefer
Notary Public, State of Wisconsin
My commission (is permanent) (expires: 4/21/21)

(Signatures may be authenticated or acknowledged. Both are not necessary.)

NOTE: THIS IS A STANDARD FORM. ANY MODIFICATION TO THIS FORM SHOULD BE CLEARLY IDENTIFIED.

LEGAL DESCRIPTION

Parcel 1: 400-410 Fox Shores Dr., Kaukauna WI 54130
Lot One (1), Certified Survey Map No. 6200 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on September 20, 2010, in Volume 36 on Page 6200, as Document No. 1886271, being part of Parcel "3", Outagamie County CSM No. 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040800

PARCEL 2: 380 Bicentennial Ct., Kaukauna WI 54130
All of Lot Two (2) of Certified Survey Map No. 307 as filed in the Office of the Register of Deeds for Outagamie County on June 13, 1983 in Volume 2 of Certified Survey Maps, on page 307 as Document No. 826686, being a part of Parcel "3", Outagamie County Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040802

PARCEL 3: 400 Bicentennial Ct., Kaukauna, WI 54130
All of Lot One (1), Certified Survey Map 307, recorded in Volume 2 of Certified Survey Maps, page 307, being part of Parcel 3, Certified Survey Map 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040801

PARCEL 4: Vacant Land
Lot Two (2), Certified Survey Map No. 6200 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on September 20, 2010, in Volume 36 on Page 6200, as Document No. 1886271, being part of Parcel "3", Outagamie County Certified Survey Map No. 59, being part of Gov't Lot 8, Section 21, Township 21 North, Range 18 East, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040804

Parcel 5: 180 Fox Shores Dr., Kaukauna, WI 54130
Lot One (1) of Certified Survey Map No. 348 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on August 9, 1984 in Volume 2 on page 348 as Document No. 849894, being part of Parcel 3, Outagamie County Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin, which was corrected by Affidavit recorded September 25, 1984 in Jacket 4928, Image 46, Document No. 852188.
Tax Parcel No. 323 040803

Document Number 1886271 Filed this 20 day of September, 2010 at 4:24 PM and filed in Volume 36 Stock No. 26273 of Certified Survey Maps on page 6200 as Certified Survey Map Number 6200.

Janice Flenz, Register of Deeds

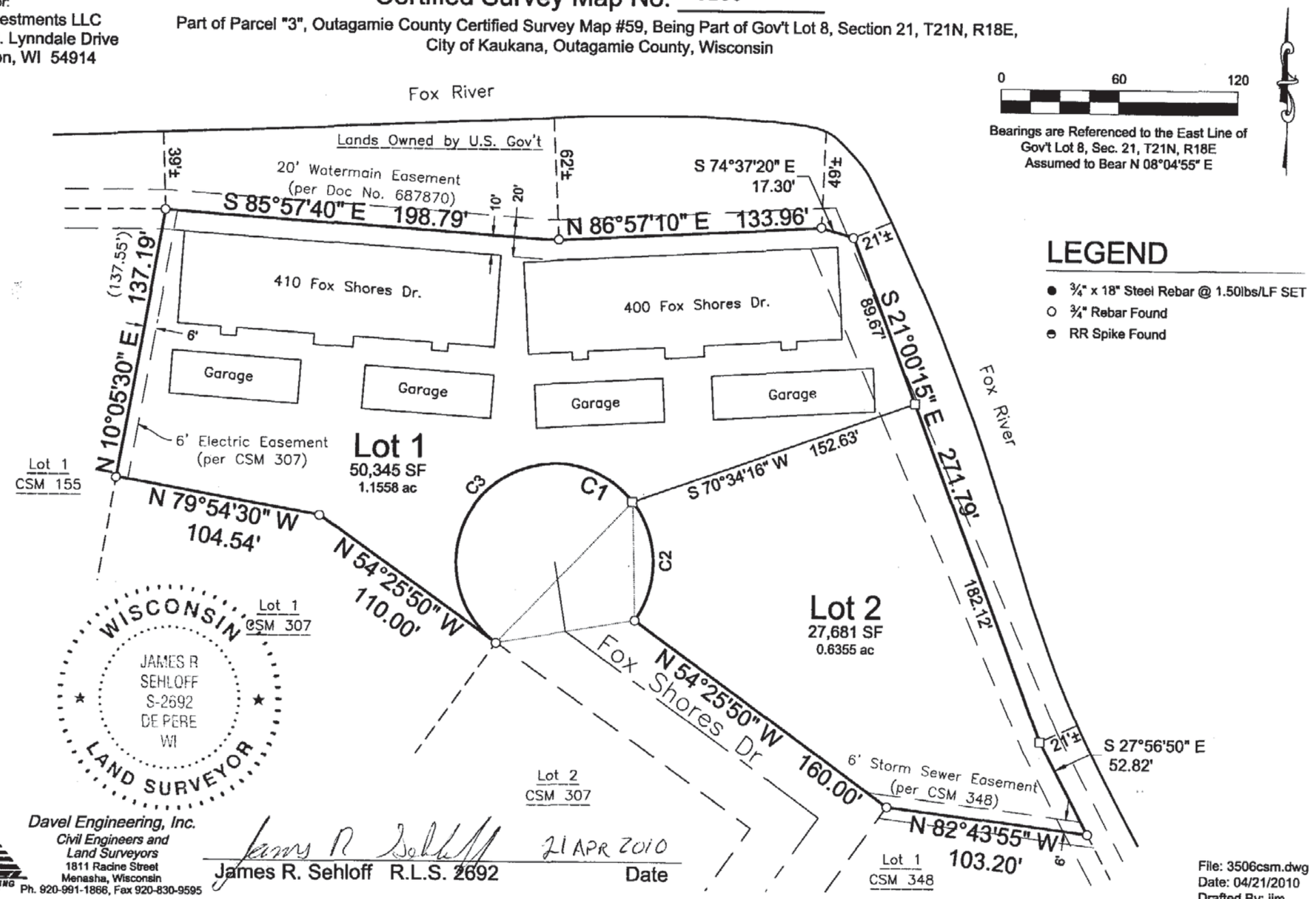
Page 6200 (Three Pages)

FORM NO. 985-A HCM Miller

Certified Survey Map No. 6200

Survey for:
Fox Investments LLC
2220 N. Lynndale Drive
Appleton, WI 54914

Part of Parcel "3", Outagamie County Certified Survey Map #59, Being Part of Gov't Lot 8, Section 21, T21N, R18E,
City of Kaukana, Outagamie County, Wisconsin



0 60 120

Bearings are Referenced to the East Line of Gov't Lot 8, Sec. 21, T21N, R18E Assumed to Bear N 08°04'55" E

LEGEND

- ● ¾" x 18" Steel Rebar @ 1.50lbs/LF SET
- ○ ¾" Rebar Found
- ◓ RR Spike Found

WISCONSIN
JAMES R SEHLOFF
S-2692
DE PERE
WI
LAND SURVEYOR

Davel Engineering, Inc.
Civil Engineers and Land Surveyors
1811 Racine Street
Menasha, Wisconsin
Ph. 920-991-1866, Fax 920-830-9595

James R Sehloff 21 APR 2010

James R. Sehloff R.L.S. 2692 Date

File: 3506csm.dwg
Date: 04/21/2010
Drafted By: jim
Sheet: 1 of 3

4/21/2010 9:33 AM J:\Projects\3506ver\dwg\Civil 3D\3506csm.dwg Printed by: jim

FORM NO. 985-A

HCMiller

Stock No. 26273

Certified Survey Map No. 6200

Surveyor's Certificate

I, James R. Sehloff, registered land surveyor, hereby certify: That in full compliance with the provisions of Chapter 236 of the Wisconsin Statutes and the subdivision regulations of the City of Kaukauna and Outagamie County, and under the direction of Fox Investments LLC and Thomas R. Vandeyacht & Mary K. Vandeyacht, the property owners of said land, I have surveyed divided and mapped this Certified Survey Map; that such map correctly represents all exterior boundaries and the subdivision of the land surveyed; and that this land is part of Parcel 3, Certified Survey Map #59 located in the City of Kaukauna, Outagamie County, Wisconsin, containing 78,026 Square Feet (1.7913 Acres) of land described as follows:

Beginning at the Northeast corner of Lot 1, Certified Survey Map 155, thence S85°57'40"E, 198.79 feet; thence N86°57'10"E, 133.96 feet; thence S74°37'20"E 17.30 feet; thence S21°00'15"E, 271.79 feet; thence S27°56'50"E, 52.82 feet to the Northeast corner of Lot 1, Certified Survey Map 348; thence along the North line of said Lot 1 N82°43'55"W, 103.20 feet to a point of the Northeasterly right of way of Fox Shores Dr.; thence along the northerly right of way line of said Fox Shores Dr., N54°25'50"W 160.00 feet; thence 235.21 feet along and arc of a curve to the left with a radius of 50.00 feet and a chord which bears S80°34'10"W, 71.00 feet to the East corner of Lot 1, Certified Survey Map 307; thence along the Northerly line of said Lot 1, N54°25'50"W 110.00 feet; thence continuing along said Northerly line, N79°54'30"W 104.54 feet to a point on the East line of said Lot 1 Certified Survey Map 155; thence along said East line, N10°05'30"E 137.18 feet to the point of beginning, subject to all easements and restrictions of record.

Given under my hand this 21 day of APRIL, 2010.

James R. Sehloff, Wisconsin Registered Land Surveyor No. S-2692

WISCONSIN
JAMES R SEHLOFF S-2692 DE PERE WI
LAND SURVEYOR

City of Kaukauna Common Council Approval Certificate

Resolved, that this Certified Survey Map in the City of Kaukauna, Fox Investments LLC and Thomas R. Vandeyacht & Mary K. Vandeyacht, owners, are hereby approved by the Common Council.

Mayor — Date 05/07/10

I hereby certify that the foregoing is a copy of a resolution adopted by the Common Council of the City of Kaukauna.

City Clerk — Date 5/7/10

Owners' Certificate

Thomas R. Vandeyacht and Mary K. Vandeyacht as the property owners, we hereby certify that we caused the land described on this certified survey map to be surveyed, divided and mapped all as shown and represented on this map.

Dated this 26th day of April 2010

Thomas R. Vandeyacht, property owner

Mary K. Vandeyacht, property owner

NOTARY PUBLIC
WILLIAM R. BISHOP JR
STATE OF WISCONSIN

State of Wisconsin)
)SS
Winnebago County)

Personally came before me on the 26 day of April, 2010, the above the property owner(s) to me known to be the persons who executed the foregoing instrument and acknowledge the same.

Notary Public, Wisconsin My Commission Expires 12-15-2013

File: 3506csm.dwg
Date: 04/20/2010
Drafted By: jim
Sheet: 2 of 3

FORM NO. 985-A

HCMiller

Stock No. 26273

Page 6200 (Three Pages)

Certified Survey Map No. 6200

Corporate Owner's Certificate

Fox Investments LLC, a limited liability company duly organized and existing under and by virtue of the Laws of the State of Wisconsin, as the property owners, do hereby certify that we caused the land above described to be surveyed, divided and mapped all as shown and represented on this map.

IN WITNESS WHEREOF, the said Fox Investments LLC, has caused these presents to be

signed by its authorized representatives, located at, Appleton, Wisconsin,

this 26 day of April, 2010.

In the Presence of: Fox Investments LLC

Thomas R Vandeyacht
Thomas R. Vandeyacht, Member

Mary K. Vandeyacht, Member

NOTARY PUBLIC
WILLIAM R. BISHOP JR.
STATE OF WISCONSIN

State of Wisconsin)
)ss
Winnebago County)

Personally came before me this 26 day of April, 2010,

the above named, members of said company, and acknowledged that they executed the foregoing instrument as such members as the deed of said company, by its authority.

William R Bishop Jr.
Notary Public, Wisconsin

My commission expires: 12-15-2013

Treasurers' Certificate

We, being the duly elected, qualified and acting Treasurers' of the City of Kaukauna and Outagamie County, do hereby certify that in accordance with the records in our office, there are no unredeemed tax sales and unpaid taxes, or special assessments on and of the land included in this plat.

City Treasurer — Date 5/7/10

County Treasurer Deputy — Date 9-20-10

This Certified Survey Map is contained wholly within the property described in the following recorded instruments:

Owners of Record:	Recording Information:	Parcel Number(s):
Fox Investments LLC	Doc. No. 1289591	32-3-0408-00
Thomas R. Vandeyacht & Mary K. Vandeyacht	Doc. No. 1863117	32-3-0408-04

CURVE TABLE					
Curve	Radius	Chord Direction	Chord Length	Arc Length	Central Angle
C1	50.00'	S 80°50'22" W	71.34'	234.74'	268°59'00"
C2	50.00'	S 80°50'22" W	71.34'	234.74'	268°59'00"
C3	50.00'	S 80°50'22" W	71.34'	234.74'	268°59'00"

WISCONSIN
JAMES R SEHLOFF
S-2692
DE PERE
WI
LAND SURVEYOR

James R. Sehloff Registered Land Surveyor No. S-2692 — 21 APR 2010 Date

File: 3506csm.dwg
Date: 04/20/2010
Drafted By: jim
Sheet: 3 of 3

CERTIFIED SURVEY MAP

PART OF PARCEL "3", OUTAGAMIE COUNTY CERTIFIED SURVEY MAP #59, CITY OF KAUKAUNA, OUTAGAMIE COUNTY, WISCONSIN.

ANGLES
a = 112°-10'-00"
b, d & e = 90°-00'-00"
c = 154°-31'-20"
f = 180°-40'-00"
g = 182°-38'-40"

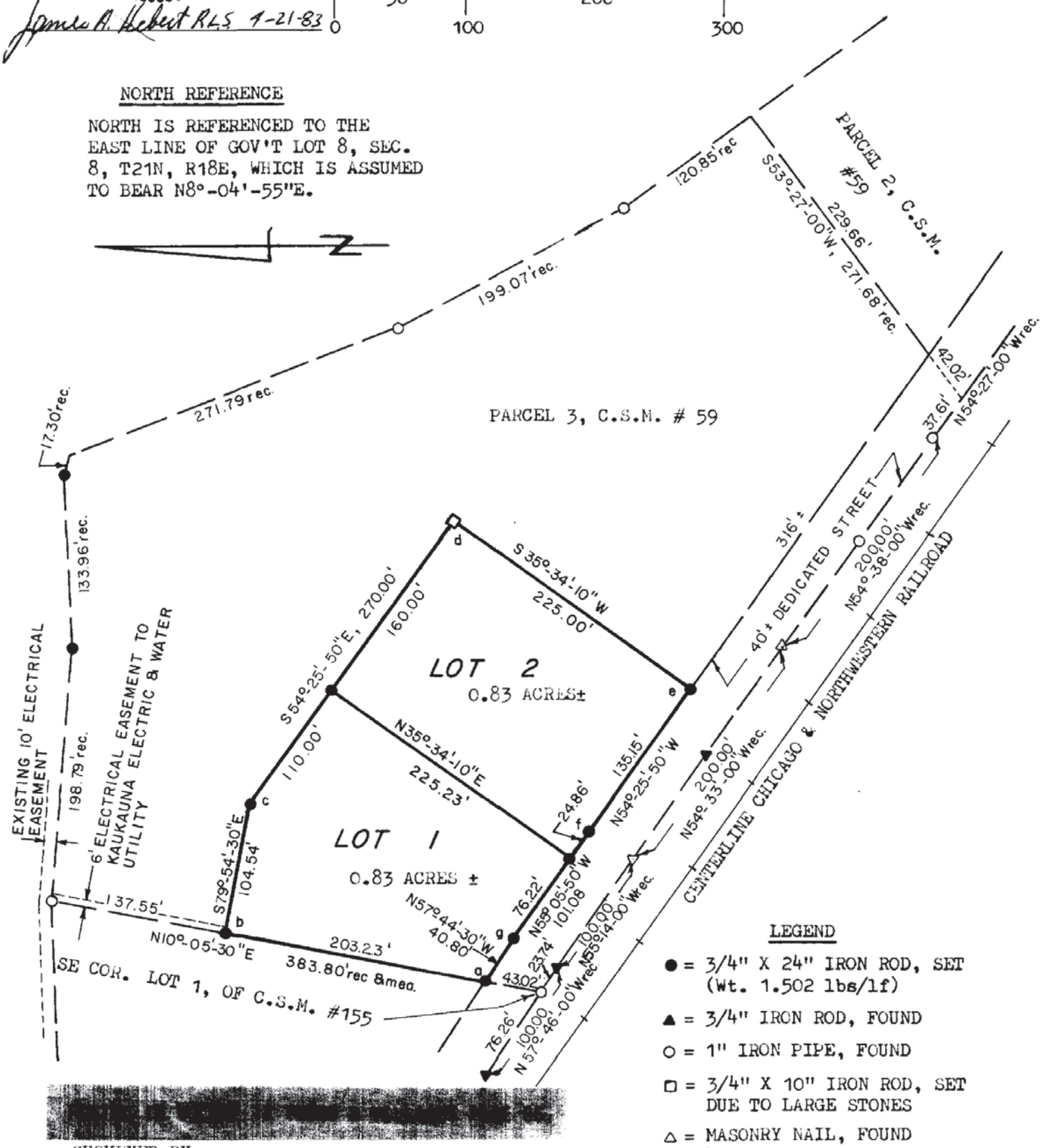
WISCONSIN
JAMES A. HEBERT
S-980
APPLETON, WIS.
LAND SURVEYOR

James A. Hebert RLS 1-21-83

SCALE 1"=100'
0 50 100 200 300

NORTH REFERENCE

NORTH IS REFERENCED TO THE EAST LINE OF GOV'T LOT 8, SEC. 8, T21N, R18E, WHICH IS ASSUMED TO BEAR N8°-04'-55"E.



LEGEND

● = 3/4" X 24" IRON ROD, SET (Wt. 1.502 lbs/lf)
▲ = 3/4" IRON ROD, FOUND
○ = 1" IRON PIPE, FOUND
□ = 3/4" X 10" IRON ROD, SET DUE TO LARGE STONES
△ = MASONRY NAIL, FOUND
rec = RECORDED AS
mea = MEASURED AS

SURVEYED BY
OUTAGAMIE LAND SURVEYING
APPLETON, WISCONSIN

FILE #83017CM
PAGE 1 OF 1
SIDE 1 OF 2

J.K. T.A.C.

SURVEYOR'S CERTIFICATE

I, JAMES A. HEBERT, REGISTERED WISCONSIN LAND SURVEYOR, DO HEREBY CERTIFY THAT I HAVE SURVEYED, DIVIDED AND MAPPED ALL THAT PART OF PARCEL # 3, OUTAGAMIE COUNTY CERTIFIED SURVEY MAP # 59, LOCATED IN THE CITY OF KAUKAUNA, OUTAGAMIE COUNTY, WISCONSIN AND BEING MORE FULLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF LOT # 1, OF OUTAGAMIE COUNTY C.S.M. # 155; THENCE N10°-05'-30"E, 43.02 FEET ALONG THE EAST LINE OF SAID LOT # 1 OF C.S.M # 155 TO THE POINT OF BEGINNING; THENCE CONTINUING N10°-05'-30"E, 203.23 FEET ALONG SAID EAST LINE; THENCE S79°-54'-30"E, 104.54 FEET; THENCE S54°-25'-50"E, 270.00 FEET; THENCE S35°-34'-10"W, 225.00 FEET TO THE NORTHEASTERLY LINE OF A DEDICATED STREET; THENCE N54°-25'-50"W, 135.15 FEET ALNOG SAID NORTHEASTERLY LINE; THENCE CONTINUING ALONG SAID NORTHEASTERLY LINE, N55°-05'-50"W, 101.08 FEET; THENCE CONTINUING ALONG SAID NORTHEASTERLY LINE, N57°-44'-30"W, 40.80 FEET TO THE POINT OF BEGINNING.

I FURTHER CERTIFY THAT I HAVE MADE SUCH SURVEY, MAP AND LAND DIVISION AS SHOWN HEREON UNDER THE DIRECTION OF THE OWNERS OF SAID LANDS, AND THAT I HAVE FULLY COMPLIED WITH THE PROVISIONS OF CHAPER 236.34 OF THE WISCONSIN STATUTES AND WITH SUBDIVISION ORDINANCE NO. 750, OF THE CITY OF KAUKAUNA, IN SURVEYING, DIVIDING AND MAPPING THE SAME.

James A Hebert R.L.S. S-980 4-21-83

JAMES A. HEBERT R.L.S. DATED

OWNERS CERTIFICATE

AS OWNERS WE HEREBY CERTIFY THAT WE CAUSED THE LAND DESCRIBED HEREON TO BE SURVEYED, DIVIDED AND MAPPED AND DEDICATED AS REPRESENTED ON THE CERTIFIED SURVEY MAP. WE ALSO CERTIFY THAT THIS SURVEY IS REQUIRED BY S. 236.34 AND THE KAUKAUNA SUBDIVISION ORDINANCE TO BE SUBMITTED TO COMMON COUNCIL FOR APPROVAL OR OBJECTION.

Oswald W Kramer _____ _____

OWNER ADDRESS WITNESS

Robert R Kramer _____ _____

OWNER ADDRESS WITNESS

Joseph Jacobson _____ _____

OWNER ADDRESS WITNESS

NOTARY CERTIFICATE

PERSONALLY CAME BEFORE ME THIS 5th DAY OF May 1983, THE ABOVE NAMED PERSONS, TO ME TO ME KNOWN TO BE THE PERSONS WHO EXECUTED THE FOREGOING INSTRUMENT AND ACKNOWLEDGE THE SAME.

Jane R Lee

NOTARY PUBLIC, Outagamie, COUNTY, WISCONSIN

MY COMMISSION EXPIRES 5-25-86

COMMON COUNCIL RESOLUTION

RESOLVED BY THE COMMON COUNCIL OF THE CITY OF KAUKAUNA, THAT THE ABOVE CERTIFIED SURVEY MAP OF THE DESCRIBED PROPERTY IS APPROVED, PASSED AND APPROVED BY RESOLUTION # 2375, THIS 7th DAY OF June, 1983.

I HEREBY CERTIFY THAT THE ABOVE IS A TRUE AND CORRECT COPY OF THE RESOLUTION ADOPTED BY THE COMMON COUNCIL ON June 7, 1983.

Joan M Cleveland, CITY CLERK

RECORDING DATA

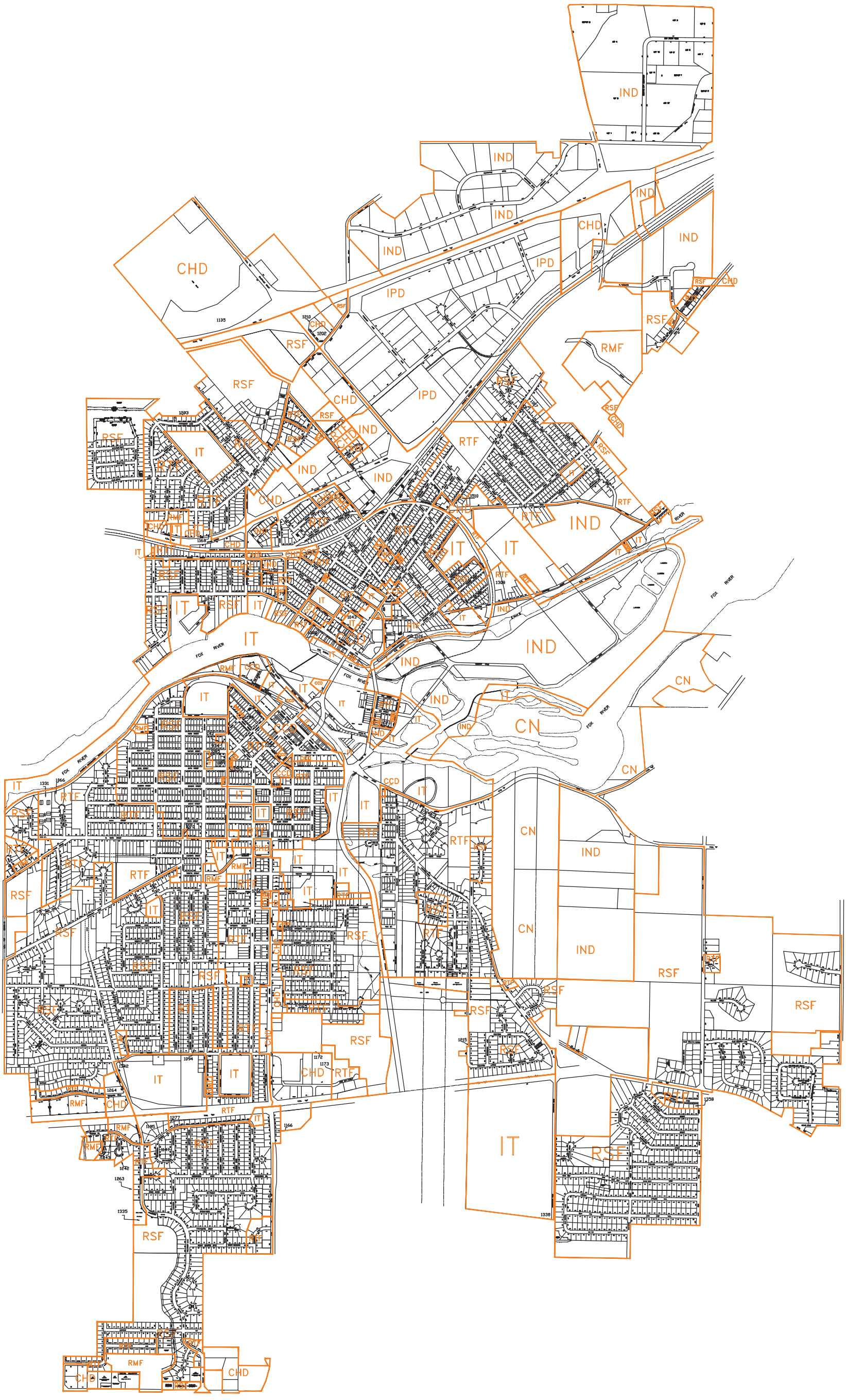
FILED THIS 13 DAY OF June, 19 83, AT 9:20 A M., IN VOLUME 2 OF CERTIFIED SURVEY MAPS, ON PAGE # 307 BEING OUTAGAMIE COUNTY CERTIFIED SURVEY MAP # 307, DOCUMENT # 826686.

Grace Herb, Register of Deed

WISCONSIN JAMES A. HEBERT S-980 APPLETON, WIS. LAND SURVEYOR

James A. Hebert RLS S-980 4-21-83

FILE # 83017CM
PAGE 1 of 1
SIDE 2 of 2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Fox Shores Apartments

400/410 Fox Shores Drive; 380/400 Bicentennial Court, Kaukauna, WI

Parcels #323040800; #323040801, #323040802, #323040804

(WDNR BRRTS #02-45-582746)

I, Thomas R. Vandeyacht, (please print) hereby certify that the legal description(s) attached to this statement are complete and accurate for all the properties within the site boundaries at the time closure is requested.

Signed by Responsible Party: Thomas R Vandeyacht Date: January 24, 2021

Document #: **2199610**
Date: 07-17-2020 Time: 12:27 PM
Pages: 2 Fee: $30.00
County: OUTAGAMIE COUNTY State: WI
Transfer Fee: **$15300.00**

Sarah R. VanCamp

SARAH R VAN CAMP, REGISTER OF DEEDS
Return via MAIL (REGULAR)
FOX SHORES LLC

State Bar of Wisconsin Form 1-2003

WARRANTY DEED

Document Number | Document Name

THIS DEED, made between GTFC Investments, LLC, a Wisconsin limited liability company, as to Parcels 1, 2, 3, 4 and Clay J. Eiting, as to Parcel 5 ("Grantor," whether one or more), and Fox Shores, LLC, a Wisconsin limited liability company ("Grantee," whether one or more).

Grantor for a valuable consideration, conveys to Grantee the following described real estate, together with the rents, profits, fixtures and other appurtenant interests, in Outagamie County, State of Wisconsin ("Property") (if more space is needed, please attach addendum):

SEE ATTACHED LEGAL DESCRIPTION

Recording Area

Name and Return Address
Fox Shores, LLC
Attn: Logan Rankin
109 E 8th Street
Kaukauna, WI 54130

(2)

See attached PINs
Parcel Identification Number (PIN)

This is not homestead property.
~~(is)~~ (is not)

Grantor warrants that the title to the Property is good, indefeasible, in fee simple and free and clear of encumbrances except:

municipal and zoning ordinances, recorded easements for public utilities serving the property, recorded building and use restrictions and covenants, and general taxes levied in the year of closing and will warrant and defend the same.

Dated July 15, 2020.

_____ (SEAL)
* Clay J. Eiting, Individually

_____ (SEAL)
*

GTFC INVESTMENTS, LLC

_____ (SEAL)
* Clay J. Eiting, Member

_____ (SEAL)
*

AUTHENTICATION

Signature(s) _____
_____
authenticated on _____
*
TITLE: MEMBER STATE BAR OF WISCONSIN
(If not, authorized by Wis. Stat. § 706.06)

JOSHUA J. SCHAEFER NOTARY PUBLIC STATE OF WISCONSIN

ACKNOWLEDGMENT

STATE OF WISCONSIN)
) ss.
OUTAGAMIE COUNTY)

Personally came before me on July 15, 2020,
the above-named Clay J. Eiting
to me known to be the person(s) who executed the foregoing instrument and acknowledged the same.

* Joshua J Schaefer
Notary Public, State of Wisconsin
My commission (is permanent) (expires: 4/21/21)

THIS INSTRUMENT DRAFTED BY:
Attorney Steven J. Frassetto
Appleton, WI 54912-0785

(Signatures may be authenticated or acknowledged. Both are not necessary.)
NOTE: THIS IS A STANDARD FORM. ANY MODIFICATION TO THIS FORM SHOULD BE CLEARLY IDENTIFIED.

LEGAL DESCRIPTION

Parcel 1: 400-410 Fox Shores Dr., Kaukauna WI 54130
Lot One (1), Certified Survey Map No. 6200 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on September 20, 2010, in Volume 36 on Page 6200, as Document No. 1886271, being part of Parcel "3", Outagamie County CSM No. 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040800

PARCEL 2: 380 Bicentennial Ct., Kaukauna WI 54130
All of Lot Two (2) of Certified Survey Map No. 307 as filed in the Office of the Register of Deeds for Outagamie County on June 13, 1983 in Volume 2 of Certified Survey Maps, on page 307 as Document No. 826686, being a part of Parcel "3", Outagamie County Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040802

PARCEL 3: 400 Bicentennial Ct., Kaukauna, WI 54130
All of Lot One (1), Certified Survey Map 307, recorded in Volume 2 of Certified Survey Maps, page 307, being part of Parcel 3, Certified Survey Map 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040801

PARCEL 4: Vacant Land
Lot Two (2), Certified Survey Map No. 6200 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on September 20, 2010, in Volume 36 on Page 6200, as Document No. 1886271, being part of Parcel "3", Outagamie County Certified Survey Map No. 59, being part of Gov't Lot 8, Section 21, Township 21 North, Range 18 East, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040804

Parcel 5: 180 Fox Shores Dr., Kaukauna, WI 54130
Lot One (1) of Certified Survey Map No. 348 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on August 9, 1984 in Volume 2 on page 348 as Document No. 849894, being part of Parcel 3, Outagamie County Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin, which was corrected by Affidavit recorded September 25, 1984 in Jacket 4928, Image 46, Document No. 852188.
Tax Parcel No. 323 040803

ATTACHMENT G – NOTIFICATIONS TO OWNERS OF AFFECTED PROPERTIES

TABLE OF CONTENTS

G.1. Notifications to Owners of Affected Properties…….....42 pages

Section A: Deeded Property Notification: Residual Contamination and/or Continuing Obligations

KEEP THIS DOCUMENT WITH YOUR PROPERTY RECORDS

518 Main Street #346
Wrightstown, WI, 54180

Dear Mr. Rankin:

I am providing this letter to inform you of the location and extent of contamination remaining on your property, and of certain long-term responsibilities (continuing obligations) for which you may become responsible.
I have investigated a release of:
polycyclic aromatic hydrocarbons (PAHs), resource conservation and recovery act (RCRA)
metals, and/or volatile organic compounds (VOCs)
on 400/410 Fox Shores Dr., 380/400 Bicentennial Ct., Par. #323040804, Kaukauna, WI, 54130 that has shown that contamination remains on this source property.
I have responded to the release and will be requesting that the Department of Natural Resources (DNR) grant case closure. Closure means that the DNR will not be requiring any further investigation or cleanup action to be taken. However, continuing obligations may be imposed as a condition of closure approval.

You have 30 days to comment on the attached legal description of your property and on the proposed closure request:

Please review the enclosed legal description of your property, and notify Jeffrey Brand at 1165 Scheuring Road, De Pere, WI, 54115 within the next 30 days if the legal description is incorrect.

The DNR will not review my closure request for at least 30 days after the date of receipt of this letter. As an affected property owner, you have a right to contact the DNR to provide any technical information that you may have that indicates that closure should not be granted for this site. If you would like to submit any information that is relevant to this closure request, or if you want to waive the 30 day comment period, you should mail that information to the DNR contact: 2984 Shawano Ave, Green Bay, WI, 54313, or at sarah.krueger@wisconsin.gov.

Your Long-Term Responsibilities as a Property Owner and Occupant:

The responses included
remedial excavation of soil and the placement of a site-wide cap.
The continuing obligations I am proposing that affect your property are listed below, under the heading **Continuing Obligations**. Under s. 292.12 (5), Wis. Stats., current and future owners and occupants of this property are responsible for complying with continuing obligations imposed as part of an approved closure.

The fact sheet "Continuing Obligations for Environmental Protection" (DNR publication RR 819) has been included with this letter, to help explain the responsibilities you may have for maintenance of a certain continuing obligation, the limits of any liability for investigation and cleanup of contamination, and how these differ. If the fact sheet is lost, you may obtain copies at http://dnr.wi.gov/files/PDF/pubs/rr/RR819.pdf.

Contract for responsibility for continuing obligation:

Before I request closure, I will need to inform the DNR as to whom will be responsible for the continuing obligation/s on your property.
Fox Shores LLC - Logan Rankin

Under s. 292.12, Wis. Stats., the responsibility for maintaining all necessary continuing obligations for your property will fall on you or any subsequent property owner, unless another person has a legally enforceable responsibility to comply with the requirements of the final closure letter. If you need more time to finalize an agreement on the responsibility for the continuing obligations on your Property, you may request additional time from the DNR contact identified in **Contact Information.**

(Note: Future property owners would need to negotiate a new agreement.)

Remaining Contamination:

Soil Contamination:

Soil contamination remains at :
400/410 Fox Shores Dr., 380/400 Bicentennial Ct., Par. #323040804

The remaining contaminants include:
PAHs, RCRA metals, VOCs

at levels which exceed the soil standards found in ch. NR 720, Wis. Adm. Code. The following steps have been taken to address any exposure to the remaining soil contamination.
Soil contamination has been capped with an engineered fabric followed by 12 inches of clean soil.

Groundwater Contamination:

Groundwater contamination originated at the property located at 400/410 Fox Shores Dr., 380/400 Bicentennial Ct., Par. #323040804, Kaukauna, WI, 54130. The levels of
PAH
contamination in the groundwater on your property are above the state groundwater enforcement standards found in ch. NR 140, Wis. Adm. Code.

However, the environmental consultants who have investigated this contamination have informed me that this groundwater contaminant plume is stable or receding and will naturally degrade over time. I believe that allowing natural attenuation, or the breakdown of contaminants in groundwater due to naturally occurring processes, to complete the cleanup at this site will meet the case closure requirements of ch. NR 726, Wis. Adm. Code. As part of my request for case closure, I am requesting that the DNR accept natural attenuation as the final remedy for this site.

The following DNR fact sheet (RR 671, "What Landowners Should Know: Information About Using Natural Attenuation to Clean Up Contaminated Groundwater") has been included with this notification, to help explain the use of natural attenuation as a remedy. If the fact sheet is lost, you may obtain a copy at http://dnr.wi.gov/files/PDF/pubs/rr/RR671.pdf.

Continuing Obligations on Your Property: As part of the cleanup, I am proposing that the following continuing obligations be used at your property, to address future exposure to residual contamination. If my closure request is approved, you will be responsible for the following continuing obligations.

To construct a new well or to reconstruct an existing well, the property owner at the time of construction or reconstruction will need to obtain prior approval from the DNR. See **Well Construction Requirements**. Typically, this results in casing off a portion of the aquifer during drilling, when needed, to protect the water supply.

Residual Soil Contamination:

If soil is excavated from the areas with residual contamination, the property owner at the time of excavation will be responsible for the following:

- determine if contamination is present
- determine whether the material would be considered solid or hazardous waste
- ensure that any storage, treatment or disposal is in compliance with applicable statutes and rules.

Contaminated soil may be managed in-place, in accordance with ch. NR 718, Wis. Adm. Code, with prior DNR approval. In addition, all current and future property owners and occupants of the property and right-of-way holders need to be aware that excavation of the contaminated soil may pose an inhalation or other direct contact hazard and as a result special precautions may need to be taken during excavation activities to prevent a health threat to humans.

Depending on site-specific conditions, construction over contaminated soils or groundwater may result in vapor migration of contaminants into enclosed structures or migration along underground utility lines. The potential for vapor inhalation and means of mitigation should be evaluated when planning any future redevelopment, and measures should be taken to ensure the continued protection of public health, safety, welfare and the environment at the site.

Maintenance of a Cover:

A soil cover/engineered cover/other has been placed over remaining contamination to limit contact with the soil,
and this cover will need to be maintained. Inspections will be required, and submittal of inspection reports may be required. Certain activities which would disturb the cover or barrier will be prohibited.
If the cover was intended for industrial or commercial use, notification of the DNR may be required before changing the land use to a residential type use, to determine if the cover will be protective for that use.
A maintenance plan is attached, which describes the maintenance activities likely to be required.
An updated maintenance plan will be provided at closure, if the requires changes to the maintenance plan.

A map, figure 3 , is attached, which shows the location of the extent of contamination and the extent of the cover.

Maintenance and Audits of Continuing Obligations:

If compliance with a maintenance plan is required as part of a continuing obligation, an inspection log will need to be filled out periodically, and kept available for inspection by the DNR. Submittal of the inspection log may also be required. You will also need to notify any future owners or occupants of this property of the need to maintain the continuing obligation and to document that maintenance in the inspection log. Periodic audits of these continuing obligations may be conducted by the DNR, to ensure that potential exposure to residual contamination is being addressed. The DNR provides notification before conducting site visits as part of the audit.

Well Construction Requirements:

If this site is closed, all properties within the site boundaries where contamination remains, or where a continuing obligation is applied, will be listed on the Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web, at https://dnr.wi.gov/topic/Brownfields/WRRD.html. Inclusion on this database provides public notice of remaining contamination and of any continuing obligations. Documents can be viewed on this database, and include final closure letters, site maps and any applicable maintenance plans. The location of the site may also be viewed on the Remediation and Redevelopment Sites Map (RR Sites Map), at the same internet address listed above.

DNR approval prior to well construction or reconstruction is required in accordance with s. NR 812.09 (4) (w), Wis. Adm. Code. This requirement applies to private drinking water wells and high capacity wells. Special well construction standards may be necessary to protect the well from the remaining contamination. The property owner needs to first obtain approval from a regional water supply specialist in DNR's Drinking Water and Groundwater Program. A well driller can help complete this form. The well construction application, form 3300−254, is on the internet at https://dnr.wi.gov/files/PDF/forms/3300/3300-254.pdf.

Site Closure:

If the DNR grants closure, you will receive a letter which defines the specific continuing obligations on your property. The status of the site (open or closed) may also be checked by searching BRRTS on the Web. You may view or download a copy of the closure letter (sent to the responsible party) from BRRTS on the Web. You may also request a copy of the closure letter from the **responsible party** or by writing to the DNR contact, at Sarah Krueger, sarah.krueger@wisconsin.gov, (920) 510-8277 . The final closure letter will contain a description of the continuing obligation, any prohibitions on activities and will include any applicable maintenance plan.

If you have any questions regarding this notification, I can be reached at: (920) 883-8501 , Jeff.Brand@Stantec.com .

Jeffrey R. Brand

Date Signed 02/25/2022

Signature of responsible party/environmental consultant for the responsible party

Attachments

Contact Information

Legal Description for each Parcel:

Maps:

Maintenance plan

Maintenance of a cover Maintenance of a Cover - Maintenance Plan Date 01/24/2022

Factsheets:

RR 819, Continuing Obligations for Environmental Protection

RR 671, What Landowners Should Know: Information About Using Natural Attenuation to Clean Up Contaminated Groundwater

SOURCE PROPERTY

Notification of Continuing Obligations and Residual Contamination

The affected property is:

- (●) the source property (the source of the hazardous substance discharge), but the property is not owned by the person who conducted the cleanup (a deeded property)
- ( ) a deeded property affected by contamination from the source property
- ( ) a right-of-way (ROW)
- ( ) a Department of Transportation (DOT) ROW

Include this completed page as an attachment with all notifications provided under sections A and B.

Contact Information

Responsible Party: The person responsible for sending this form, and for conducting the environmental investigation and cleanup is:

Responsible Party Name: Fox Investments LLC

Contact Person Last Name	First	MI	Phone Number (include area code)
Vandeyacht	Thomas	R	(920) 380-9631

Address	City	State	ZIP Code
2220 N Lynndale Drive	Appleton	WI	54914

E-mail: tomv@vmi-vdi.com

Name of Party Receiving Notification:

Business Name, if applicable: Fox Shores LLC

Title	Last Name	First	MI	Phone Number (include area code)
Mr.	Rankin	Logan		(920) 255-3259

Address	City	State	ZIP Code
518 Main Street #346	Wrightstown	WI	54180

Site Name and Source Property Information:

Site (Activity) Name: Fox Shores Apartments

Address	City	State	ZIP Code
400/410 Fox Shores Dr., 380/400 Bicentennial Ct., Par. #323040804	Kaukauna	WI	54130

DNR ID # (BRRTS#)	(DATCP) ID #
02-45-582746	

Contacts for Questions:

If you have any questions regarding the cleanup or about this notification, please contact the Responsible Party identified above, or contact:

Environmental Consultant: Stantec Consulting Services Inc.

Contact Person Last Name	First	MI	Phone Number (include area code)
Brand	Jeffrey	R	(920) 278-3208

Address	City	State	ZIP Code
1165 Scheuring Road	De Pere	WI	54115

E-mail: jeff.brand@stantec.com

Department Contact:

To review the Department's case file, or for questions on cleanups or closure requirements, contact:

Department of: Natural Resources (DNR) Office: Green Bay

Address	City	State	ZIP Code
2984 Shawano Ave	Green Bay	WI	54313

Contact Person Last Name	First	MI	Phone Number (include area code)
Krueger	Sarah		(920) 510-8277

E-mail (Firstname.Lastname@wisconsin.gov): sarah.krueger@wisconsin.gov

SOURCE PROPERTY

Document #: **2199610**
Date: **07-17-2020** Time: **12:27 PM**
Pages: **2** Fee: **$30.00**
County: **OUTAGAMIE COUNTY** State: **WI**
Transfer Fee: **$15300.00**

Sarah R Van Camp

SARAH R VAN CAMP, REGISTER OF DEEDS
Return via MAIL (REGULAR)
FOX SHORES LLC

State Bar of Wisconsin Form 1-2003

WARRANTY DEED

Document Number | Document Name

THIS DEED, made between GTFC Investments, LLC, a Wisconsin limited liability company, as to Parcels 1, 2, 3, 4 and Clay J. Eiting, as to Parcel 5 ("Grantor," whether one or more), and Fox Shores, LLC, a Wisconsin limited liability company ("Grantee," whether one or more).

Grantor for a valuable consideration, conveys to Grantee the following described real estate, together with the rents, profits, fixtures and other appurtenant interests, in Outagamie County, State of Wisconsin ("Property") (if more space is needed, please attach addendum):

SEE ATTACHED LEGAL DESCRIPTION

Recording Area

Name and Return Address
Fox Shores, LLC
Attn: Logan Rankin
109 E 8th Street
Kaukauna, WI 54130

(2)

See attached PINs
Parcel Identification Number (PIN)

This is not homestead property.
~~(is)~~ (is not)

Grantor warrants that the title to the Property is good, indefeasible, in fee simple and free and clear of encumbrances except:

municipal and zoning ordinances, recorded easements for public utilities serving the property, recorded building and use restrictions and covenants, and general taxes levied in the year of closing and will warrant and defend the same.

Dated July 15, 2020.

_____ (SEAL)
* Clay J. Eiting, Individually

_____ (SEAL)
*

GTFC INVESTMENTS, LLC

_____ (SEAL)
* Clay J. Eiting, Member

_____ (SEAL)
*

AUTHENTICATION

Signature(s) _____
_____
authenticated on _____
_____
*
TITLE: MEMBER STATE BAR OF WISCONSIN
(If not, _____
authorized by Wis. Stat. § 706.06)

JOSHUA J. SCHAEFER NOTARY PUBLIC STATE OF WISCONSIN

ACKNOWLEDGMENT

STATE OF WISCONSIN)
) ss.
OUTAGAMIE COUNTY)

Personally came before me on July 15, 2020,
the above-named Clay J. Eiting
to me known to be the person(s) who executed the foregoing instrument and acknowledged the same.

* Joshua J Schaefer
Notary Public, State of Wisconsin
My commission (is permanent) (expires: 4/21/21)

THIS INSTRUMENT DRAFTED BY:
Attorney Steven J. Frassetto
Appleton, WI 54912-0785

(Signatures may be authenticated or acknowledged. Both are not necessary.)
NOTE: THIS IS A STANDARD FORM. ANY MODIFICATION TO THIS FORM SHOULD BE CLEARLY IDENTIFIED.

SOURCE PROPERTY

LEGAL DESCRIPTION

Parcel 1: 400-410 Fox Shores Dr., Kaukauna WI 54130
Lot One (1), Certified Survey Map No. 6200 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on September 20, 2010, in Volume 36 on Page 6200, as Document No. 1886271, being part of Parcel "3", Outagamie County CSM No. 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040800

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Tax Parcel No. 323 040802

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All of Lot One (1), Certified Survey Map 307, recorded in Volume 2 of Certified Survey Maps, page 307, being part of Parcel 3, Certified Survey Map 59, City of Kaukauna, Outagamie County, Wisconsin.
Tax Parcel No. 323 040801

PARCEL 4: Vacant Land
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Tax Parcel No. 323 040804

Parcel 5: 180 Fox Shores Dr., Kaukauna, WI 54130
Lot One (1) of Certified Survey Map No. 348 filed in the Office of the Register of Deeds for Outagamie County, Wisconsin on August 9, 1984 in Volume 2 on page 348 as Document No. 849894, being part of Parcel 3, Outagamie County Certified Survey Map No. 59, City of Kaukauna, Outagamie County, Wisconsin, which was corrected by Affidavit recorded September 25, 1984 in Jacket 4928, Image 46, Document No. 852188.
Tax Parcel No. 323 040803

SOURCE PROPERTY

COVER MAINTENANCE PLAN

January 24, 2022

Property Located at:

380/400 Bicentennial Court; 400/410 Fox Shores Drive; Lot 2 CSM 6200

DNR BRRTS # 02-45-582746

Parcel Identification Numbers #323040800, #323040801, #323040802, #323040804

Introduction

This document is the Maintenance Plan for building structures, asphalt, concrete, gravel, and soil cover at the above-referenced property in accordance with the requirements of s. NR 724.13 (2), Wis. Adm. Code. The maintenance activities relate to the existing pavement, structural, or soil covers which addresses or occupies the area over the contaminated soil and groundwater plume.

More site-specific information about this property/site may be found in:

- The case file in the DNR Northeast Regional office
- At http://dnr.wi.gov/topic/Brownfields/wrrd.html, which includes:
  - BRRTS on the Web (DNR's internet-based data base of contaminated sites) for the link to a PDF for site-specific information at the time of closure and on continuing obligations;
  - RR Sites Map for a map view of the site, and
- The DNR project manager for Outagamie County.

D.1. Descriptions:

Description of Contamination

Soil contaminated by polycyclic aromatic hydrocarbons (PAHs), resource conservation and recovery act (RCRA) metals, and/or volatile organic compounds (VOCs) has been identified at a depth of 0 to 4 feet across the property. Groundwater contaminated by arsenic and PAHs is located at a depth of 4 to 6 feet below ground surface. The extent of the soil and groundwater contamination is shown on the attached **Figures 1 and 2**.

Description of the Cover to be Maintained

The cover consists of either building structures, gravel, impermeable surfaces such as concrete and asphalt, or a landscape cap made up of permeable filter fabric overlain with clean fill totaling 12 inches. The cap is located across the entire property as shown on the attached **Figure 3**.

Cover Purpose

The buildings, gravel, paved surfaces, and landscaped soils in place cover the remaining contaminated soil and groundwater and serve as a barrier to prevent direct human contact with residual soil contamination that might otherwise pose a threat to human health. Based on the current use of the property as a residential apartment complex, the barrier should function as intended unless disturbed.

SOURCE PROPERTY

Annual Inspection

The cover overlying the contaminated soil and groundwater and as depicted in **Figures 1 and 2** will be inspected once a year, normally in the spring after all snow and ice is gone, for deterioration, cracks and other potential problems that can cause exposure to underlying soils. The inspections will be performed by the property owner or their designated representative. The inspections will be performed to evaluate damage due to settling, exposure to the weather, wear from traffic, increasing age and other factors. Any area where soils have become or are likely to become exposed will be documented.

A log of the inspections and any repairs will be maintained by the property owner and is included as D.4, Form 4400-305, Continuing Obligations Inspection and Maintenance Log. The log will include recommendations for necessary repair of any areas where underlying soils are exposed and where infiltration from the surface will not be effectively minimized. Once repairs are completed, they will be documented in the inspection log. A copy of the maintenance plan and inspection log will be kept at the site; or, if there is no acceptable place (for example, no building is present) to keep it at the site, at the address of the property owner and available for submittal or inspection by Wisconsin Department of Natural Resources (DNR) representatives upon their request.

Maintenance Activities

If problems are noted during the annual inspections or at any other time during the year, repairs will be scheduled as soon as practical. Repairs can include patching and filling or larger resurfacing or construction operations. In the event that necessary maintenance activities expose the underlying soil, the owner must inform maintenance workers of the direct contact exposure hazard and provide them with appropriate personal protection equipment (PPE). The owner must also sample any soil that is excavated from the site prior to disposal to ascertain if contamination remains. The soil must be treated, stored and disposed of by the owner in accordance with applicable local, state and federal law.

In the event the gravel, soil cover, and/or impervious surfaces overlying the contaminated soil and groundwater are removed or replaced, the replacement barrier must be equally impervious. Any replacement barrier will be subject to the same maintenance and inspection guidelines as outlined in this Maintenance Plan unless indicated otherwise by the DNR or its successor.

The property owner, in order to maintain the integrity of the gravel, soil cover, and impervious surfaces, will maintain a copy of this Maintenance Plan at the site; or, if there is no acceptable place to keep it at the site (for example, no building is present), at the address of the property owner and make it available to all interested parties (i.e. on-site employees, contractors, future property owners, etc.) for viewing.

Prohibition of Activities and Notification of DNR Prior to Actions Affecting a Cover

The following activities are prohibited on any portion of the property where [pavement, a building foundation, soil cover, engineered cap or other barrier] is required as shown on the attached map, unless prior written approval has been obtained from the Wisconsin Department of Natural Resources: 1) removal of the existing barrier; 2) replacement with another barrier; 3) excavating or grading of the land surface; 4) filling on capped or paved areas; 5) plowing for agricultural cultivation; 6) construction or placement of a building or other structure; 7) changing the use or occupancy of the property to single-family residential use; or 8) changing the construction of a building that has a vapor mitigation system in place.

SOURCE PROPERTY

If removal, replacement or other changes to a cover, or a building which is acting as a cover, are considered, the property owner will contact DNR at least 45 days before taking such an action, to determine whether further action may be necessary to protect human health, safety, or welfare or the environment, in accordance with s. NR 727.07, Wis. Adm. Code.

Amendment or Withdrawal of Maintenance Plan

This Maintenance Plan can be amended or withdrawn by the property owner and its successors with the written approval of DNR.

Contact Information

January 2022

Site Owner and Operator: Fox Shores LLC
Logan Rankin
518 Main Street #346
Wrightstown, WI 54180
(920) 255-3259

Signature: 

Consultant: Stantec Consulting Services Inc.
Jeffrey R. Brand
1165 Scheuring Road
De Pere, WI 54115
(920) 592-8400

DNR: Sarah Krueger
2984 Shawano Avenue
Green Bay, WI 54313-6727
(920) 510-8277

D.2 Location Map(s)

D. 3 Photographs of Cover/Barrier

D.4 Continuing Obligations Inspection and Maintenance Log
Form 4400-305

SOURCE PROPERTY

HA–13
B4
SB10–2
HA–11
SB11
B5
SB12
HA–16
HA–15
PARCEL #323040804
B3
HA–12
HA–17
SB14
HA–1
HA–18
HA–19
SB7
HA–9
SB15
FOX SHORES DRIVE
SB6
HA–10
SB16
HA–8
B2
SB13
SB10–1
SB9
HA–7
SB17
B1
HA–14
SB8
HA–2
HA–6
HA–3
BICENTENNIAL COURT
HA–4
HA–5

FOX RIVER

N

SCALE IN FEET

30 0 30 60

LEGEND

- B1 — PARTNER ENGINEERING AND SCIENCE INC. SOIL BORING LOCATION
- SB6 — STANTEC SOIL BORING LOCATION
- HA–1 — STANTEC HAND AUGER SOIL BORING LOCATION
- APPROXIMATE PROPERTY LINE
- ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION (ASSUMED TO BE SITEWIDE)

Stantec

1165 Scheuring Road, Green Bay, Wisconsin 54115
Phone: 920-592-8400 Fax: 920-592-8444

This drawing and all information contained thereon is the property of Stantec. Stantec will not be held liable for improper or incorrect usage. Professional seals and signatures do not apply to electronic drawing files. The user assumes all responsibility and risk for the accuracy and verification of all information contained in electronic files.

ESTIMATED EXTENT OF SOIL CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
04/24/20	JRB	JRB	193706620	1



N

SCALE IN FEET

30 0 30 60

LEGEND

TW10	TEMPORARY MONITORING WELL LOCATION
B1–GW	PARTNER ENGINEERING AND SCIENCE INC. TEMPORARY MONITORING WELL LOCATION
	APPROXIMATE PROPERTY LINE
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
	ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES

Stantec

1165 Scheuring Road, Green Bay, Wisconsin 54115
Phone: 920-592-8400 Fax: 920-592-8444

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ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
05/22/20	JRB	JRB	193706620	2



N

SCALE IN FEET

30 0 30 60

LEGEND

- BRRTS CASE #02-45-582746 AND ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING WDNR RCLs FOR DIRECT CONTACT AND/OR GROUNDWATER PROTECTION. (ASSUMED TO BE SITEWIDE)
- APPROXIMATE PROPERTY LINE
- ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING ES
- ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING PAL
- PAVED CAP
- BUILDING CAP
- BERM LOCATION
- LANDSCAPE CAP
- GAVEL CAP

Stantec

1165 Scheuring Road, Green Bay, Wisconsin 54115
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CAP LOCATION MAP

FOX SHORES APARTMENTS
400 FOX SHORES DRIVE
KAUKAUNA, WISCONSIN

DATE:	DRAWN BY:	PROJECT MANAGER:	PROJECT NUMBER:	FIGURE
02/05/21	JRB	JRB	193706620	3


SOURCE PROPERTY
Fox
Fox
Fox Shores Dr
Fox Shores Dr
Bicentennial Ct
Ghost Town Fitness

SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 1

Photo Location:
Lot 2

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 2

Photo Location:
Lot 2

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 3

Photo Location:
Lot 2

Direction:
North

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 4

Photo Location:
380/390 Bicentennial Court

Direction:
Southwest

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 5

Photo Location:
400 Bicentennial Court

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 6

Photo Location:
400/410 Bicentennial Court

Direction:
Southwest

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 7

Photo Location:
400/410 Bicentennial Court

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 8

Photo Location:
410 Bicentennial Court

Direction:
Southwest

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 9

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 10

Photo Location:
410 Fox Shores Drive

Direction:
South

Survey Date:
9/28/2021

Comments:
Soil Cap



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 11 **Photo Location:** 410 Bicentennial Court **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Soil Cap With Added Mulch	
Photograph ID: 12 **Photo Location:** 390 Bicentennial Court **Direction:** Southeast **Survey Date:** 9/28/2021 **Comments:** Soil Cap With Added Mulch	

SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 13

Photo Location:
380 Bicentennial Court

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Soil cap



Photograph ID: 14

Photo Location:
380 Bicentennial Court

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Soil Cap



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 15

Photo Location:
Lot 2

Direction:
Northwest

Survey Date:
9/28/2021

Comments:
Soil Cap



Photograph ID: 16

Photo Location:
Lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 17

Photo Location:
Lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 18

Photo Location:
Lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 19

Photo Location:
lot 2

Direction:
Southeast

Survey Date:
9/28/2021

Comments:
Capped Berm



Photograph ID: 20

Photo Location:
Lot 2

Direction:
Northeast

Survey Date:
9/28/2021

Comments:
Capped Berm



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 21 **Photo Location:** Lot 2 **Direction:** North **Survey Date:** 10/4/2021 **Comments:** Final Seeding With Straw/Erosion Mat	
Photograph ID: 22 **Photo Location:** lot 2 **Direction:** Southwest **Survey Date:** 10/4/2021 **Comments:** Final Seeding With Straw	

SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 23

Photo Location:
380/390 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 24

Photo Location:
390/400 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 25

Photo Location:
400 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 26

Photo Location:
400/410 Bicentennial Court

Direction:
South

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 27

Photo Location:
410 Bicentennial Court

Direction:
Southwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw/Erosion Mat



Photograph ID: 28

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 29

Photo Location:
410 Fox Shores Drive

Direction:
East

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 30

Photo Location:
390/400 Bicentennial Court

Direction:
Northwest

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 31

Photo Location:
380 Bicentennial Court

Direction:
Southeast

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



Photograph ID: 32

Photo Location:
380 Bicentennial Court

Direction:
Northeast

Survey Date:
10/4/2021

Comments:
Final Seeding With Straw



SOURCE PROPERTY

Stantec

Photographic Log

Client:	**Tom Vandeyacht - Fox Investments LLC**	**Project:**	**193706620**
Site Name:	**Fox Shores Apartments**	**Site Location:**	**400 Fox Shores Drive, Kaukauna, Wisconsin**

Photograph ID: 33

Photo Location:
410 Fox Shores Drive

Direction:
North

Survey Date:
7/28/2021

Comments:
Lanscaping With Gravel Cap



Photograph ID: 34

Photo Location:
410 Fox Shores Drive

Direction:
Northeast

Survey Date:
7/28/2021

Comments:
Lanscaping With Gravel Cap



State of Wisconsin
Department of Natural Resources
dnr.wi.gov

SOURCE PROPERTY

Continuing Obligations Inspection and Maintenance Log

Form 4400-305 (R 7/20)

Directions: In accordance with s. NR 727.05 (1) (b) 3., Wis. Adm. Code, use of this form for documenting the inspections and maintenance of certain continuing obligations is required. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Public Records law [ss. 19.31-19.39, Wis. Stats.]. When using this form, identify the condition that is being inspected. See the closure approval letter for this site for requirements regarding the submittal of this form to the Department of Natural Resources. A copy of this inspection log is required to be maintained either on the property, or at a location specified in the closure approval letter. Do NOT delete previous inspection results. This form was developed to provide a continuous history of site inspection results. The Department of Natural Resources project manager is identified in the closure letter. The project manager may also be identified from the database, BRRTS on the Web, at http://dnr.wi.gov/botw/SetUpBasicSearchForm.do, by searching for the site using the BRRTS ID number, and then looking in the "Who" section.

Activity (Site) Name	BRRTS No.
Fox Shores Apartments	02-45-582746

Inspections are required to be conducted (see closure approval letter):

- (●) annually
- ( ) semi-annually
- ( ) other – specify _____

When submittal of this form is required, submit the form electronically to the DNR project manager. An electronic version of this filled out form, or a scanned version may be sent to the following email address (see closure approval letter):

Inspection Date	Inspector Name	Item	Describe the condition of the item that is being inspected	Recommendations for repair or maintenance	Previous recommendations implemented?	Photographs taken and attached?
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N
		☐ monitoring well ☐ cover/barrier for soil ☐ sediment cap ☐ other:			◯ Y ◯ N	◯ Y ◯ N

{Click to Add/Edit Image}	Date added:
Title:	

{Click to Add/Edit Image}	Date added:
Title:	

SOURCE PROPERTY

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Logan Rankin
518 main St. #346
Wrightstown, WI 54180

9590 9402 7156 1251 5278 22

2. Article Number *(Transfer from service label)*

7020 3160 0002 0182 8545

COMPLETE THIS SECTION ON DELIVERY

A. Signature

x Ashley R

☐ Agent
☐ Addressee

B. Received by *(Printed Name)* Ashley Rankin

C. Date of Delivery 3/4/22

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type

- ☐ Adult Signature
- ☐ Adult Signature Restricted Delivery
- ☑ Certified Mail®
- ☐ Certified Mail Restricted Delivery
- ☐ Collect on Delivery
- ☐ Collect on Delivery Restricted Delivery
- ☐ Priority Mail Express®
- ☐ Registered Mail™
- ☐ Registered Mail Restricted Delivery
- ☐ Signature Confirmation™
- ☐ Signature Confirmation Restricted Delivery

PS Form 3811, July 2020 PSN 7530-02-000-9053 Domestic Return Receipt

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Ronald W. Kazmierczak, Regional Director

Oshkosh Service Center
625 East County Road Y, STE. 700
Oshkosh, WI 54901-9731
TELEPHONE 920-424-3050
FAX 920-424-4404

October 9, 2006

Clay Eiting
Ghost Town Fitness Center, LLC
180 Fox Shores Drive
Kaukauna, WI 54130

SUBJECT: Final Case Closure with PAL Exemption by Closure Committee for **Ghost Town Fitness Center**, 180 Fox Shores Dr, Kaukauna, WI
WDNR BRRTS Activity #: 02-45-547911

Dear Mr. Eiting:

On October 3, 2006, the Northeast Regional Closure Committee reviewed the above referenced case for closure. This committee reviews environmental remediation cases for compliance with state laws and standards to maintain consistency in the closure of these cases.

On October 6, 2006, the Department received documentation for abandonment of the monitoring well, indicating that you have complied with the final requirements of closure. Based on the correspondence and data provided, it appears that your case has been remediated to Department standards in accordance with s. NR 726.05, Wis. Adm. Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time.

Recent groundwater monitoring data at this site indicates exceedances of the NR 140 preventive action limit (PAL) for arsenic and selenium at monitoring well, MW-1, but compliance with the NR 140 enforcement standard. The Department may grant an exemption to a PAL for a substance of public health concern, other than nitrate, pursuant to s. NR 140.28(2)(b), Wis. Adm. Code, if all of the following criteria are met:

1. The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically and economically feasible.

2. Compliance with the PAL is either not technically or economically feasible.

3. The enforcement standard for the substance will not be attained or exceeded at the point of standards application.

4. Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

Based on the information you provided, the Department believes that the above criteria have been or will be met. Therefore, pursuant to s. NR 140.28(2)(b), Wis. Adm. Code, an exemption to the PAL is granted for arsenic and selenium at MW-1. This letter serves as your exemption.

Please be aware that this case may be reopened pursuant to s. NR 726.09, Wis. Adm. Code, if additional information regarding site conditions indicates that contamination on or from the site poses a threat to public health, safety or welfare, or the environment.

If you have any questions regarding this letter, please contact me at the number below.

Sincerely,

Jennifer Borski
Hydrogeologist
Bureau for Remediation & Redevelopment
(920) 424-7887

Ecc: Terracon
Bill Phelps – DNR, Madison – DG/2

State of Wisconsin
Department of Natural Resources
P.O. Box 7921, Madison, WI 53707-7921

GIS REGISTRY (Cover Sheet)
Form 4400-280 (R 6/13)

Source Property Information

CLOSURE DATE: 08/11/2003

BRRTS #: **03-45-001729**

FID #:

ACTIVITY NAME: KAUKAUNA CTY - WASTE OIL COLLECTION SITE

DATCP #:

PROPERTY ADDRESS: 3rd St, 200 Block

PECFA#: 54130240622A

MUNICIPALITY: Kaukauna

PARCEL ID #: 323040200

***WTM COORDINATES:**

X: **657662** Y: **424330**

** Coordinates are in WTM83, NAD83 (1991)*

WTM COORDINATES REPRESENT:

- (•) Approximate Center Of Contaminant Source
- ( ) Approximate Source Parcel Center

Please check as appropriate: (BRRTS Action Code)

CONTINUING OBLIGATIONS

Contaminated Media for Residual Contamination:

- [x] Groundwater Contamination > ES *(236)*
  - [ ] Contamination in ROW
  - [ ] Off-Source Contamination

  *(**note:** for list of off-source properties see "Impacted Off-Source Property Information, Form 4400-246")*

- [x] Soil Contamination > *RCL or **SSRCL *(232)*
  - [ ] Contamination in ROW
  - [ ] Off-Source Contamination

  *(**note:** for list of off-source properties see "Impacted Off-Source Property Information, Form 4400-246")*

Site Specific Obligations:

- [ ] Soil: maintain industrial zoning *(220)*

  *(**note:** soil contamination concentrations between non-industrial and industrial levels)*

- [ ] Structural Impediment *(224)*
- [ ] Site Specific Condition *(228)*
- [x] Cover or Barrier *(222)*
  - [x] Direct Contact
  - [ ] Soil to GW Pathway
- [ ] Vapor Mitigation *(226)*
- [ ] Maintain Liability Exemption *(230)*

  *(**note:** local government unit or economic development corporation was directed to take a response action)*

Monitoring Wells:

Are all monitoring wells properly abandoned per NR 141? *(234)*

(•) Yes ( ) No ( ) N/A

** Residual Contaminant Level*
***Site Specific Residual Contaminant Level*

State of Wisconsin
Department of Natural Resources
http://dnr.wi.gov

PLEASE ASSEMBLE IN THIS ORDER

GIS Registry Checklist

Form 4400-245 (R 8/11)

This Adobe Fillable form is intended to provide a list of information that is required for evaluation for case closure. It is to be used in conjunction with Form 4400-202, Case Closure Request. The closure of a case means that the Department has determined that no further response is required at that time based on the information that has been submitted to the Department.

NOTICE: Completion of this form is mandatory for applications for case closure pursuant to ch. 292, Wis. Stats. and ch. NR 726, Wis. Adm. Code, including cases closed under ch. NR 746 and ch. NR 726. The Department will not consider, or act upon your application, unless all applicable sections are completed on this form and the closure fee and any other applicable fees, required under ch. NR 749, Wis. Adm. Code, Table 1 are included. It is not the Department's intention to use any personally identifiable information from this form for any purpose other than reviewing closure requests and determining the need for additional response action. The Department may provide this information to requesters as required by Wisconsin's Open Records law [ss. 19.31 - 19.39, Wis. Stats.].

BRRTS #: 03-45-001729 *(No Dashes)* PARCEL ID #: 323040200

ACTIVITY NAME: KAUKAUNA CTY - WASTE OIL COLLECTION SITE WTM COORDINATES: X: 657662 Y: 424330

CLOSURE DOCUMENTS (the Department adds these items to the final GIS packet for posting on the Registry)

- [X] **Closure Letter**
- [ ] **Maintenance Plan** (*if activity is closed with a land use limitation or condition (land use control) under s. 292.12, Wis. Stats.*)
- [ ] **Continuing Obligation Cover Letter** (for property owners affected by residual contamination and/or continuing obligations)
- [ ] **Conditional Closure Letter**
- [ ] **Certificate of Completion (COC)** (for VPLE sites)

SOURCE LEGAL DOCUMENTS

- [X] **Deed:** The most recent deed as well as legal descriptions, for the **Source Property** (where the contamination originated). Deeds for other, off-source (off-site) properties are located in the **Notification** section.
  Note: *If a property has been purchased with a land contract and the purchaser has not yet received a deed, a copy of the land contract which includes the legal description shall be submitted instead of the most recent deed. If the property has been inherited, written documentation of the property transfer should be submitted along with the most recent deed.*
- [ ] **Certified Survey Map:** A copy of the certified survey map or the relevant section of the recorded plat map *for those properties where the legal description in the most recent deed refers to a certified survey map or a recorded plat map.* (lots on subdivided or platted property (e.g. lot 2 of xyz subdivision)).

  Figure #: **Title:**
- [X] **Signed Statement:** A statement signed by the Responsible Party (RP), which states that he or she believes that the attached legal description accurately describes the correct contaminated property.

MAPS (meeting the visual aid requirements of s. NR 716.15(2)(h))

Maps must be no larger than 11 x 17 inches unless the map is submitted electronically.

- [X] **Location Map:** A map outlining all properties within the contaminated site boundaries on a U.S.G.S. topographic map or plat map in sufficient detail to permit easy location of all parcels. If groundwater standards are exceeded, include the location of all potable wells within 1200 feet of the site.
  Note: *Due to security reasons municipal wells are not identified on GIS Packet maps. However, the locations of these municipal wells must be identified on Case Closure Request maps.*

  Figure #: 1 **Title: Site Location Map**
- [X] **Detailed Site Map:** A map that shows all relevant features (buildings, roads, individual property boundaries, contaminant sources, utility lines, monitoring wells and potable wells) within the contaminated area. This map is to show the location of all contaminated public streets, and highway and railroad rights-of-way in relation to the source property and in relation to the boundaries of groundwater contamination exceeding a ch. NR 140 Enforcement Standard (ES), and/or in relation to the boundaries of soil contamination exceeding a Residual Contaminant Level (RCL) or a Site Specific Residual Contaminant Levels (SSRCL) as determined under s. NR 720.09, 720.11 and 720.19.

  Figure #: 2 **Title: Site Detail Map, Site Plan Prior to Remediation**
- [X] **Soil Contamination Contour Map:** For sites closing with residual soil contamination, this map is to show the location of all contaminated soil and a single contour showing the horizontal extent of each area of contiguous residual soil contamination that exceeds a Residual Contaminant Level (RCL) or a Site Specific Residual Contaminant Level (SSRCL)as determined under s. NR 720.09, 720.11 and 720.19.

  Figure #: 7 **Title: Estimated Extent of Contamination Exceeding RC:s in the Vadose and Smear Zones**

BRRTS #: 03-45-001729 ACTIVITY NAME: KAUKAUNA CTY - WASTE OIL COLLECTION SITE

MAPS (continued)

☒ **Geologic Cross-Section Map:** A map showing the source location and vertical extent of residual soil contamination exceeding a Residual Contaminant Level (RCL) or a Site Specific Residual Contaminant Level (SSRCL). If groundwater contamination exceeds a ch. NR 140 Enforcement Standard (ES) when closure is requested, show the source location and vertical extent, water table and piezometric elevations, and locations and elevations of geologic units, bedrock and confining units, if any.

Figure #: 4 **Title: Pre-Remedial Geologic Cross Section A-A'**

Figure #: **Title:**

☒ **Groundwater Isoconcentration Map:** For sites closing with residual groundwater contamination, this map shows the horizontal extent of all groundwater contamination exceeding a ch. NR140 Preventive Action Limit (PAL) and an Enforcement Standard (ES). Indicate the direction and date of groundwater flow, based on the most recent sampling data.
Note: *This is intended to show the total area of contaminated groundwater.*

Figure #: 6 **Title: Groundwater Contour Map**

☒ **Groundwater Flow Direction Map:** A map that represents groundwater movement at the site. If the flow direction varies by more then 20° over the history of the site, submit 2 groundwater flow maps showing the maximum variation in flow direction.

Figure #: 6 **Title: Ground-water Flow Direction**

Figure #: 5 **Title: Groundwater Elevation Contours**

TABLES (meeting the requirements of s. NR 716.15(2)(h)(3))

Tables must be no larger than 11 x 17 inches unless the table is submitted electronically. Tables must not contain shading and/or cross-hatching. The use of **BOLD** or *ITALICS* is acceptable.

☒ **Soil Analytical Table:** A table showing remaining soil contamination with analytical results and collection dates.
Note: This is one table of results for the contaminants of concern. Contaminants of concern are those that were found during the site investigation, that remain after remediation. It may be necessary to create a new table to meet this requirement.

Table #: 1,1, 2 **Title: Summary of Soil Analytical Results, Summary of Field Headspace Analysis, Summary of..**

☒ **Groundwater Analytical Table:** Table(s) that show the most recent analytical results and collection dates, for all monitoring wells and any potable wells for which samples have been collected.

Table #: 3, 1, 4 **Title: Summary of Laboratory Analysis Groundwater, Summary of GW Analytical Results**

☐ **Water Level Elevations:** Table(s) that show the previous four (at minimum) water level elevation measurements/dates from all monitoring wells. If present, free product is to be noted on the table.

Table #: **Title:**

IMPROPERLY ABANDONED MONITORING WELLS

For each monitoring well not properly abandoned according to requirements of s. NR 141.25 include the following documents.
Note: *If the site is being listed on the GIS Registry for only an improperly abandoned monitoring well you will only need to submit the documents in this section for the GIS Registry Packet.*

☒ **Not Applicable**

☐ **Site Location Map:** A map showing all surveyed monitoring wells with specific identification of the monitoring wells which have not been properly abandoned.
Note: *If the applicable monitoring wells are distinctly identified on the Detailed Site Map this Site Location Map is not needed.*

Figure #: **Title:**

☐ **Well Construction Report:** Form 4440-113A for the applicable monitoring wells.

☐ **Deed:** The most recent deed as well as legal descriptions for each property where a monitoring well was not properly abandoned.

☐ **Notification Letter:** Copy of the notification letter to the affected property owner(s).

BRRTS #: 03-45-001729 ACTIVITY NAME: KAUKAUNA CTY - WASTE OIL COLLECTION SITE

NOTIFICATIONS

Source Property

☒ **Not Applicable**

☐ **Letter To Current Source Property Owner:** If the source property is owned by someone other than the person who is applying for case closure, include a copy of the letter notifying the current owner of the source property that case closure has been requested.

☐ **Return Receipt/Signature Confirmation:** Written proof of date on which confirmation was received for notifying current source property owner.

Off-Source Property

Group the following information per individual property and label each group according to alphabetic listing on the "Impacted Off-Source Property" attachment.

☒ **Not Applicable**

☐ **Letter To "Off-Source" Property Owners:** Copies of all letters sent by the Responsible Party (RP) to owners of properties with groundwater exceeding an Enforcement Standard (ES), and to owners of properties that will be affected by a land use control under s. 292.12, Wis. Stats.
Note: *Letters sent to off-source properties regarding residual contamination must contain standard provisions in Appendix A of ch. NR 726.*

Number of "Off-Source" Letters:

☐ **Return Receipt/Signature Confirmation:** Written proof of date on which confirmation was received for notifying any off-source property owner.

☐ **Deed of "Off-Source" Property:** The most recent deed(s) as well as legal descriptions, for all affected deeded **off-source property(ies).** This does not apply to right-of-ways.
Note: *If a property has been purchased with a land contract and the purchaser has not yet received a deed, a copy of the land contract which includes the legal description shall be submitted instead of the most recent deed. If the property has been inherited, written documentation of the property transfer should be submitted along with the most recent deed.*

☐ **Certified Survey Map:** A copy of the certified survey map or the relevant section of the recorded plat map *for those properties where the legal description in the most recent deed refers to a certified survey map or a recorded plat map.* (lots on subdivided or platted property (e.g. lot 2 of xyz subdivision)).

Figure #: **Title:**

☐ **Letter To "Governmental Unit/Right-Of-Way" Owners:** Copies of all letters sent by the Responsible Party (RP) to a city, village, municipality, state agency or any other entity responsible for maintenance of a public street, highway, or railroad right-of-way, within or partially within the contaminated area, for contamination exceeding a groundwater Enforcement Standard (ES) and/or soil exceeding a Residual Contaminant Level (RCL) or a Site Specific Residual Contaminant Level (SSRCL).

Number of "Governmental Unit/Right-Of-Way Owner" Letters:

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary

Oshkosh Service Center
625 East County Road Y, STE 700
Oshkosh, Wisconsin 54901-9731
TELEPHONE 920-424-3050
FAX 920-424-4404

August 11, 2003

Paul Van Berkel
Kaukauna City Attorney
201 West Second Street
PO Box 890
Kaukauna, WI 54130-0890

WDNR BRRTS #: 03-45-001729

SUBJECT: Final Case Closure By Project Manager, Deed Restriction Filed
Kaukauna City - Waste Oil Site, 222 West 3rd St. Kaukauna, WI

Dear Mr. Van Berkel:

Your site as described above was reviewed for closure by the Department of Natural Resources. The Department reviews environmental remediation cases for compliance with state laws and standards to maintain consistency in the closure of these cases.

On July 29, 2003, the Department received correspondence indicating that you have complied with the conditions of closure. The soil and groundwater deed restrictions were filed on May 20, 2003. Based on the correspondence and data provided, it appears that your case meets the screening criteria of s. NR 746.07, and the requirements of ch. NR 726, Wis. Adm. Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time.

Your site will be listed on the DNR Remediation and Redevelopment GIS Registry of Closed Remediation Sites. Information that was submitted with your closure request application will be included on the registry. To review the sites on the GIS Registry web page, visit
http://gomapout.dnr.state.wi.us/org/at/et/geo/gwur/index.htm

If this is a PECFA site, section 101.143, Wis. Stats., requires that PECFA claimants seeking reimbursement of interest costs, for sites with petroleum contamination, submit a final reimbursement claim within 120 days after they receive a closure letter on their site. For claims not received by the PECFA Program within 120 days of the date of this letter, interest costs after 60 days of the date of this letter will not be eligible for PECFA reimbursement.

Please be aware that this case may be reopened pursuant to s. NR 726.09, Wis. Adm. Code, if additional information regarding site conditions indicates that contamination on or from the site poses a threat to public health, safety or welfare, or the environment. The Department appreciates your efforts to restore the environment at this site. If you have any questions regarding this letter, please contact me at 920-303-5435.

Sincerely,

Cheryl Laatsch
Hydrogeologist
Bureau for Remediation & Redevelopment

1544717

Document Number

DEED RESTRICTION

OUTAGAMIE COUNTY
RECEIVED FOR RECORD

MAY 20 2003

AT 9:45 O'CLOCK A.M. ~~P.M.~~
JANICE FLENZ
REGISTER OF DEEDS

2P 27

Declaration of Restrictions

In Re: The parcel of property described in No. 4 of Exhibit A (Warranty Deed) hereby attached and made a part of this restriction.

Recording Area

Name and Return Address
Paul Van Berkel
Attorney, City of Kaukauna
180 West Wisconsin Avenue
Kaukauna, WI 54130

pd 27.00

STATE OF WISCONSIN)
) ss
COUNTY OF OUTAGAMIE)

32-3-0402-00
Parcel Identification Number (PIN)

WHEREAS, the City of Kaukauna is the owner of the above-described property.

WHEREAS, one or more petroleum discharges have occurred on this property. Petroleum contaminated groundwater above ch. NR 140, Wis. Adm. Code enforcement standards existed on this property at the following location(s) on the following date(s): monitoring well 4 (MW-4) benzene was 260 micrograms per liter on November 29, 1999, and iron was 10 milligrams per liter on April 8, 1999; monitoring well 1 (MW-1) iron was 10 milligrams per liter on April 8, 1999 and soil contamination existed on the property at the following location(s) on the following date(s): Soil boring 6 (B-6) with 150 milligrams per kilogram (mg/kg) lead at 1 to 3 feet, B-9 with 370 mg/kg lead, 1500 micrograms per kilogram (ug/kg) benzene, 11190 ug/kg xylene at 1-3 feet on April 15, 1998 and B15 with 2200 mg/kg gasoline range organics (GRO) ethylbenzene, 3500 mg/kg diesel range organics (DRO), 13000 ug/kg benzene, 54000 ug/kg ethylbenzene, 3500 ug/kg toluene and 166800 ug/kg xylene at 2.5 to 4.5 feet on August 28, 1998.

Location of monitoring wells and soil borings are provided on Exhibit B, (Figure 3), hereby attached and made part of this restriction.

WHEREAS, it is the desire and intention of the property owner to impose on the property restrictions which will make it unnecessary to conduct further groundwater or soil remediation activities on the property at the present time.

WHEREAS, natural attenuation has been approved by the Department of Natural Resources to remediate groundwater contamination exceeding ch. NR 140, Wis. Adm. Code groundwater standards within the boundaries of this property.

WHEREAS, construction of wells where the water quality does not comply with drinking water standards in ch. NR 809, Wis. Adm. Code is restricted by chs. NR 811 and NR 812, Wis. Adm. Code. Special well construction standards or water treatment requirements, or both, or well construction prohibitions may apply.

NOW THEREFORE, the owner hereby declares that all of the property described above is held and shall be held, conveyed or encumbered, leased, rented, used, occupied and improved subject to the following limitation and restrictions:

Anyone who proposes to construct or reconstruct a well on this property is required to contact the Department of Natural Resources' Bureau of Drinking Water and Groundwater, or it successor agency, to determine what specific requirements are applicable, prior to constructing or reconstructing a well on this property. No well may be constructed on this property unless applicable requirements are met.

The following activities are prohibited on that portion of the property above described in Exhibit C, where a cap or cover has been placed as identified in Exhibit B (Figure 3), unless prior written approval has been obtained from the Wisconsin Department of Natural Resources or its successor or assign: (1) Excavating or grading of the land surface; (2) Filling on the capped area; (3) Plowing for agricultural cultivation; and (4) Construction or installation of a building of other structure with a foundation that would sit on or be places within a cap or cover. In addition, the cap or cover shall be maintained in compliance with a plan prepared and submitted to the Wisconsin Department of Natural Resources by a responsible party, as required by section NR 724.13 (2), Wis. Adm. Code (1999).

This restriction is hereby declared to be a covenant running with the land and shall be fully binding upon all persons acquiring the above-described property whether by descent, devise, purchase or otherwise. This restriction benefits and is enforceable by the Wisconsin Department of Natural Resources, its successors or assigns. The Department, its successors or assigns, may initiate proceedings at law or in equity against any person or persons who violate or are proposing to violate this covenant, to prevent the proposed violation or to recover damages for such violation.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Natural Resources or its successor issue a determination that one or more of the restrictions set forth in this covenant is no longer required. Upon the receipt of such a request, the Wisconsin Department of Natural Resources shall determine whether or not the restrictions contained herein can be extinguished. If the Department determines that the restrictions can be extinguished, an affidavit, attached to

a copy of the Department's written determination, may be recorded to give notice that this deed restriction, or portions of this deed restriction, are no longer binding.

By Signing the document, John J. Lambie, Mayor, and Susan J. Duda, Clerk/Treasurer, assert that they are duly authorized to sign this document on behalf of the City of Kaukauna.

IN WITNESS WHEREOF, the owner of the property has executed this Declaration of Restrictions, this 13th day of May, 2003.

Signature: John J. Lambie
Printed Name: John J. Lambie
Title: Mayor

Signature: Susan J Duda
Printed Name: Susan J. Duda
Title: Clerk/Treasurer

Subscribed and sworn to before me
this 13th day of May, 2003.

Notary Public, State of Wisconsin
My commission is permanent

This document was drafted by the Wisconsin Department of Natural Resources based on information provided by Fischer Environmental, Inc. and the City of Kaukauna.

EXHIBIT A

EXHIBIT A

WARRANTY DEED VOL 957 PAGE 71

THIS INDENTURE, made by BADGER NORTHLAND INC., also known as BADGER NORTHLAND, INC., a Corporation duly organized and existing under and by virtue of the laws of the State of Delaware, formerly known as M-F Badger Corporation, a Delaware Corporation, located at Kaukauna, Wisconsin, Outagamie County, Grantor, of the City of Kaukauna, Outagamie County, Wisconsin, hereby conveys and warrants to the CITY OF KAUKAUNA, a Wisconsin Municipal Corporation, Grantee, of the City of Kaukauna, Outagamie County, Wisconsin, for valuable consideration of $447,000, and other good and valuable consideration, the following tracts of land located in Outagamie County, State of Wisconsin:

1. All of Lots 1 through 16, in Block eight (8), of LEDYARD PLAT, and all that portion of the vacated alley located in Block 8, LEDYARD PLAT, abutting upon Lots 5 through 12, inclusive, on Second Street and upon Lots 13 through 16, inclusive, on Third Street, said vacated alley being a parcel of land 20 feet wide and 200 feet long, all according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin.

2. That part of Lot "A" Ledyard Plat of the City of Kaukauna, bounded and described as follows: Commencing at the most Westerly corner of Block 8 of aforesaid Ledyard Plat, being a point on the Northeasterly line of Third Street; thence Northwesterly along said Northeasterly line of Third Street, a distance of 723.5 feet to a point distant 25 feet Southerly, measured radially, from the center line of the Main track of the Chicago and North Western Railway Company, as said main track is now located; thence Easterly along a line parallel with said main track center line, said parallel line being a curved line concave to the South and having a radius of 810.00 feet (the long chord of which forms an angle of $24^{\circ}32'$ as measured from Southeast to East, with the Northeasterly line of Third Street and has a length of 226.7 feet) a distance of 227.45 feet to the point of beginning of the parcel of land herein described; thence Easterly along a curved line convex to the South and having a radius of 920 feet (the chord of which forms an angle of $14^{\circ}20'$ to the right of an extension Easterly, of the long chord of the last described curve and has a length of 289.9 feet) a distance of 291.11 feet; thence Easterly along a straight line which forms an angle of $8^{\circ}10'$ to the left of an extension, Easterly of the long chord of the last described curve, a distance of 237 feet, more or less, to an intersection with the Southwesterly line of Second Street extended Northwesterly; thence Southeasterly along the extension of said Southwesterly line of Second Street, a distance of 6.8 feet, more or less, to the most Northerly corner of aforesaid Block 8, Ledyard Plat; thence Northeasterly along the Northeasterly extension of the Northwesterly line of said Block 8, a distance of 45 feet, more or less, to a point distant 25 feet Southwesterly, measured at right angles, from the center line of the main track of the Chicago and North Western Railway Company aforesaid; thence Northwesterly along a line parallel with said main track center line, a distance of 520 feet, more or less,

EXHIBIT A PAGE 2

to the point of beginning. (The above described premises located in the unplatted part of Ledyard Plat according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin, excepting and reserving unto the Chicago and Northwestern Railroad Company, a Wisconsin corporation, the right to maintain, operate, use, reconstruct and replace any and all existing conduits, sewers, water mains, gas lines, electric power lines, communication lines, wires and other utilities upon said premises.

3. A part of Lot "B" in the Plat of Ledyard, now a part of the City of Kaukauna, bounded and described as follows: Commencing at the point of intersection of the Northwesterly line of Fourth Avenue (State Trunk Highway 55) and the Northeasterly line of Second Street; thence Northwesterly along said Northeasterly line of Second Street, a distance of 215 feet to the point of beginning of the parcel of land herein described; thence Northeasterly along a line at right angles to said Northeasterly line of Second Street, a distance of 110 feet, more or less, to a point distant 32 feet Southwesterly, measured at right angles, from the center line of the main track of the Chicago and North Western Railway Company, as said main track is now located; thence Southwesterly along a straight line, a distance of 335 feet, more or less, to a point on the Northeasterly line of Second Street aforesaid, distant 35 feet Southwesterly, measured at right angles, from said main track center line; thence Southeasterly along said Northeasterly line of Second Street, a distance of 315 feet, more or less, less and excepting that property conveyed by Badger Northland Inc. to the City of Kaukauna by Warranty Deed dated September 29, 1972, for road purposes. The above described premises located in the unplatted part of Ledyard Plat according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin. Less and excepting a reservation unto the prior grantor, Chicago and Northwestern Railway Company, a Wisconsin corporation, for its right to maintain, operate, use, reconstruct and replace any and all existing conduits, sewers, water mains, gas lines, electric power lines, communication lines, wires and other utilities upon the premises.

4. That part of Lot "A" Ledyard Plat of the City of Kaukauna, Outagamie County and State of Wisconsin, described as follows, to-wit: Beginning at the most Westerly corner of Block 8 of aforesaid Ledyard Plat; thence Northwesterly along the Northeasterly line of Third Street, a distance of 723.5 feet to a point distant 25 feet Southerly, measured radially, from the center line of the main track of the Chicago and North Western Railway Company as said main track is now located and established; thence Easterly along a line parallel with the center line of said main track, said line being a curved line concave to the South and having a radius of 810.00 feet (the long chord of which forms an angle of 24°32', as measured from Southeast to East, with the Northeasterly line of Third Street and has a length of 226.7 feet) a distance of 227.45 feet, thence Easterly along a curved line convex to the South and having a radius of 920.00 feet (the long chord of which forms an angle of 14°20' to the right of an extension Easterly, of the long chord of the last described curve and has a length of 289.9 feet) a distance of 291.11 feet; thence Easterly along a straight line which forms an angle of 8°10' to the left of an extension, Easterly, of the long chord

S/A 1st Desc. in V763 P473

EXHIBIT A PAGE 3

of the last described curve, a distance of 237.0 feet, more or less, to an intersection with the Southwesterly line of Second Street extended Northwesterly; thence Southeasterly along the extension of said line of Second Street, a distance of 6.8 feet, more or less, to the most Northerly corner of aforesaid Block 8, Ledyard Plat; thence Southwesterly along the Northwesterly line of said Block 8, a distance of 220.0 feet, more or less, to the point of beginning, (said premises being located in the unlotted part of Ledyard Plat according to the recorded Assessor's Plat of said City). Subject to the rights of the City of Kaukauna under a lease to construct, maintain and use a water line, as it presently exists, in such real estate.

FEE
2
EXEMPT

Except for easements, covenants and restrictions of record, and covenants for any public roadway purposes.

Exempt from Real Estate Transfer Return and transfer tax, Exempt # 2.

IN WITNESS WHEREOF, the said grantor corporation has caused these presents to be signed by Gail E. Janssen, its corporation president and countersigned by Kenneth B. Myers, its corporation secretary, at Kaukauna, Wisconsin, and its corporate seal hereunto affixed this 26th day of July, 1974.

BADGER NORTHLAND INC.
A Delaware Corporation
a/k/a BADGER NORTHLAND, INC.,
a Delaware Corporation

(CORPORATE SEAL)

Gail E. Janssen, President

Countersigned:

Kenneth B. Myers, Secretary

STATE OF WISCONSIN)
) SS.
OUTAGAMIE COUNTY)

Personally came before me this 26th day of July, 1974, Gail E. Janssen, corporation president and Kenneth B. Myers, corporation secretary, of the above named corporation, Badger Northland Inc., a/k/a Badger Northland, Inc., to me known to be the persons who executed the foregoing instrument and to me known to be such president and secretary of said corporation, and acknowledge that they executed the foregoing instrument as such officers and as the deed of said corporation, all by its authority.

Charles J. Hartzheim, Notary Public.

OUTAGAMIE
Document # 685856

STATE OF WISCONSIN

IN _____ COURT

FOR _____ COUNTY

Plaintiff

Defendant

REGISTER'S OFFICE
OUTAGAMIE COUNTY, WIS.

Received for Record the 26
day of July A.D. 19 74
10 o'clock A M. and Recorded in
Vol. 957 of Records on page 71

D. P. Peetersma
REGISTER

pd. 4.00

Don Steen, Atty

VOL 957 PAGE 74

EXHIBIT A PAGE 4

EXHIBIT A Page 4

~~WERRLING, C~~
~~ATTO~~
~~301 Nor~~
~~Appleton,~~

EXHIBIT B

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

B-7 MW-3
B-13
B-12
B-15 MW-5
B-8 MW-4
10,000 GALLON UNLEADED GASOLINE UST
10,000 GALLON DIESEL FUEL UST
10,000 GALLON DIESEL FUEL UST
DISPENSER ISLAND
B-14
B-9
B-10
B-6 MW-2
SIDEWALK
ASPHALT
B-11
B-3 MW-1
B-1
B-4
MW-6 B-16
B-2
B-5
GATE
WEST 3RD STREET
OE
G
W
PP
FH
SA
MH

N

Reduced from 11 inches by 17 inches.

10' 0 10' 20'

SCALE: 1" = 20'
ALL LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

The West line of Lot 13, Block 8, of Ledyard Plat, according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin.

NOTE:

B-1 THROUGH B-5 AND MW-1 INSTALLED BY OMNNI
ALL OTHERS BORINGS AND WELLS INSTALLED BY FISCHER

NOT ALL UTILITIES ARE LOCATED
UTILITY LOCATIONS ARE APPROXIMATE

✳ CONTAMINANTS DETECTED IN SOIL SAMPLES COLLECTED FROM VADOSE ZONE AT CONCENTRATIONS EXCEEDING NR720 RCLs.

FIGURE 3: PRE-REMEDIAL SITE PLAN AND SOIL SAMPLE LOCATION MAP

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003

DRAWN BY:	KP
REVIEWED BY:	
DATE:	7/21/98
APPROVED BY:	
ISM:	CLOSURE\FIG4

FISCHER
RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

EXHIBIT C

A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows: Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point being also being on the northerly Right of Way line of Third Street; also the point of beginning; thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat, a distance of 78 feet to the point of beginning.

File

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Ronald W. Kazmierczak, Regional Director

Northeast Region Headquarters
Green Bay Service Center
1125 N. Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448
Telephone 920-492-5800
FAX 920-492-5913
TDD 920-492-5912

January 19, 2000

City of Kaukauna
John Sundelius
201 2nd Street
Kaukauna, WI 54130

SUBJECT: Closure - Kaukauna City Waste Oil Site,
WDNR BRRTS ID #:03-45-001729

Dear Mr. Sundelius:

On December 16, 1999 the Department received your Addendum to Case Closure Request. After review the Department feels that the site meets the requests of the additional word described in the letter sent on November 10,1999.

- Soil contamination at boring location B-3 (MW-1) must be further investigated for direct contact concerns.

- A minimum of one additional round of groundwater samples analyzed for PVOC and naphthalene to evaluate post remediation contaminant trend.

Please complete the attached restriction and return a draft to this office for approval with a copy of the deed/legal description, survey map if available and a site map showing the contaminated groundwater locations. Pending Department approval the restrictions can be filed with the Outagamie County Register of Deeds. Only when the Department has received documentation that the restriction has been filed with County Register of Deeds Office and the monitoring wells abandoned according to the requirements of NR 141 Wis. Adm. Code, will the Department consider the site closed.

If you have any questions, please contact Greg Tilkens at (920) 492-5868 or Scott C. Miller at (920) 492-5871.

Sincerely,

Scott C. Miller
Hydrogeologist
Remediation & Redevelopment Program

cc: Karen Burkman; Fischer; PO Box 127, Kaukauna, WI 54130

WARRANTY DEED

THIS INDENTURE, made by BADGER NORTHLAND INC., also known as BADGER NORTHLAND, INC., a Corporation duly organized and existing under and by virtue of the laws of the State of Delaware, formerly known as M-F Badger Corporation, a Delaware Corporation, located at Kaukauna, Wisconsin, Outagamie County, Grantor, of the City of Kaukauna, Outagamie County, Wisconsin, hereby conveys and warrants to the CITY OF KAUKAUNA, a Wisconsin Municipal Corporation, Grantee, of the City of Kaukauna, Outagamie County, Wisconsin, for valuable consideration of $447,000, and other good and valuable consideration, the following tracts of land located in Outagamie County, State of Wisconsin:

1. All of Lots 1 through 16, in Block eight (8), of LEDYARD PLAT, and all that portion of the vacated alley located in Block 8, LEDYARD PLAT, abutting upon Lots 5 through 12, inclusive, on Second Street and upon Lots 13 through 16, inclusive, on Third Street, said vacated alley being a parcel of land 20 feet wide and 200 feet long, all according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin.

2. That part of Lot "A" Ledyard Plat of the City of Kaukauna, bounded and described as follows: Commencing at the most Westerly corner of Block 8 of aforesaid Ledyard Plat, being a point on the Northeasterly line of Third Street; thence Northwesterly along said Northeasterly line of Third Street, a distance of 723.5 feet to a point distant 25 feet Southerly, measured radially, from the center line of the Main track of the Chicago and North Western Railway Company, as said main track is now located; thence Easterly along a line parallel with said main track center line, said parallel line being a curved line concave to the South and having a radius of 810.00 feet (the long chord of which forms an angle of 24°32' as measured from Southeast to East, with the Northeasterly line of Third Street and has a length of 226.7 feet) a distance of 227.45 feet to the point of beginning of the parcel of land herein described: thence Easterly along a curved line convex to the South and having a radius of 920 feet (the chord of which forms an angle of 14°20' to the right of an extension Easterly, of the long chord of the last described curve and has a length of 289.9 feet) a distance of 291.11 feet: thence Easterly along a straight line which forms an angle of 8°10' to the left of an extension, Easterly of the long chord of the last described curve, a distance of 237 feet, more or less, to an intersection with the Southwesterly line of Second Street extended Northwesterly; thence Southeasterly along the extension of said Southwesterly line of Second Street, a distance of 6.8 feet, more or less, to the most Northerly corner of aforesaid Block 8, Ledyard Plat: thence Northeasterly along the Northeasterly extension of the Northwesterly line of said Block 8, a distance of 45 feet, more or less, to a point distant 25 feet Southwesterly, measured at right angles, from the center line of the main track of the Chicago and North Western Railway Company aforesaid: thence Northwesterly along a line parallel with said main

to the point of beginning. (The above described premises located in the unplatted part of Ledyard Plat according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin, excepting and reserving unto the Chicago and Northwestern Railroad Company, a Wisconsin corporation, the right to maintain, operate, use, reconstruct and replace any and all existing conduits, sewers, water mains, gas lines, electric power lines, communication lines, wires and other utilities upon said premises.

3. A part of Lot "B" in the Plat of Ledyard, now a part of the City of Kaukauna, bounded and described as follows: Commencing at the point of intersection of the Northwesterly line of Fourth Avenue (State Trunk Highway 55) and the Northeasterly line of Second Street; thence Northwesterly along said Northeasterly line of Second Street, a distance of 215 feet to the point of beginning of the parcel of land herein described; thence Northeasterly along a line at right angles to said Northeasterly line of Second Street, a distance of 110 feet, more or less, to a point distant 32 feet Southwesterly, measured at right angles, from the center line of the main track of the Chicago and North Western Railway Company, as said main track is now located; thence Southwesterly along a straight line, a distance of 335 feet, more or less, to a point on the Northeasterly line of Second Street aforesaid, distant 35 feet Southwesterly, measured at right angles, from said main track center line; thence Southeasterly along said Northeasterly line of Second Street, a distance of 315 feet, more or less, less and excepting that property conveyed by Badger Northland Inc. to the City of Kaukauna by Warranty Deed dated September 29, 1972, for road purposes. The above described premises located in the unplatted part of Ledyard Plat according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin. Less and excepting a reservation unto the prior grantor, Chicago and Northwestern Railway Company, a Wisconsin corporation, for its right to maintain, operate, use, reconstruct and replace any and all existing conduits, sewers, water mains, gas lines, electric power lines, communication lines, wires and other utilities upon the premises.

4. That part of Lot "A" Ledyard Plat of the City of Kaukauna, Outagamie County and State of Wisconsin, described as follows, to-wit: Beginning at the most Westerly corner of Block 8 of aforesaid Ledyard Plat; thence Northwesterly along the Northeasterly line of Third Street, a distance of 723.5 feet to a point distant 25 feet Southerly, measured radially, from the center line of the main track of the Chicago and North Western Railway Company as said main track is now located and established; thence Easterly along a line parallel with the center line of said main track, said line being a curved line concave to the South and having a radius of 810.00 feet (the long chord of which forms an angle of $24^{\circ}32'$, as measured from Southeast to East, with the Northeasterly line of Third Street and has a length of 226.7 feet) a distance of 227.45 feet, thence Easterly along a curved line convex to the South and having a radius of 920.00 feet (the long chord of which forms an angle of $14^{\circ}20'$ to the right of an extension Easterly, of the long chord of the last described curve and has a length of 289.9 feet) a distance of 291.11 feet; thence Easterly along a straight line which forms an angle of $8^{\circ}10'$ to the left of an extension, Easterly, of the long chord

of the last described curve, a distance of 237.0 feet, more or less, to an intersection with the Southwesterly line of Second Street extended Northwesterly; thence Southeasterly along the extension of said line of Second Street, a distance of 6.8 feet, more or less, to the most Northerly corner of aforesaid Block 8, Ledyard Plat; thence Southwesterly along the Northwesterly line of said Block 8, a distance of 220.0 feet, more or less, to the point of beginning, (said premises being located in the unlotted part of Ledyard Plat according to the recorded Assessor's Plat of said City). Subject to the rights of the City of Kaukauna under a lease to construct, maintain and use a water line, as it presently exists, in such real estate.

FEE EXEMPT # 2

Except for easements, covenants and restrictions of record, and covenants for any public roadway purposes.

Exempt from Real Estate Transfer Return and transfer tax, Exempt # 2.

IN WITNESS WHEREOF, the said grantor corporation has caused these presents to be signed by Gail E. Janssen, its corporation president and countersigned by Kenneth B. Myers, its corporation secretary, at Kaukauna, Wisconsin, and its corporate seal hereunto affixed this 26th day of July, 1974.

BADGER NORTHLAND INC.
A Delaware Corporation

a/k/a BADGER NORTHLAND, INC.,
a Delaware Corporation

(CORPORATE SEAL)

Gail E. Janssen, President

Countersigned:

Kenneth B. Myers, Secretary

STATE OF WISCONSIN)
) SS.
OUTAGAMIE COUNTY)

Personally came before me this 26th day of July, 1974, Gail E. Janssen, corporation president and Kenneth B. Myers, corporation secretary, of the above named corporation, Badger Northland Inc., a/k/a Badger Northland, Inc., to me known to be the persons who executed the foregoing instrument and to me known to be such president and secretary of said corporation, and acknowledge that they executed the foregoing instrument as such officers and as the deed of said corporation, all by its authority.

Charles J. Hartzheim, Notary Public,
State of Wisconsin
My Commission is Permanent.

THIS INSTRUMENT DRAFTED BY:

HERRLING, CLARK & HARTZHEIM,
By: Charles J. Hartzheim
Attorneys at Law
301 N. Lynndale Drive
Appleton, Wisconsin 54911

OUTAGAMIE
Document # 685856

STATE OF WISCONSIN

IN _____ COURT

FOR _____ COUNTY

Plaintiff

Defendant

REGISTER'S OFFICE
OUTAGAMIE COUNTY, WIS.

Received for Record the 26
day of [illegible] A.D. 19 74
10 o'clock A M. and Recorded as
vol. 157 of Records on page 71

[illegible]
REGISTER

pd 4.00

Don Green Atty

VOL 957 PAGE 74

~~HERRLING, C~~
~~301 Ho~~
~~Appleton,~~

Kaukauna
ON THE FOX

CITY ATTORNEY
PAUL VAN BERKEL
PHONE: (920) 766-6318
FAX: (920) 766-6318

July 29, 2003

Ms. Cheryl Laatsch
Wisconsin DNR-Oshkosh Service Center
625 East County Road Y, Suite 700
Oshkosh, WI 54901-9731

Re: Soil and Groundwater Restrictions – City of Kaukauna Lands

Dear Ms. Laatsch:

I am told you want a statement from me that the legal description in the recorded Deed Restriction, a copy of which I previously forwarded to you on June 23rd, 2003, is correct. It is, in fact, correct.

The Common Council of the City of Kaukauna passed a resolution on May 6th, 2003, approving and accepting the deed restrictions using the same legal description based on my representation that they were accurate.

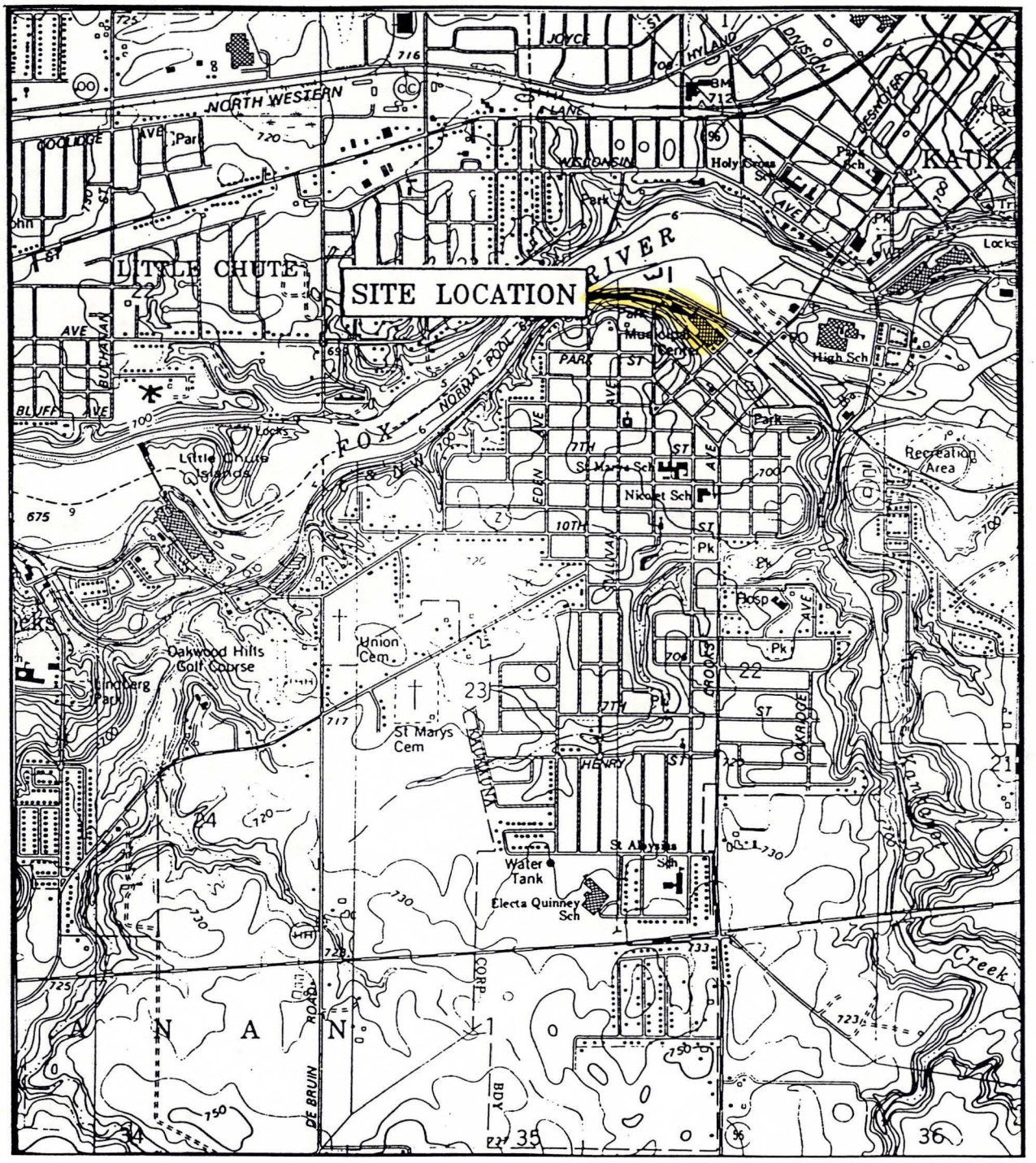
Attorney Renville of your department and I had exchanged correspondence on several occasions to clarify and establish the proper legal description to use in this Deed Restriction.

I trust that the foregoing meets your requirements. If not, please speak to me directly so that I may better understand what you need.

Sincerely yours,

Paul Van Berkel
City Attorney

Jsb
A:LtrDNRDeedRestrictions.CityCorres.J



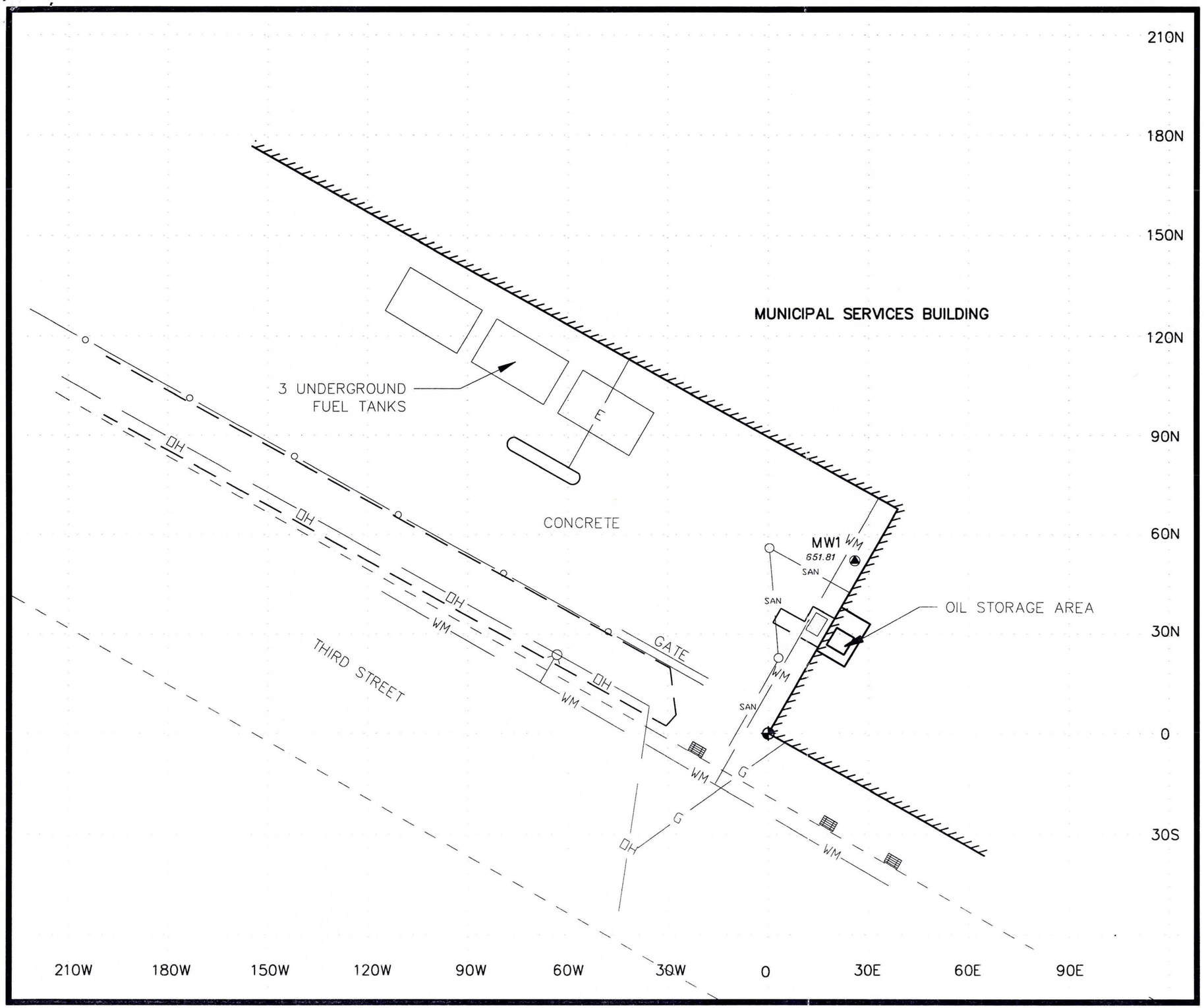
KAUKAUNA QUADRANGLE
U.S.G.S. 7.5 MINUTE SERIES
(TOPOGRAPHIC) OUTAGAMIE COUNTY
WISCONSIN

N

SCALE: 1:24,000

FIGURE 1: SITE LOCATION MAP

FISCHER RIPON OFFICE P.O. BOX 552, RIPON, WI 54971 KAUKAUNA OFFICE P.O. BOX 127, KAUKAUNA, WI 54130	JOB #:398132.003 DATE: 5/12/99 ID#: RAP\FIG1	**KAUKAUNA MAINTENANCE GARAGE** **KAUKAUNA, WISCONSIN** **CLOSURE REQUEST**



LOCAL GRID NORTH
N

0' 6' 15' 30'
SCALE: 1" = 30'

LEGEND:

MW1 ▲	WELL LOCATION AND I.D. No.
MW1 ▲ 651.81	GROUNDWATER ELEVATION AT WELL
◇	EXISTING WASTE OIL TANK LOCATION
⬭	PUMP ISLAND
—— SAN ——○	SANITARY SEWER AND MANHOLE
—— G ——	NATURAL GAS
—— WM ——	WATERMAIN
—— OH ——	OVERHEAD UTILITIES
—— E ——	ELECTRICAL LINE
○	HYDRANT
—— ——	EDGE OF ASPHALT
— — —	EDGE OF STREET
—— o ——	FENCE
//////////	BUILDING FACE
30N	GRID LINE (30' INTERVAL)
⊕	REFERENCE POINT

FIGURE 1
SITE DETAIL MAP
(9/26/95)

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

PROJECT :	N1019B
CAD FILE:	N1019B3.DWG
DRAWN :	DLD
DATE :	10/19/95
REVIEWED :	

ONE SYSTEMS DRIVE APPLETON, WISCONSIN 54914-1654
PHONE : (414) 735-6900 FAX : (414) 830-6100

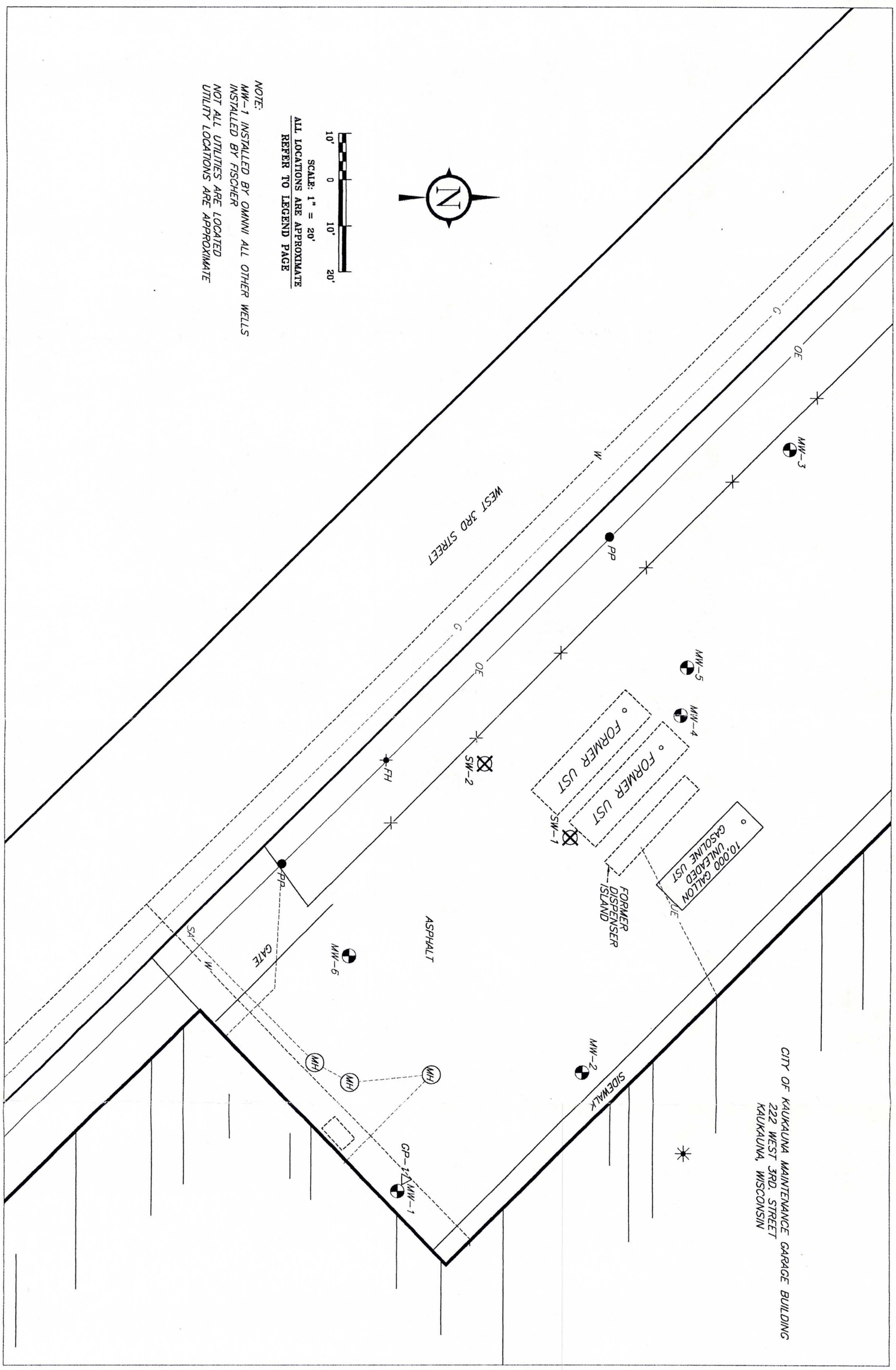
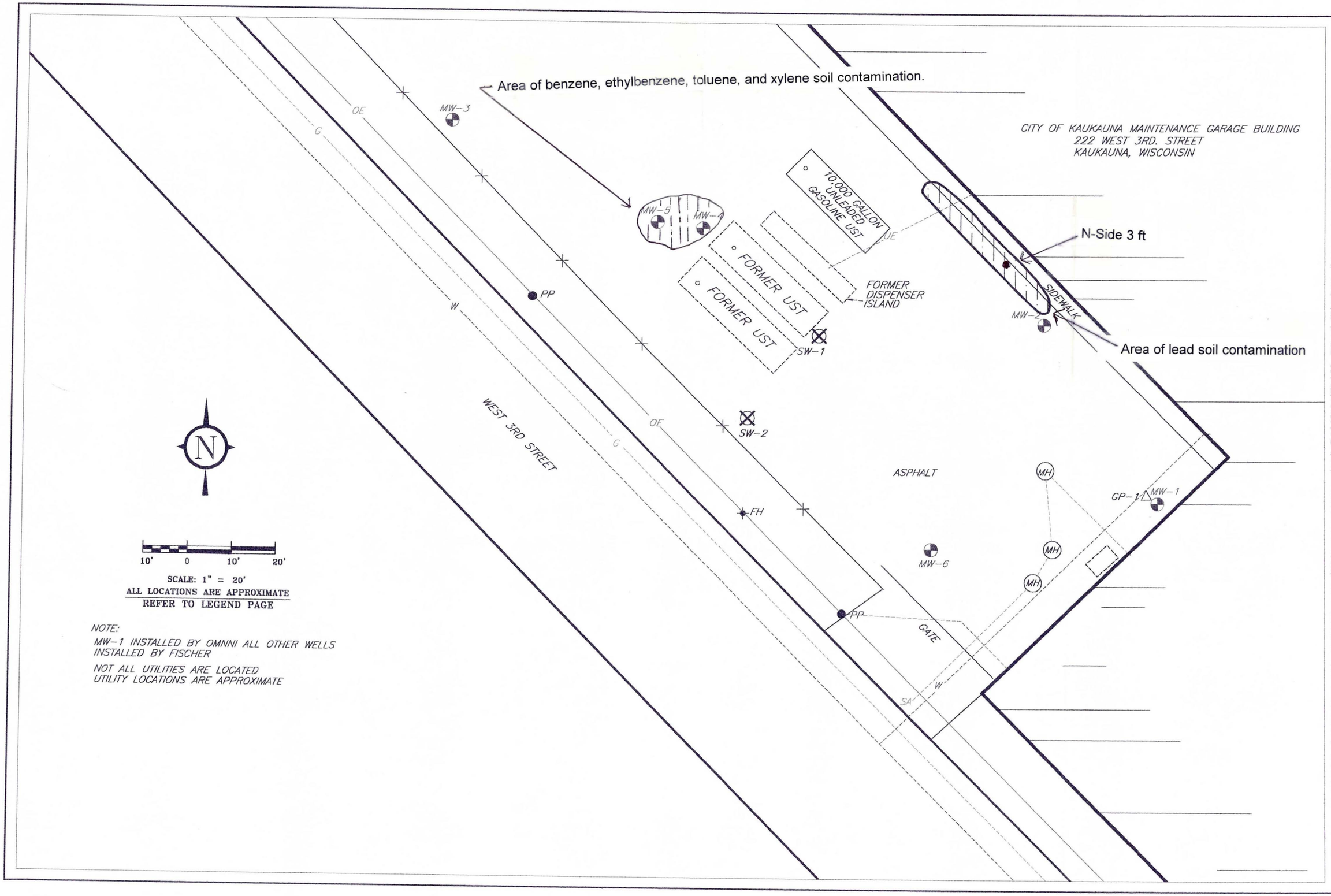


FIGURE 1: POST-REMEDIAL SITE MAP

FISCHER RIPON KAUKAUNA GREEN BAY

398132.003	
DRAWN BY: KP	REVIEWED BY:
DATE: 12/7/99	APPROVED BY:
ID#: CLOSURE	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST



ATTACHMENT 2: ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING RCL IN VADOSE ZONE

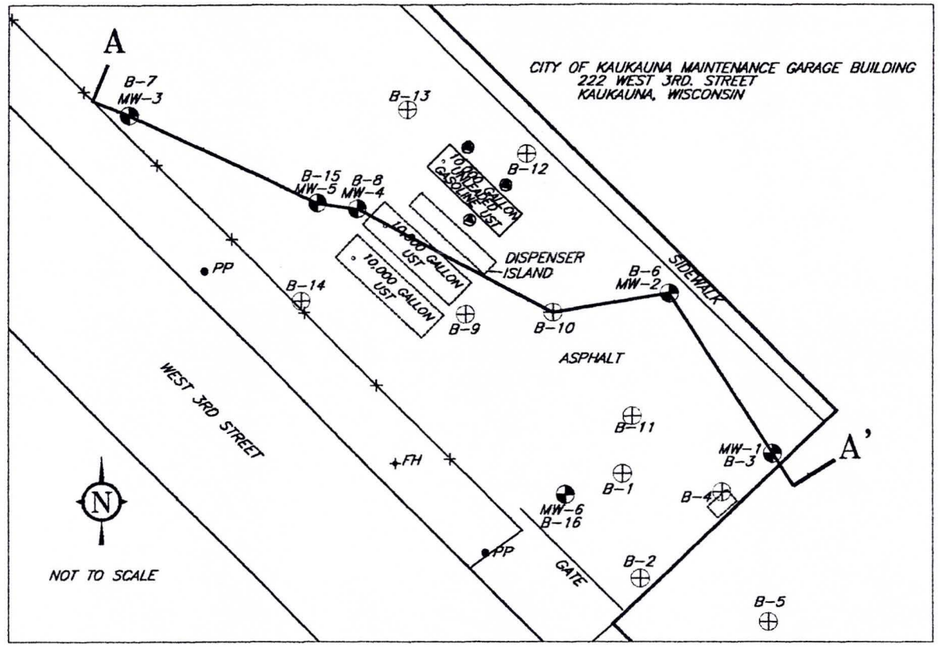
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN

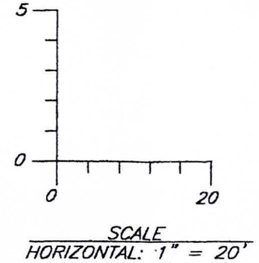
398132.003

DRAWN BY: KP
DATE: 1/27/00
ID#: ATTACHMENTS\ATT-1
REVIEWED BY:
APPROVED BY:

FISCHER

RIPON
KAUKAUNA
GREEN BAY





EXPLANATION

SOILS CLASSIFICATION		MONITORING WELL
ASPHALT	See bore logs	Bentonite Seal
FILL	See bore logs	Water table measured on 9/16/98
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Well Screen
GM	Silty gravels, gravel–sand–silt mixtures.	
BEDROCK	See bore logs	
WEATHERED BEDROCK	See bore logs	
	Not observed	

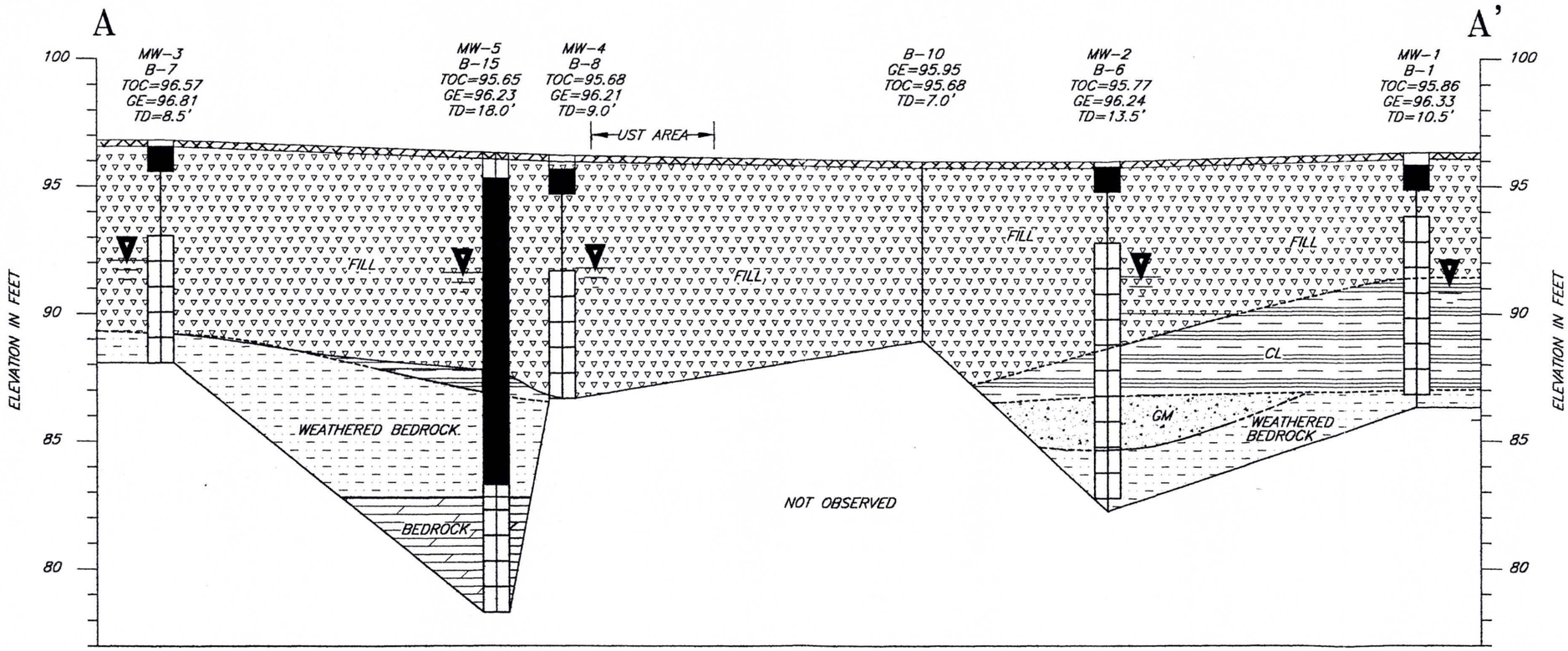


FIGURE 4: PRE-REMEDIAL GEOLOGIC CROSS -SECTION A-A'

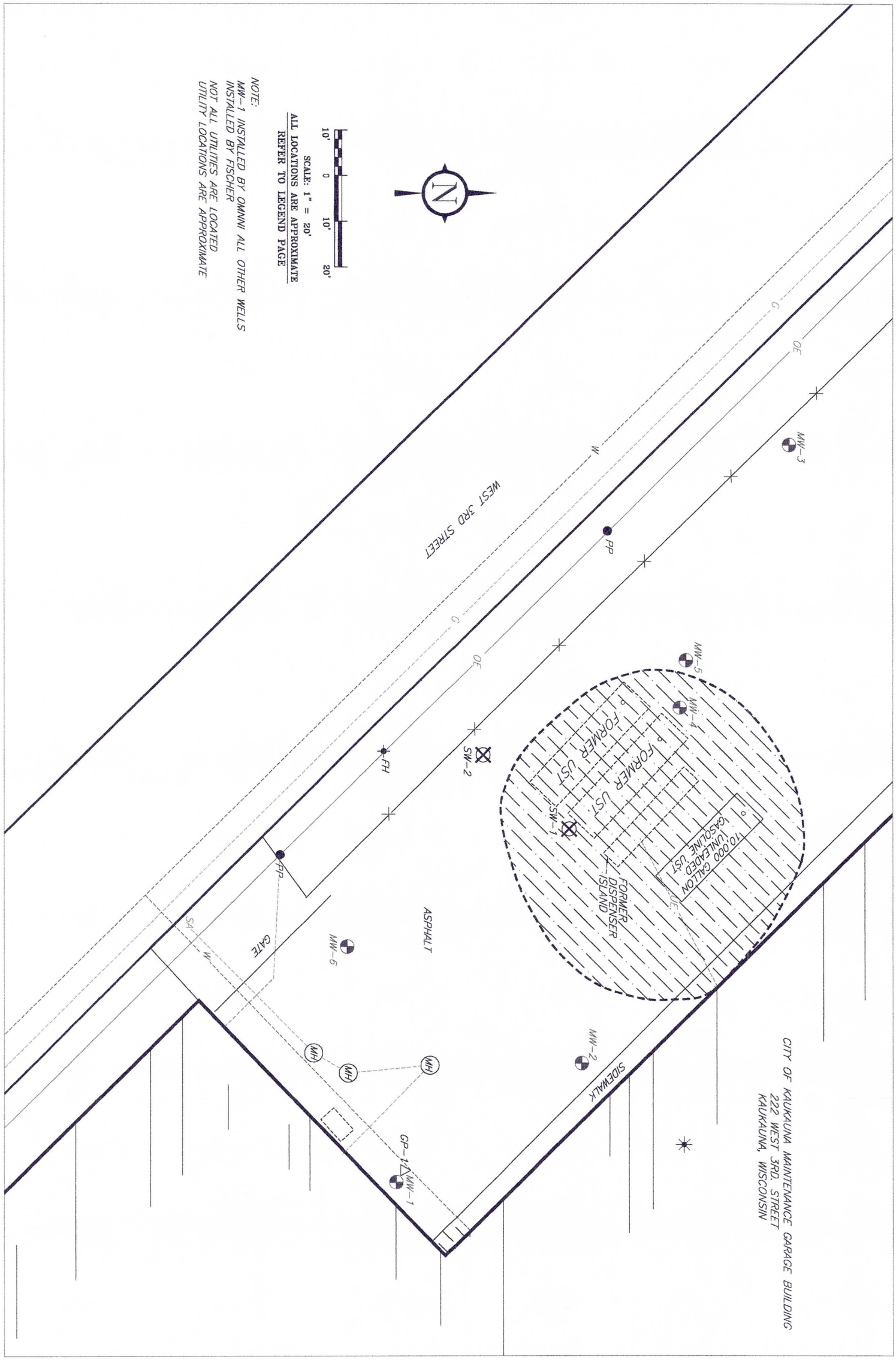
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003			
DRAWN BY: KP	REVIEWED BY:		
DATE: 7/20/99	APPROVED BY:		
IDW: CLOSURES\CROSS			

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971

KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

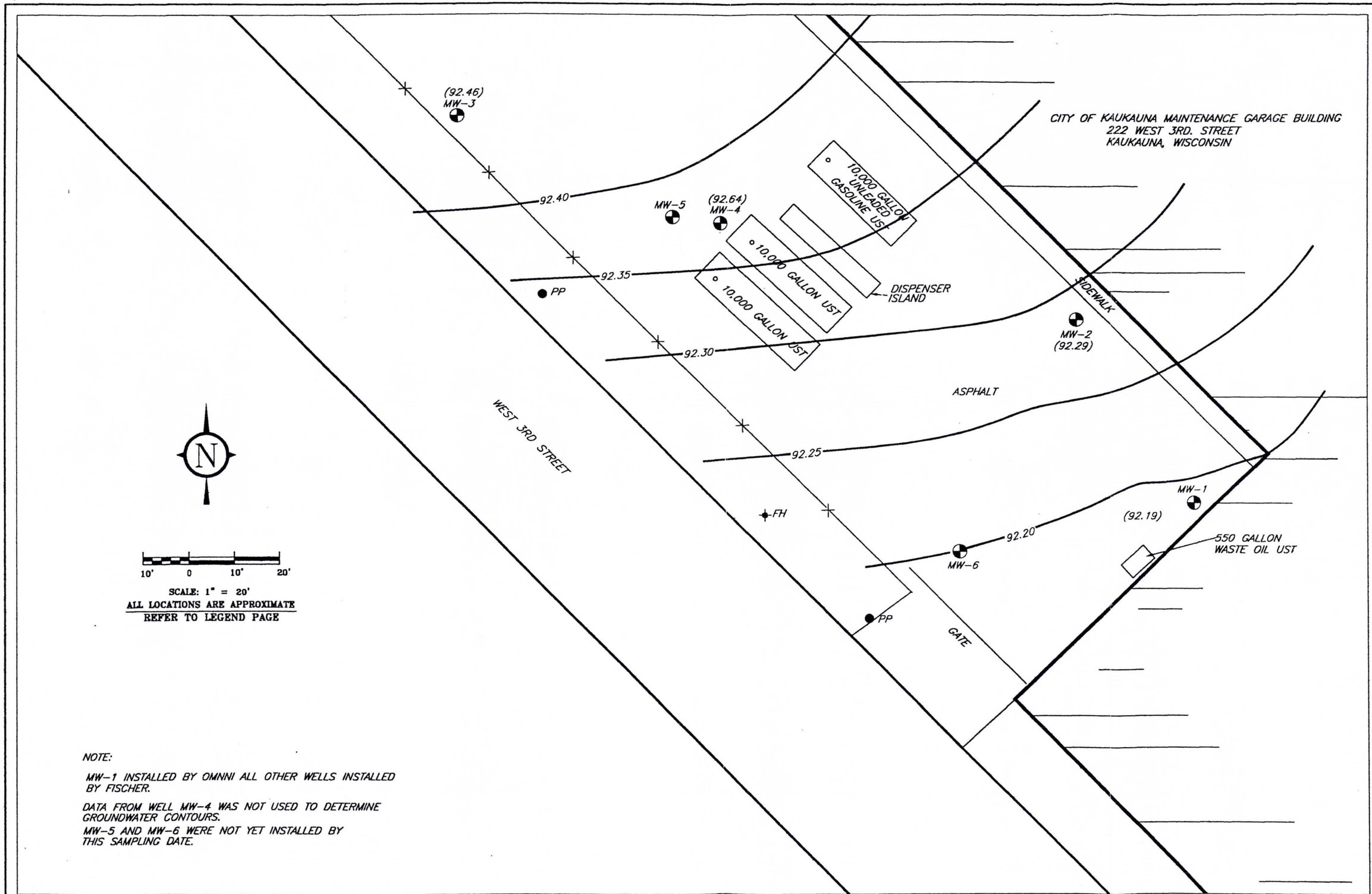


ATTACHMENT 1: ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING THE ENFORCEMENT STANDARDS

FISCHER RIPON KAUKAUNA GREEN BAY

398132.003	
DRAWN BY: KP	REVIEWED BY:
DATE: 1/27/00	APPROVED BY:
ID#: ATTACHMENTS\ATT-1	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN



NOTE:

MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER.

DATA FROM WELL MW-4 WAS NOT USED TO DETERMINE GROUNDWATER CONTOURS.

MW-5 AND MW-6 WERE NOT YET INSTALLED BY THIS SAMPLING DATE.

FIGURE 6: GROUNDWATER CONTOUR MAP - APRIL 21, 1998

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003

DRAWN BY: KP | REVIEWED BY:
DATE: 7/31/98 | APPROVED BY:
ID#: CLOSURE\FIG6

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

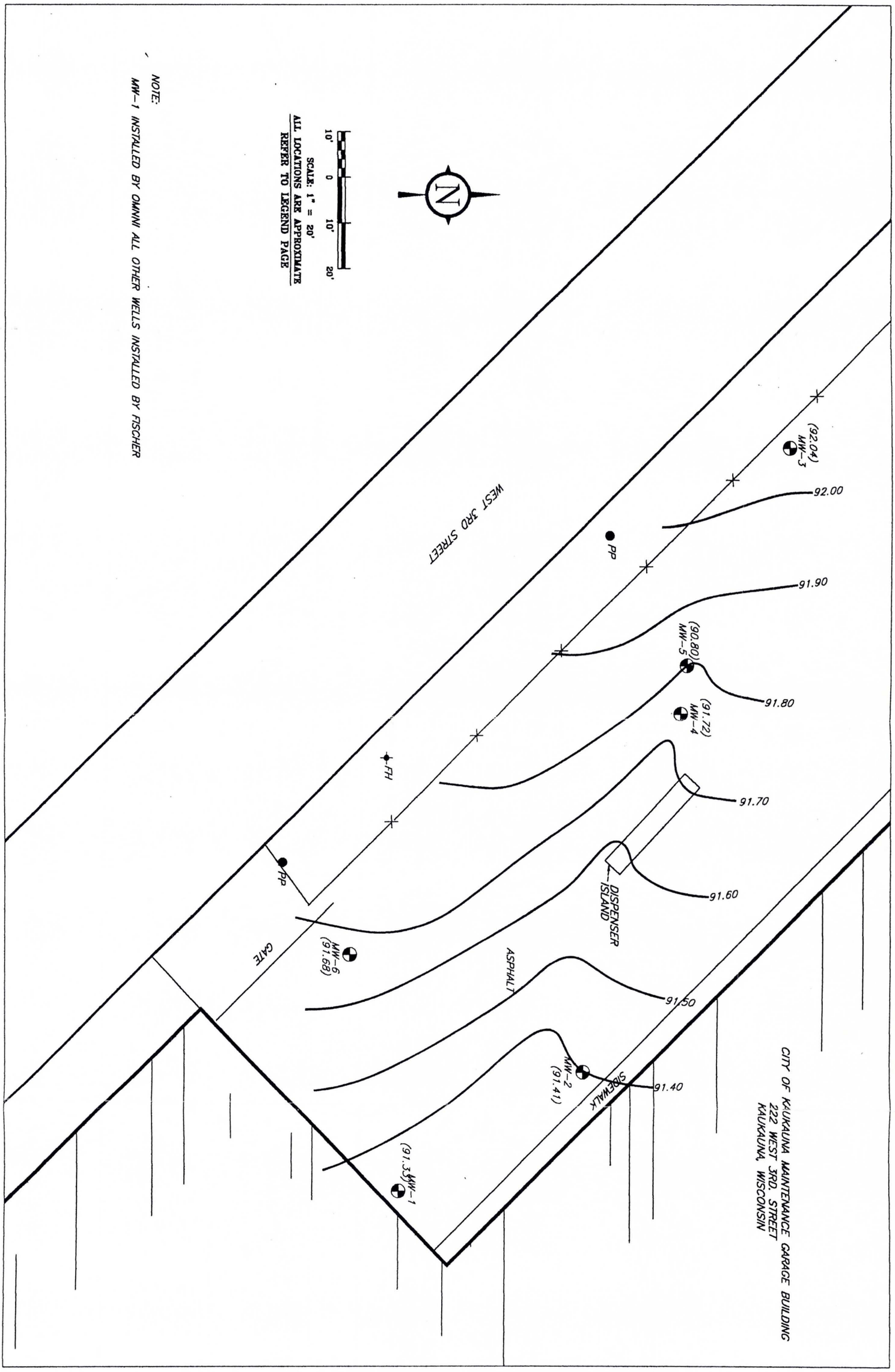
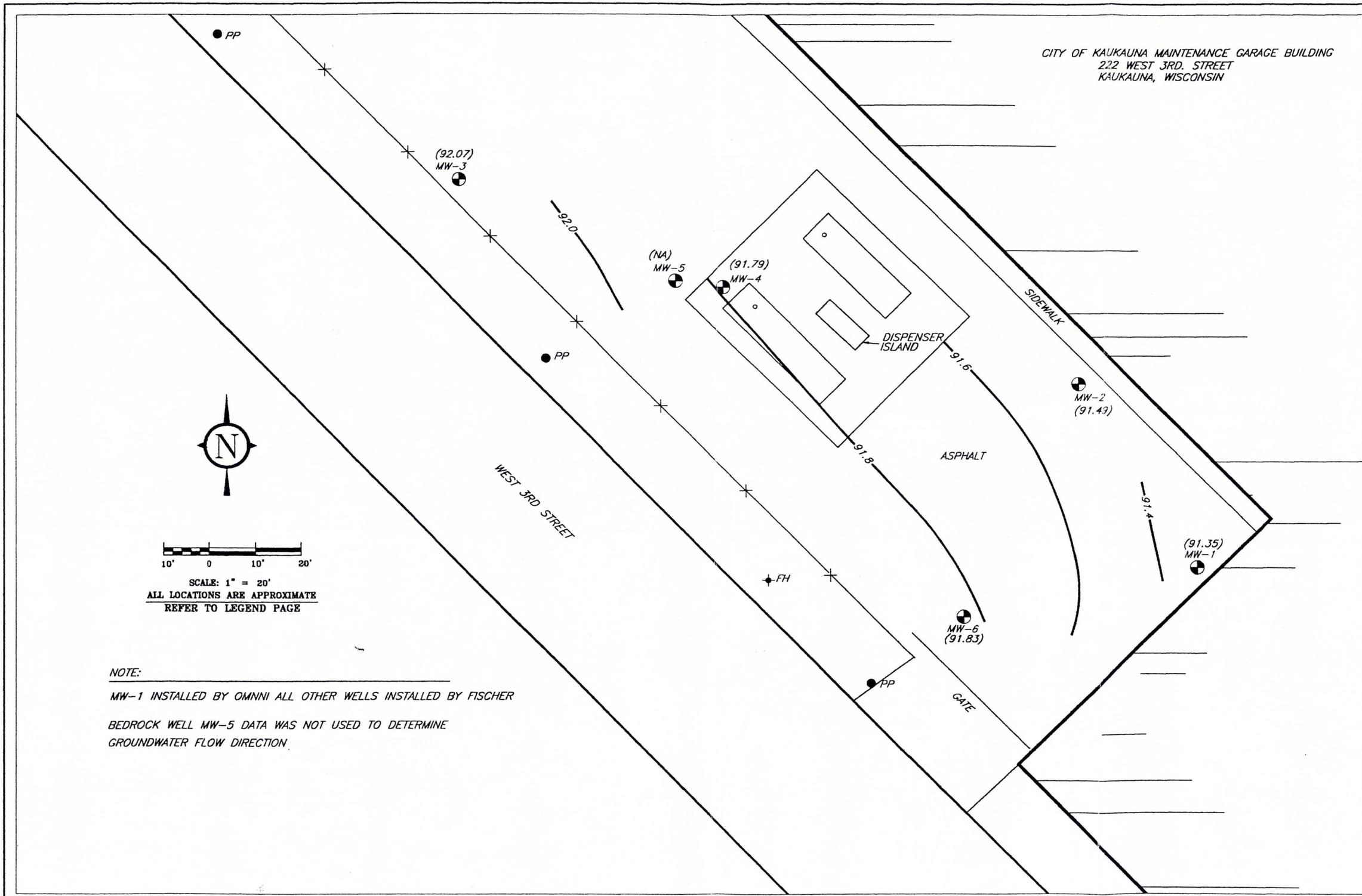


FIGURE 7: GROUNDWATER CONTOUR MAP - SEPTEMBER 16, 1998

FISCHER	RIPON OFFICE P.O. BOX 552 RIPON, WISCONSIN 54971 KAUKAUNA OFFICE P.O. BOX 127 KAUKAUNA, WISCONSIN 54130	398132.003 DRAWN BY: KP / REVIEWED BY: DATE: 7/21/99 / APPROVED BY: ID#: CLOSURE\FIG7	KAUKAUNA MAINTENANCE GARAGE KAUKAUNA, WISCONSIN CLOSURE REQUEST



NOTE:

MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER

BEDROCK WELL MW-5 DATA WAS NOT USED TO DETERMINE GROUNDWATER FLOW DIRECTION

FIGURE 5: GROUNDWATER ELEVATION CONTOURS ON APRIL 8, 1999

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

398132.003

DRAWN BY: KP
DATE: 7/21/99
ID#: RAP\FIG7
REVIEWED BY:
APPROVED BY:

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

TABLE 1

SUMMARY OF SOIL ANALYTICAL RESULTS - REMEDIAL EXCAVATION
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sampling Date	2/23/99	2/23/99	2/23/99	2/23/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99	RCL
Parameter	Confirmation #1	Confirmation #2	S-Side 2 ft	S-Side 8 ft	NE-Base 6 ft	N-Side 3 ft	NE-Side 3 ft	E-Side 1 ft	E-Base 6 ft	SE-Side 3 ft	
DRO (mg/kg)	1300	<4.7	<4.6	<3.9	<3.8	110	57	<3.8	<3.7	210	250
GRO (mg/kg)	120	<3.1	<3.1	<2.9	<2.8	<3.4	3.4	<2.6	<2.7	12	250
Lead (mg/kg)	NA	NA	NA	NA	<3.9	110	NA	NA	4.6Q	NA	50
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg											
Benzene	<50	<25	<25	<25	<25	<25	<25	<25	<25	<25	5.5
Ethylbenzene	130Q	<25	<25	<25	<25	<25	44	<25	<25	<25	2900
Methyl-Tert-Butyl-Ether	60Q	<25	<25	<25	<25	98	<25	<25	<25	140	NE
Toluene	<50	<25	<25	<25	<25	<25	<25	<25	<25	<25	1500
1,2,4-Trimethylbenzene	1800	60Q	<25	<25	<25	66Q	150	<25	<25	<25	NE
1,3,5-Trimethylbenzene	360	<25	<25	<25	<25	<25	59	<25	<25	<25	NE
m,p-Xylenes	<50	70Q	<25	<25	<25	180	180	27Q	<25	65Q	4100
o-Xylenes	110Q	<25	<25	<25	<25	45Q	50Q	<25	<25	<25	

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 1 (Continued)

SUMMARY OF SOIL ANALYTICAL RESULTS - REMEDIAL EXCAVATION

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sampling Date	2/25/99	2/25/99	3/1/99	3/1/99	3/1/99	3/1/99	2/23/99	3/1/99	RCL
Parameter	**N-Side 2 2 ft**	**NW-Base 4 ft**	**NW-Side 2 ft**	**W-Side 2 ft**	**SW-Side 5 ft**	**SE-Side 2 6 ft**	**WO S-Side 3 ft**	**W-Side 5 ft**	
DRO (mg/kg)	<4.2	<4.4	<4.0	<4.3	<4.1	4.9	22	**1800**	250
GRO (mg/kg)	<2.7	12	<2.7	<2.7	9.0	7.6	<2.8	**700**	250
Lead (mg/kg)	NA	8.3Q	3.7Q	NA	<3.9	NA	NA	NA	50
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg									
Benzene	<25	**200**	<25	<25	<25	<25	<25	**1700**	5.5
Ethylbenzene	<25	400	<25	<25	<25	31Q	<25	**11000**	2900
Methyl-Tert-Butyl-Ether	<25	<25	<25	<25	<25	<25	<25	890Q	NE
Toluene	<25	52Q	<25	<25	<25	<25	<25	620Q	1500
1,2,4-Trimethylbenzene	<25	930	<25	<25	100	370	<25	42000	NE
1,3,5-Trimethylbenzene	<25	290	<25	<25	39Q	38Q	<25	15000	NE
m,p-Xylenes	<25	1200	<25	<25	55Q	73	<25	**37000**	4100
o-Xylenes	<25	46Q	<25	<25	<25	<25	<25	**2800**	

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 1

Soil Analytical Results - April 15, 1998 and August 28, 1998

Kaukauna Maintenance Garage - FISCHER Project #398132.002

Parameter	B-6 1-3'	B-7 3-5'	B-8 1-3'	B-9 1-3'	B-9 3-5'	B-10 1-3'	B-10 5-7'	B-11 1-3'	B-11 2-5'	RCL
GRO (mg/kg)	<3.9	<2.8	22	85	16	<2.9	3.3	<2.9	<3.2	250
DRO (mg/kg)	19	<4.0	47	27	<4.3	9.0	12	8.0	<4.4	250
Lead (mg/kg)	**150**		40	**370**						50
Naphthalene (ug/kg)				48						NE
1,2-Dichloroethane (ug/kg)				<25						4.9
s-Butylbenzene (ug/kg)				47						NE
n-Butylbenzene (ug/kg)				74						NE
Isopropylbenzene (ug/kg)				340						NE
p-Isopropylbenzene (ug/kg)				42						NE
n-Propylbenzene (ug/kg)				330						NE
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOCs) ug/kg										
Benzene	<25	<25	**2300**	**1500**	**190**	<25	**71**	<25	<25	5.5
Ethylbenzene	<25	<25	550	1900	460	30	<25	<25	<25	2900
Methyl-Tert-Butyl-Ether	<25	<25	<25	<25	<25	<25	<25	<25	<25	NE
Toluene	<25	<25	160	160	<25	92	<25	110	<25	1500
1,2,4-Trimethylbenzene	45	<25	590	2600	2200	65	300	<25	<25	NE
1,3,5-Trimethylbenzene	44	<25	230	1600	610	<25	73	<25	<25	NE
Xylenes, Total	110	<25	1600	**11190**	2200	136	130	<25	<25	4100
POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) ug/kg (Compounds Detected)										
Benzo(a)anthracene			16							NE
Fluoranthene			27							NE
1-Methylnaphthalene			430							NE
2-Methylnaphthalene			790							NE
Naphthalene			630							NE
Phenanthrene			23							NE
Pyrene			17							NE

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
Blank - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - Residual Contaminant Levels (WDNR NR 720)
NE - RCL not established

TABLE 1 (Continued)

Soil Analytical Results - April 15, 1998 and August 28, 1998

Kaukauna Maintenance Garage - FISCHER Project #398132.002

Parameter	B-12 1-3'	B-12 5-7'	B-13 1-3'	B-13 5-7'	B-14 1-3'	B-14 3-5'	B-15 2.5-4.5'	B-15 4.5-6.5'	B-16 4.5-6.5'	RCL
GRO (mg/kg)	<3.0	100	<2.7	<2.9	3.9	<2.9	**2200**	**1100**	<2.9	250
DRO (mg/kg)	33	48	56	<3.7	23	<4.1	**3500**	**920**	140	250
Lead (mg/kg)		6.5								50
Naphthalene (ug/kg)		6400								NE
1,2-Dichloroethane (ug/kg)		<250								4.9
p-Isopropyltoluene (ug/kg)		1400								NE
s-Butylbenzene (ug/kg)		1400								NE
n-Butylbenzene (ug/kg)		4400								NE
Isopropylbenzene (ug/kg)		2100								NE
p-Isopropyltoluene (ug/kg)		750								NE
n-Propylbenzene (ug/kg)		8400								NE
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOCs) ug/kg										
Benzene	<25	**2100**	<25	<25	<25	<25	**13000**	**7100**	<25	5.5
Ethylbenzene	<25	**15000**	36	<25	<25	<25	**54000**	**32000**	<25	2900
Methyl-Tert-Butyl-Ether	<25	<250	<25	<25	<25	<25	<1000	3200	<25	NE
Toluene	34	1500	30	<25	<25	<25	**3500**	850	<25	1500
1,2,4-Trimethylbenzene	47	45000	70	<25	55	<25	120000	69000	<25	NE
1,3,5-Trimethylbenzene	<25	14000	27	<25	38	<25	39000	23000	<25	NE
Xylenes, Total	69	**55000**	153	<25	86	<25	**166800**	**94800**	66	4100

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
Blank - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - Residual Contaminant Levels (WDNR NR 720)
NE - RCL not established

TABLE 1
SUMMARY OF FIELD HEADSPACE ANALYSIS
SOIL BORING SAMPLES
CONCENTRATION IN PPM (ISOBUTYLENE EQUIVALENTS)
MARCH 21, 1994, SAMPLING EVENT

SAMPLE ID	SAMPLE LOCATION	DEPTH (FEET)	PID	SOIL CHARACTERISTICS
B1–1	Boring B1	2.0 – 4.0	4.0	Black silt with gravel fill. Slight odor?
* B1–2		4.0 – 6.0	10.0	Brown sand with silt and gravel. No odor.
B1–3		6.0 – 8.0	10.0	Brown clay. No odor.
B1–4		8.0 – 10.0	5.0	Brown clay with gravel.
B2–1	Boring B2	2.0 – 4.0	4.0	Brown silt with some gravel and cinders. No odor.
B2–2		4.0 – 6.0	3.0	Brown clay with gravel. No odor.
* B2–3		6.0 – 8.0	3.0	Brown clay with gravel. No odor.
B2–4		8.0 – 10.0	3.0	Tight red brown clay with no gravel. No odor.
B3–1	Monitoring Well MW1	2.0 – 4.0	1000	Black silt (fill) with cinders and gravel. Solvent/paint odor
* B3–2		4.0 – 6.0	93.0	Brown clay with some tan sand and gravel. No odor.
B3–3		6.0 – 8.0	3.0	Brown clay with gravel. No odor.
B3–4		8.0 – 10.0	1.0	Brown clay with gravel. No odor.
B4–1	Boring B4	2.0 – 4.0	0.0	Black silt with cinders (fill) and gravel. No odor.
B4–2		4.0 – 6.0	111	Clay with gravel and sand. Waste oil odor at tip.
* B4–3		6.0 – 8.0	15.0	Clay with gravel and sand. Some waste oil odor to 7 feet.
B4–4		8.0 – 10.0	0.0	Red brown clay. No odor.
B5–1	Boring B5	1	0.0	Silt with sand. No odor.
* B5–2		2.0 – 4.0	0.0	Silt with some gravel. No odor.
B5–3		4.0 – 6.0	0.0	Silt with wood organics. No odor.
B5–4		6.0 – 8.0	0.0	Silt. No odor.

* = sample sent in for laboratory analysis

TABLE 2
SUMMARY OF LABORATORY ANALYSIS
SOIL BORING SAMPLES
MARCH 21, 1994 SAMPLING EVENT

PARAMETER	GUIDE	B1-2	B2-3	B3-2	B4-3	B5-2
SAMPLE DEPTH (feet)	-	4.0 - 6.0	6.0 - 8.0	4.0 - 6.0	6.0 - 8.0	2.0 - 4.0
DIESEL RANGE ORGANICS (mg/kg)	250	ND	ND	ND	280	12
DETECTED PCBs (µg/kg)	-	NA	NA	NA	ND	NA
CADMIUM (mg/kg)	-	NA	NA	NA	0.03	NA
LEAD (mg/kg)	50	NA	NA	NA	4.4	NA
DETECTED PAHs (µg/kg)	-	NA	NA	NA	ND	NA
DETECTED PVOCs (µg/kg)						
BENZENE	5.5	1.7	ND	ND	ND	ND
ETHYLBENZENE	2900	ND	ND	ND	2.4	ND
MTBE	-	3.1	ND	ND	ND	ND
m,p-XYLENE	4100	ND	ND	380	12	ND
o-XYLENE	4100	ND	ND	ND	1.1	ND

NA = not analyzed
ND = not detected
[ ] = sample concentrations detected over the DNR guideline

TABLE 3
SUMMARY OF LABORATORY ANALYSIS
GROUNDWATER
APRIL 12, 1994, SAMPLING EVENT

PARAMETER (µg/L)	ES	PAL	MW1
DETECTED VOCs			
BENZENE	5	0.5	1.2
1,2-DICHLOROETHANE	5	0.5	4.9
ETHYLBENZENE	700	140	3.6
MTBE	65	12	17
m,p-XYLENE	620	124	23
DIESEL RANGE ORGANICS	-	-	690
CADMIUM	5	0.5	0.1

ES = enforcement standard
PAL = preventive action limit
[ ] = sample concentrations detected over the preventive action limit

Analyzed for full VOCs
Cadmium & Lead

No PAHs ?

TABLE 1

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-1							MW-2			
Sampling Date	ES	PAL	4/12/94	1/23/95	9/26/95	4/21/98	6/5/98	4/8/99*	11/29/99*	4/21/98	6/5/98	4/8/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)													
Benzene	5	0.5	1.2	<0.6	<0.6	<0.27	<0.27	<0.27	<0.27	150	170	<0.26	<0.26
Ethylbenzene	700	140	3.6	<1.0	<1.0	<0.32	<0.32	<0.32	<0.32	11	38	<0.24	<0.24
Methyl-tert-butyl-ether	60	12	17	5.2	9.6	6.4	6.7	2.8	2.8	19	17	11	7.5
Toluene	343	68.6	<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	<0.27	5.5	1.9	0.33Q	<0.21
1,2,4-Trimethylbenzene	484	96	<1.0	<1.0	<1.0	<0.22	<0.22	<0.22	<0.22	3.7	15	<0.86	<0.86
1,3,5-Trimethylbenzene			<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	<0.27	<0.27	0.32Q	<0.54	<0.54
Xylenes, m + p	620	124	23	<1.0	<1.0	<0.43	<0.43	<0.43	<0.43	8.6	26	<0.97	<0.97
Xylene, o			<1.0	<1.0	<1.0	<0.24	<0.24	<0.24	<0.24	0.78	0.37Q	<0.37	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)													
1,2-Dichloroethane	5	0.5	4.9	4.7	7.8	NA	4.0	3.3	3.9	<0.37	NA	<0.24	NA
Isopropylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	NA	1.4	NA	NA	NA
n-Propylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	NA	1.2Q	NA	NA	NA
LEAD and CADMIUM													
Lead	15	1.5	NA	NA	NA	NA	NA	NA	NA	<1.6	NA	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)

Shading indicates analytical result above NR 140 enforcement standards

All concentrations in micrograms per liter (ug/l).

* Post-remedial samples. All other samples are pre-remedial.

NA = Parameter not analyzed

NE = NR 140 enforcement standard (ES) not established

PAL = NR 140 Preventive Action Limit

TABLE 1 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-3				MW-4			
Sampling Date	ES	PAL	4/21/98	6/5/98	4/8/99*	11/29/99*	4/21/98	6/5/98	4/8/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)										
Benzene	5	0.5	<0.27	<0.27	<0.26	<0.26	**2400**	**2300**	**1100**	**260**
Ethylbenzene	700	140	<0.32	<0.32	<0.24	<0.24	560	470	230	76
Methyl-tert-butyl-ether	60	12	<0.32	<0.32	<0.22	<0.22	15Q	20	6.7Q	<0.55
Toluene	343	68.6	<0.27	<0.27	<0.21	<0.21	67	58	27	2.2
1,2,4-Trimethylbenzene	484	96	<0.22	<0.22	<0.86	<0.86	**660**	**480**	160	17
1,3,5-Trimethylbenzene			<0.27	<0.27	<0.54	<0.54	**160**	**110**	26Q	<1.4
Xylenes, m + p	620	124	<0.43	<0.43	<0.97	<0.97	**1700**	**1300**	370	20
Xylene, o			<0.24	<0.24	<0.37	<0.37	**41**	**40**	15Q	1.8Q
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)										
n-Butylbenzene	NE	NE	<0.29	NA	NA	NA	23	NA	NA	NA
Naphthalene	40	8	<0.35	NA	NA	NA	**130**	**110**	37Q	6.6Q
s-Butylbenzene	NE	NE	<0.29	NA	NA	NA	11Q	NA	NA	NA
Isopropylbenzene	NE	NE	<0.26	NA	NA	NA	43	NA	NA	NA
p-Isopropyltoluene	NE	NE	<0.24	NA	NA	NA	7.0Q	NA	NA	NA
n-Propylbenzene	NE	NE	<0.76	NA	NA	NA	110	NA	NA	NA
LEAD and CADMIUM (ug/L)										
Lead	15	1.5	<1.6	NA	NA	NA	<1.6	NA	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA	NA	NA
DETECTED POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)										
Fluorene	400	880	NA	NA	NA	NA	2.0Q	NA	NA	NA
1-methylnaphthalene	NE	NE	NA	NA	NA	NA	30	NA	NA	NA
2-methylnaphthalene	NE	NE	NA	NA	NA	NA	41	NA	NA	NA
Naphthalene	40	8	NA	NA	NA	NA	**60**	NA	NA	NA
Phenanthrene	NE	NE	NA	NA	NA	NA	15	NA	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates analytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial samples. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

TABLE 1 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 140		MW-5			MW-6		
Sampling Date	ES	PAL	8/31/98	4/15/99*	11/29/99*	8/31/98	4/8/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)								
Benzene	5	0.5	5.5	<0.26	<0.26	<0.27	<0.26	<0.26
Ethylbenzene	700	140	8.2	<0.24	<0.24	<0.32	<0.24	<0.24
Methyl-tert-butyl-ether	60	12	<0.32	<0.22	<0.22	<0.32	<0.22	<0.22
Toluene	343	68.6	0.63	<0.21	<0.21	<0.27	<0.21	<0.21
1,2,4-Trimethylbenzene	484	96	14	<0.86	<0.86	<0.22	<0.86	<0.86
1,3,5-Trimethylbenzene			5.0	<0.54	<0.54	<0.27	<0.54	<0.54
Xylenes, m + p	620	124	23	<0.97	<0.97	<0.43	<0.97	<0.97
Xylene, o			1.3	<0.37	<0.37	<0.24	<0.37	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)								
s-Butylbenzene	NE	NE	0.53Q	NA	NA	<0.29	NA	NA
n-Butylbenzene	NE	NE	1.4	NA	NA	<0.29	NA	NA
Chloroform	6	0.6	0.68Q	NA	NA	<0.35	NA	NA
Naphthalene	40	8	3.2	<0.89	<0.89	<0.35	NA	NA
Isopropylbenzene	NE	NE	0.90	NA	NA	<0.26	NA	NA
n-Propylbenzene	NE	NE	2.8	NA	NA	<0.76	NA	NA
LEAD								
Lead	15	1.5	<1.6	NA	NA	<1.6	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)

Shading indicates anaytical result above NR 140 enforcement standards

All concentrations in micrograms per liter (ug/l).

* Post-remedial samples. All other samples are pre-remedial.

NA = Parameter not analyzed

NE = NR 140 enforcement standard (ES) not established

PAL = NR 140 Preventive Action Limit

TABLE 1 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sump Well	NR 140		SW-1		SW-2	
Sampling Date	ES	PAL	4/8/99*	11/29/99*	4/15/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)						
Benzene	5	0.5	1.2	<0.26	<0.26	<0.26
Ethylbenzene	700	140	2.3	<0.24	<0.24	<0.24
Methyl-tert-butyl-ether	60	12	0.66Q	<0.22	<0.22	<0.22
Toluene	343	68.6	0.51Q	<0.21	<0.21	<0.21
1,2,4-Trimethylbenzene	484	96	5.9	<0.86	<0.86	<0.86
1,3,5-Trimethylbenzene			2.8	<0.54	<0.54	<0.54
Xylenes, m + p	620	124	12	<0.97	<0.97	<0.97
Xylene, o			1.8	<0.37	<0.37	<0.37

All concentrations in ug/l - micrograms per liter
ES = Enforcement Standard (exceedances shaded)
PAL = Preventive Action Limit
NA = not analyzed for parameter
Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
NE = NR 140 enforcement standard (ES) not established
* Post-remedial samples.

TABLE 4

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-1			MW-2			MW-3		
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99
Nitrate/Nitrite	mg/l	NA	NA	0.061*	NA	NA	0.087*	NA	NA	0.57*
Sulfate	mg/l	NA	NA	64	NA	NA	160	NA	NA	170
Methane	ug/l	NA	NA	270	NA	NA	<0.9	NA	NA	7.4
FIELD TEST										
Temperature	°C	10.4	15.1	10.8	9.7	13.6	10.2	7.0	12.9	7.1
Conductivity	uS/cm	1200	2680	NA	1120	1460	NA	2090	3760	NA
pH	units	7.34	6.72	NA	7.44	6.49	NA	7.20	6.55	NA
Dissolved Oxygen	ppm	1.3	0.37	0.31	2.2	0.50	0.21	6.1	0.80	0.24
ORP	mV	NA	NA	15	NA	NA	-70	NA	NA	20
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	0.5	NA	NA	0.5

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

TABLE 4 (Continued)

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-4			MW-5			MW-6			SW-1	SW-2
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/15/9	4/21/98	6/5/98	4/8/99	4/8/99	4/15/99
Nitrate/Nitrite	mg/l	NA	NA	0.069*	NA	NA	NA	NA	NA	0.066*	NA	NA
Sulfate	mg/l	NA	NA	85	NA	NA	NA	NA	NA	81	NA	NA
Methane	ug/l	NA	NA	430	NA	NA	NA	NA	NA	530	NA	NA
FIELD TEST												
Temperature	°C	8.6	14.1	8.0	15.3	NA	NA	19.4	NA	7.9	7.9	NA
Conductivity	uS/cm	2210	2870	NA	780	NA	NA	5490	NA	NA	NA	NA
pH	units	7.37	6.58	NA	5.72	NA	NA	5.27	NA	NA	NA	NA
Dissolved Oxygen	ppm	4.3	0.53	0.17	0.22	NA	NA	0.24	NA	0.14	0.12	NA
ORP	mV	NA	NA	-65	130	NA	NA	-60	NA	OR	-75	NA
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	NA	NA	NA	0.5	0.5	NA

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

TABLE 2
GROUNDWATER ELEVATION DATA
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Well No.	Date	Depth to GW (ft)	TOC Reference Elevation (ft)	GW Elevation (ft)	Well Depth (ft)	Height of Water Column (ft)	Comments
MW-1	4/21/98	3.67	95.86	92.19	9.57	5.90	
MW-2	4/21/98	3.48	95.77	92.29	13.28	9.80	
MW-3	4/21/98	4.11	96.57	92.46	8.76	4.65	
MW-4	4/21/98	3.04	95.68	92.64	8.13	5.09	
MW-1	5/1/98	4.05	95.86	91.81	9.57	5.52	
MW-2	5/1/98	3.82	95.77	91.95	13.28	9.46	
MW-3	5/1/98	4.46	96.57	92.11	8.76	4.30	
MW-4	5/1/98	3.32	95.68	92.36	8.13	4.81	
MW-1	6/5/98	4.41	95.86	91.45	9.38	4.97	
MW-2	6/5/98	4.21	95.77	91.56	13.12	8.91	
MW-3	6/5/98	4.73	96.57	91.84	8.55	3.82	
MW-4	6/5/98	3.79	95.68	91.89	8.18	4.39	
MW-5*	8/28/98	4.13	95.65	91.52	17.38	13.25	Prior to development
MW-6	8/28/98	3.57	95.32	91.75	6.98	3.41	Prior to development
MW-1	9/16/98	4.53	95.86	91.33	9.38	4.85	Well depth previously measured
MW-2	9/16/98	4.36	95.77	91.41	13.12	8.76	Well depth previously measured
MW-3	9/16/98	4.53	96.57	92.04	8.55	4.02	Well depth previously measured
MW-4	9/16/98	3.96	95.68	91.72	8.18	4.22	Well depth previously measured
MW-5*	9/16/98	4.14	95.65	91.52	17.38	13.25	Well depth previously measured
MW-6	9/16/98	3.64	95.32	91.68	6.98	3.34	Well depth previously measured
MW-1	4/8/99	4.51	95.86	91.35	9.34	4.83	
MW-2	4/8/99	4.30	95.79	91.49	13.07	8.77	
MW-3	4/8/99	4.50	96.57	92.07	8.52	4.02	
MW-4	4/8/99	3.91	95.70	91.79	8.15	4.24	
MW-5*	4/8/99	-	95.65	-	-	-	Temporarily paved over
MW-6	4/8/99	3.49	95.32	91.83	6.94	3.45	
SW-1	4/8/99	3.54	-	-	12.02	-	
SW-2	4/8/99	-	-	-	-	-	Inaccessible

Notes: All depths measured from Top of Casing (TOC). * = bedrock well
GW = groundwater ft = feet
Elevations in feet in reference to benchmark with an assumed elevation of 100 feet.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary

Oshkosh Service Center
625 East County Road Y, STE 700
Oshkosh, Wisconsin 54901-9731
TELEPHONE 920-424-3050
FAX 920-424-4404

August 11, 2003

Paul Van Berkel
Kaukauna City Attorney
201 West Second Street
PO Box 890
Kaukauna, WI 54130-0890

WDNR BRRTS #: 03-45-001729

SUBJECT: Final Case Closure By Project Manager, Deed Restriction Filed
Kaukauna City - Waste Oil Site, 222 West 3rd St. Kaukauna, WI

Dear Mr. Van Berkel:

Your site as described above was reviewed for closure by the Department of Natural Resources. The Department reviews environmental remediation cases for compliance with state laws and standards to maintain consistency in the closure of these cases.

On July 29, 2003, the Department received correspondence indicating that you have complied with the conditions of closure. The soil and groundwater deed restrictions were filed on May 20, 2003. Based on the correspondence and data provided, it appears that your case meets the screening criteria of s. NR 746.07, and the requirements of ch. NR 726, Wis. Adm. Code. The Department considers this case closed and no further investigation, remediation or other action is required at this time.

Your site will be listed on the DNR Remediation and Redevelopment GIS Registry of Closed Remediation Sites. Information that was submitted with your closure request application will be included on the registry. To review the sites on the GIS Registry web page, visit http://gomapout.dnr.state.wi.us/org/at/et/geo/gwur/index.htm

If this is a PECFA site, section 101.143, Wis. Stats., requires that PECFA claimants seeking reimbursement of interest costs, for sites with petroleum contamination, submit a final reimbursement claim within 120 days after they receive a closure letter on their site. For claims not received by the PECFA Program within 120 days of the date of this letter, interest costs after 60 days of the date of this letter will not be eligible for PECFA reimbursement.

Please be aware that this case may be reopened pursuant to s. NR 726.09, Wis. Adm. Code, if additional information regarding site conditions indicates that contamination on or from the site poses a threat to public health, safety or welfare, or the environment. The Department appreciates your efforts to restore the environment at this site. If you have any questions regarding this letter, please contact me at 920-303-5435.

Sincerely,

Cheryl Laatsch
Hydrogeologist
Bureau for Remediation & Redevelopment

Kaukauna
ON THE FOX

CITY ATTORNEY
PAUL VAN BERKEL
PHONE: (920) 766-6318
FAX: (920) 766-6318

July 29, 2003

Ms. Cheryl Laatsch
Wisconsin DNR-Oshkosh Service Center
625 East County Road Y, Suite 700
Oshkosh, WI 54901-9731

Re: Soil and Groundwater Restrictions – City of Kaukauna Lands

Dear Ms. Laatsch:

I am told you want a statement from me that the legal description in the recorded Deed Restriction, a copy of which I previously forwarded to you on June 23rd, 2003, is correct. It is, in fact, correct.

The Common Council of the City of Kaukauna passed a resolution on May 6th, 2003, approving and accepting the deed restrictions using the same legal description based on my representation that they were accurate.

Attorney Renville of your department and I had exchanged correspondence on several occasions to clarify and establish the proper legal description to use in this Deed Restriction.

I trust that the foregoing meets your requirements. If not, please speak to me directly so that I may better understand what you need.

Sincerely yours,

Paul Van Berkel
City Attorney

Jsb
A:LtrDNRDeedRestrictions.CityCorres.J

Kaukauna
ON THE FOX

CITY ATTORNEY
PAUL VAN BERKEL
PHONE: 920-766-6318
FAX: 920-766-6318

June 23, 2003

Ms. Cheryl Laatsch
Wis. DNR – Oshkosh Service Center
625 E. Co. Road Y, Suite 700
Oshkosh, WI 54901-9731

Re: Soil and Groundwater Restrictions – City of Kaukauna Lands

Dear Ms. Laatsch:

Enclosed please find a copy of the final, filed deed restriction with attached Exhibits per Mr. Renville's request of February 20, 2003.

If you have any questions, please call.

Sincerely yours,

Paul Van Berkel
City Attorney-Kaukauna
PVB:dw
Enc.

Laatsch, Cheryl

From: Laatsch, Cheryl
Sent: Wednesday, February 05, 2003 4:31 PM
To: Renville, Joe W
Subject: FW: Deed Restriction

Hi Joe -

I have a deed restriction that I sent to the City of Kaukauna for signing. They are have concerns about the restriction. I have attached the restriction that was sent to them. It is my understanding that this was approved sometime in 2000...? I have attached it for your review and will fax the map to your attention. The City Attorney has some questions about the figure. I was advised by fellow OSH staff that they could have the restriction on a specific portion of the property, but that we would need a certified legal description of that portion.

Please advise as to how to proceed. I can give the attorney your name and phone, or you can call the directly.

Thanks
Cheryl

-----Original Message-----
From: John Sundelius [mailto:SUNDELIUJW@kaukauna-wi.org]
Sent: Wednesday, February 05, 2003 4:23 PM
To: Laatsch, Cheryl
Subject: Deed Restriction

RE: Deed Restriction for Kaukauna City Waste Oil Site, Kaukauna, WI
WDNR BRRTS # 03-45-001729

Cheryl:

The City of Kaukauna's Attorney, Mr. Paul VanBerkel, would like discuss the above referenced deed restriction with your legal staff. His concern remains with the vaugness of Figure 3 referenced in the deed restriction.

Please have your legal staff contact him or forward me the contact information and I will get it to Mr. VanBerkel.

He can be reached at:

180 W. Wisconsin Ave
Kaukauna, WI 54130

920-766-6318

Thank You.

John Sundelius
City of Kaukauna

Post-it® Fax Note 7671

To	Joe Renville	Date	9/5/03
Co./Dept.	LS/5	From	Cheryl L.
Phone #		Co.	DNR Oshkosh
Fax #	608-266-6983	Phone #	
		Fax #	

FIGURE 3: PRE-REMEDIAL SITE PLAN AND SOIL SAMPLE LOCATION MAP

KAUKAUNA MAINTENANCE GARAGE

398132.003

FISCHER

RIPON OFFICE P.O. BOX 359
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 54
KAUKAUNA, WISCONSIN

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

B-7 MW-3
B-13
B-12
B-15 MW-5
B-8 MW-4
10,000 GALLON UNLEADED GASOLINE UST
10,000 GALLON DIESEL FUEL UST
10,000 GALLON DIESEL FUEL UST
DISPENSER ISLAND
B-6 MW-2
SIDEWALK
B-14
B-9
B-10
ASPHALT
WEST 3RD STREET
B-11
B-1 MW-1
B-1
B-4
MW-6 B-16
B-2
GATE
B-5
OE
G
W
FH
PP
SA
WH

N

10' 0 10' 20'

SCALE: 1" = 20'

ALL LOCATIONS ARE APPROXIMATE

REFER TO LEGEND PAGE

NOTE:

B-1 THROUGH B-5 AND MW-1 INSTALLED BY OMNNI
ALL OTHERS BORINGS AND WELLS INSTALLED BY FISCHER

NOT ALL UTILITIES ARE LOCATED
UTILITY LOCATIONS ARE APPROXIMATE

✳ CONTAMINANTS DETECTED IN SOIL SAMPLES COLLECTED FROM VADOSE ZONE AT CONCENTRATIONS EXCEEDING NR720 RCLs.

Reduced From
11 inches x 17 inches

~~4~~ 9-00

With additional info (Fischer rpt – 12-13-99) closure of the site was acceptable (Miller ltr – 1-19-00) however, the Miller letter only asks for a ground water use restriction, it should of asked for a soil deed restriction and ground water use rest (see closure committee comments on 11-8-99 closure package). In addition, Fischer's draft ground water use rest. (2-11-00) is not acceptable since it only describes a small portion of the entire property which does not include the entire ground water contamination plume. In February '00 I discussed this with Karen Burkman, we decided that I would draft the deed rest. to include the soil rest. language and she would supply me with a description of a portion of the entire property that included the plume (the area highlighted in Fischer's draft rest. plus the area of the Municipal building also shown in Fischer's draft rest.). Attached to this page is a disk that includes a deed restriction for the site. In it the appropriate property description must be inserted.

Another issue is that the closure committee states that a "soil deed restriction" must be filed for the contaminated soil that remains. The soil that remains is shallow (<4 ft) and exceeds our Pb RCL and in one sample the COMM 46 benzene direct contact number in another. I think there should be an institutional control deed rest. filed for the site which requires the maintenance of the asphalt over the contaminated soil. The attached rest. on the disk is written to be an institutional control rest. and ground water use rest. If you (whoever you is :-) think a general soil rest. is OK, then change the restriction.

Tilken >

John W. Sundelius, P.E.
Deputy Director of Public Works
(920) 766-6305
(920) 766-6324 Fax
sundeliujw@kaukauna-wi.org

Kaukauna

ON THE FOX

January 3, 2003

Cheryl Laatsch
Hydrogeologist
Department of Natural Resources
625 East County Road Y, Suite 700
Oshkosh, WI 54901-9731

Subject: **Deed Restriction for Kaukauna City Waste Oil Site, Kaukauna, WI**
WDNR BRRTS #03-45-001729

Dear Ms. Laatsch:

This letter is in response to your June 27, 2002, correspondence that included a deed restriction to be signed and recorded.

The City of Kaukauna had sent Mr. Greg Tilkens, Wisconsin Department of Natural Resources, a groundwater use restriction that we intended to file. I am not sure if your June letter is in response to our February 2000, letter to Mr. Tilkens or if the original correspondence was lost.

I am enclosing copies of all the information sent along with the February 2000, letter. I request that the enclosed deed restriction be the one recorded as it has already received City Council approval and includes the restrictions requested by the DNR at that time.

Please feel free to contact me with any questions or comments you may have.

Sincerely,

John Sundelius

Enclosure

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

February 11, 2000

COPY

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: GROUNDWATER USE RESTRICTION for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

On behalf of the City of Kaukauna, FISCHER is submitting the enclosed draft groundwater use restriction, including attachments. Also enclosed is the most recent warranty deed on file with the Outagamie County Registrar of Deeds Office. Please note that the legal description on the deed is for the entire large parcel owned by the City. The City of Kaukauna provided the legal description representative of the area where groundwater contamination above enforcement standards still remains, and FISCHER inserted that legal description into the restriction.

Please review the enclosures and notify FISCHER if the restriction is acceptable to the Wisconsin Department of Natural Resources. Upon notification, the restriction will be finalized and filed with the Outagamie County Registrar of Deeds Office.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb
Enclosures
C: Mr. John Sundelius

Ripon Office: P.O. Box 552, Ripon, Wisconsin 54971
Phone: (920) 745-2200 • FAX: (920) 745-2222
E-mail: kfischer@fdldotnet.com

Green Bay Office: P.O. Box 11236
Green Bay, WI 54307
Phone/Fax: (920) 592-9540

RESOLUTION NO. 3141

RESOLUTION AUTHORIZING A WELL RESTRICTION ON CERTAIN CITY OWNED LAND IN LIEU OF FURTHER REMEDIATION ACTIVITY

WHEREAS, certain lands surrounding the fueling island adjacent to the Street Department in the Municipal Services Building have sustained some petroleum and/or lead contamination; and,

WHEREAS, remediation efforts have been completed and any remaining contamination will be naturally attenuated as approved by the Wisconsin Department of Natural Resources; and,

WHEREAS, restrictions within Wisconsin Administrative Code limit the construction of wells where certain contamination exists in the soils and the said restrictions would currently apply to the lands described below; and,

WHEREAS, it is a condition of the permission from the Wisconsin Department of Natural Resources for the use of natural attenuation that a restriction prohibiting the construction of any well upon the lands described below must be recorded with the Register of Deeds Office;

NOW, THEREFORE, BE IT RESOLVED by the Common Council of the City of Kaukauna, that the Mayor and Clerk/Treasurer are hereby authorized to execute and have recorded the attached Groundwater Use Restriction Declaration for land described as follows:

> A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows: Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point also being on the northerly Right of Way line of Third Street; also the point of beginning; thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat a distance of 78 feet to the point of beginning.

Introduced and adopted this 15th day of February, 2000.

APPROVED: John J. Lambie
John J. Lambie, Mayor

ATTEST: Susan J. Duda
Susan J. Duda, Clerk/Treasurer

Document Number	GROUNDWATER USE RESTRICTION

Declaration of Restrictions

In Re: A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows:

Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point also being on the northerly Right of Way line of Third Street; Also the Point of Beginning; Thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; Thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; Thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat a distance of 78 feet to the Point of Beginning.

Recording Area

Name and Return Address
City of Kaukauna
Attn: Mr. John Sundelius
P.O. Box 890
Kaukauna, WI 54130

32-3-0402-00-2

Parcel Identification Number (PIN)

STATE OF WISCONSIN)
) ss
COUNTY OF Outagamie)[County where this document is signed]

WHEREAS, the City of Kaukauna is the owner of the above-described property.

WHEREAS, one or more petroleum discharges have occurred on this property. Petroleum-contaminated groundwater above ch. NR 140, Wis. Adm. Code enforcement standards existed on this property on November 29, 1999 at the location of monitoring well MW-4 [benzene was detected at 260 micrograms per liter (ug/l)]. The area of groundwater contamination with contaminant concentrations exceeding ch. NR 140, Wis. Adm. Code enforcement standards is estimated on Attachment 1. One soil sample collected from the vadose zone from three feet below ground surface from the north sidewall of the final excavation had a lead concentration of 110 milligrams per kilogram (mg/kg) on February 24, 1999. The area of soil contamination in the vadose zone on the property with a lead concentration exceeding the ch. NR 720, Wis. Adm. Code residual contaminant level is estimated on Attachment 2. Attachments 1 and 2 are made part of this restriction.

WHEREAS, it is the desire and intention of the property owner to impose on the property restrictions which will make it unnecessary to conduct further groundwater or soil remediation activities on the property at the present time.

WHEREAS, natural attenuation has been approved by the Department of Natural Resources to remediate groundwater contamination exceeding ch. NR 140, Wis. Adm. Code groundwater standards within the boundaries of this property.

WHEREAS, construction of wells where the water quality does not comply with drinking water standards in ch. NR 809, Wis. Adm. Code is restricted by chs. NR 811 and NR 812, Wis. Adm. Code. Special well construction standards or water treatment requirements, or both, or well construction prohibitions may apply.

NOW THEREFORE, the owner hereby declares that all of the property described above is held and shall be held, conveyed or encumbered, leased, rented, used, occupied and improved subject to the following limitation and restrictions:

> Anyone who proposes to construct or reconstruct a well on this property is required to contact the Department of Natural Resources' Bureau of Drinking Water and Groundwater, or it successor agency, to determine what specific requirements are applicable, prior to constructing or reconstructing a well on this property. No well may be constructed on this property unless applicable requirements are met.

This restriction is hereby declared to be a covenant running with the land and shall be fully binding upon all persons acquiring the above-described property whether by descent, devise, purchase or otherwise. This restriction benefits and is enforceable by the Wisconsin Department of Natural Resources, its successors or assigns. The Department, its successors or assigns, may initiate proceedings at law or in equity against any person or persons who violate or are proposing to violate this covenant, to prevent the proposed violation or to recover damages for such violation.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Natural Resources or its successor issue a determination that one or more of the restrictions set forth in this covenant is no longer required. Upon the receipt of such a request, the Wisconsin Department of Natural Resources shall determine whether or not the restrictions contained herein can be extinguished. If the Department determines that the restrictions can be extinguished, an affidavit, attached to a copy of the Department's written determination, may be recorded to give notice that this deed restriction, or portions of this deed restriction, are no longer binding.

By signing this document, John J. Lambie, Mayor, and Susan J. Duda, Clerk/Treasurer asserts that he/she is duly authorized to sign this document on behalf of the City of Kaukauna.

IN WITNESS WHEREOF, the owner of the property has executed this Declaration of Restrictions, this _____ day of _____, 2000.

Signature: _____
Printed Name: John J. Lambie, Mayor

Signature: _____
Printed Name: Susan J. Duda, Clerk/Treasurer

Subscribed and sworn to before me
this _____ day of _____, 2000.

_____
Notary Public, State of _____
My commission _____

This document was drafted by the Wisconsin Department of Natural Resources based on information provided by Fischer Environmental, Inc. and the City of Kaukauna.

WARRANTY DEED

THIS INDENTURE, made by BADGER NORTHLAND INC., also known as BADGER NORTHLAND, INC., a Corporation duly organized and existing under and by virtue of the laws of the State of Delaware, formerly known as M-F Badger Corporation, a Delaware Corporation, located at Kaukauna, Wisconsin, Outagamie County, Grantor, of the City of Kaukauna, Outagamie County, Wisconsin, hereby conveys and warrants to the CITY OF KAUKAUNA, a Wisconsin Municipal Corporation, Grantee, of the City of Kaukauna, Outagamie County, Wisconsin, for valuable consideration of $447,000, and other good and valuable consideration, the following tracts of land located in Outagamie County, State of Wisconsin:

1. All of Lots 1 through 16, in Block eight (8), of LEDYARD PLAT, and all that portion of the vacated alley located in Block 8, LEDYARD PLAT, abutting upon Lots 5 through 12, inclusive, on Second Street and upon Lots 13 through 16, inclusive, on Third Street, said vacated alley being a parcel of land 20 feet wide and 200 feet long, all according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin.

2. That part of Lot "A" Ledyard Plat of the City of Kaukauna, bounded and described as follows: Commencing at the most Westerly corner of Block 8 of aforesaid Ledyard Plat, being a point on the Northeasterly line of Third Street; thence Northwesterly along said Northeasterly line of Third Street, a distance of 723.5 feet to a point distant 25 feet Southerly, measured radially, from the center line of the Main track of the Chicago and North Western Railway Company, as said main track is now located; thence Easterly along a line parallel with said main track center line, said parallel line being a curved line concave to the South and having a radius of 810.00 feet (the long chord of which forms an angle of 24°32' as measured from Southeast to East, with the Northeasterly line of Third Street and has a length of 226.7 feet) a distance of 227.45 feet to the point of beginning of the parcel of land herein described: thence Easterly along a curved line convex to the South and having a radius of 920 feet (the chord of which forms an angle of 14°20' to the right of an extension Easterly, of the long chord of the last described curve and has a length of 289.9 feet) a distance of 291.11 feet: thence Easterly along a straight line which forms an angle of 8°10' to the left of an extension, Easterly of the long chord of the last described curve, a distance of 237 feet, more or less, to an intersection with the Southwesterly line of Second Street extended Northwesterly; thence Southeasterly along the extension of said Southwesterly line of Second Street, a distance of 6.8 feet, more or less, to the most Northerly corner of aforesaid Block 8, Ledyard Plat: thence Northeasterly along the Northeasterly extension of the Northwesterly line of said Block 8, a distance of 45 feet, more or less, to a point distant 25 feet Southwesterly, measured at right angles, from the center line of the main track of the Chicago and North Western Railway Company aforesaid: thence Northwesterly along a line parallel with said main

to the point of beginning. (The above described premises located in the unplatted part of Ledyard Plat according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin, excepting and reserving unto the Chicago and Northwestern Railroad Company, a Wisconsin corporation, the right to maintain, operate, use, reconstruct and replace any and all existing conduits, sewers, water mains, gas lines, electric power lines, communication lines, wires and other utilities upon said premises.

3. A part of Lot "B" in the Plat of Ledyard, now a part of the City of Kaukauna, bounded and described as follows: Commencing at the point of intersection of the Northwesterly line of Fourth Avenue (State Trunk Highway 55) and the Northeasterly line of Second Street; thence Northwesterly along said Northeasterly line of Second Street, a distance of 215 feet to the point of beginning of the parcel of land herein described; thence Northeasterly along a line at right angles to said Northeasterly line of Second Street, a distance of 110 feet, more or less, to a point distant 32 feet Southwesterly, measured at right angles, from the center line of the main track of the Chicago and North Western Railway Company, as said main track is now located; thence Southwesterly along a straight line, a distance of 335 feet, more or less, to a point on the Northeasterly line of Second Street aforesaid, distant 35 feet Southwesterly, measured at right angles, from said main track center line; thence Southeasterly along said Northeasterly line of Second Street, a distance of 315 feet, more or less, less and excepting that property conveyed by Badger Northland Inc. to the City of Kaukauna by Warranty Deed dated September 29, 1972, for road purposes. The above described premises located in the unplatted part of Ledyard Plat according to the recorded Assessor's Plat of the City of Kaukauna, Outagamie County, Wisconsin. Less and excepting a reservation unto the prior grantor, Chicago and Northwestern Railway Company, a Wisconsin corporation, for its right to maintain, operate, use, reconstruct and replace any and all existing conduits, sewers, water mains, gas lines, electric power lines, communication lines, wires and other utilities upon the premises.

4. That part of Lot "A" Ledyard Plat of the City of Kaukauna, Outagamie County and State of Wisconsin, described as follows, to-wit: Beginning at the most Westerly corner of Block 8 of aforesaid Ledyard Plat; thence Northwesterly along the Northeasterly line of Third Street, a distance of 723.5 feet to a point distant 25 feet Southerly, measured radially, from the center line of the main track of the Chicago and North Western Railway Company as said main track is now located and established; thence Easterly along a line parallel with the center line of said main track, said line being a curved line concave to the South and having a radius of 810.00 feet (the long chord of which forms an angle of $24^{\circ}32'$, as measured from Southeast to East, with the Northeasterly line of Third Street and has a length of 226.7 feet) a distance of 227.45 feet, thence Easterly along a curved line convex to the South and having a radius of 920.00 feet (the long chord of which forms an angle of $14^{\circ}20'$ to the right of an extension Easterly, of the long chord of the last described curve and has a length of 289.9 feet) a distance of 291.11 feet; thence Easterly along a straight line which forms an angle of $8^{\circ}10'$ to the left of an extension, Easterly, of the long chord

of the last described curve, a distance of 237.0 feet, more or less, to an intersection with the Southwesterly line of Second Street extended Northwesterly; thence Southeasterly along the extension of said line of Second Street, a distance of 6.8 feet, more or less, to the most Northerly corner of aforesaid Block 8, Ledyard Plat; thence Southwesterly along the Northwesterly line of said Block 8, a distance of 220.0 feet, more or less, to the point of beginning, (said premises being located in the unlotted part of Ledyard Plat according to the recorded Assessor's Plat of said City). Subject to the rights of the City of Kaukauna under a lease to construct, maintain and use a water line, as it presently exists, in such real estate.

FEE EXEMPT # 2

Except for easements, covenants and restrictions of record, and covenants for any public roadway purposes.

Exempt from Real Estate Transfer Return and transfer tax, Exempt # 2.

IN WITNESS WHEREOF, the said grantor corporation has caused these presents to be signed by Gail E. Janssen, its corporation president and countersigned by Kenneth B. Myers, its corporation secretary, at Kaukauna, Wisconsin, and its corporate seal hereunto affixed this 26th day of July, 1974.

BADGER NORTHLAND INC.
A Delaware Corporation

a/k/a BADGER NORTHLAND, INC.,
a Delaware Corporation

(CORPORATE SEAL)

Gail E. Janssen, President

Countersigned:

Kenneth B. Myers, Secretary

STATE OF WISCONSIN)
) SS.
OUTAGAMIE COUNTY)

Personally came before me this 26th day of July, 1974, Gail E. Janssen, corporation president and Kenneth B. Myers, corporation secretary, of the above named corporation, Badger Northland Inc., a/k/a Badger Northland, Inc., to me known to be the persons who executed the foregoing instrument and to me known to be such president and secretary of said corporation, and acknowledge that they executed the foregoing instrument as such officers and as the deed of said corporation, all by its authority.

Charles J. Hartzheim, Notary Public,
State of Wisconsin
My Commission is Permanent.

THIS INSTRUMENT DRAFTED BY:

HERRLING, CLARK & HARTZHEIM,
By: Charles J. Hartzheim
Attorneys at Law
301 N. Lynndale Drive
Appleton, Wisconsin 54911

OUTAGAMIE
Document # 685856

STATE OF WISCONSIN

IN _____ COURT

FOR _____ COUNTY

Plaintiff

Defendant

REGISTER'S OFFICE
OUTAGAMIE COUNTY, WIS.

Received for Record the 26
day of [illegible] A.D. 19 74
10 o'clock A M. and Recorded as
vol. 157 of Records on page 71

[illegible]
REGISTER

pd 4.00

Don Green Atty

VOL 957 PAGE 74

~~HERRLING, C~~
~~301 Ho~~
~~Appleton,~~

Laatsch, Cheryl

From: Laatsch, Cheryl
Sent: Thursday, January 09, 2003 5:11 PM
To: 'sundeliujw@kaukauna-wi.org'
Subject: ground use restriction

Hi John -

Thank you for your letter addressing the required deed restriction for the Waste Oil Site. I have looked back at the file to adequately address your question on which restriction can be used.

"Fischer's draft ground water use restriction (2-11-00) is not acceptable since it only describes a small portion of the entire property which does not include the entire ground water contamination plume. In February I (Tilkens) discussed this with Karen Burkman, we decided that I would draft the deed restriction ...." - Greg Tilkens Project Manager

The above memo was in the file. Thus I consulted with our legal services and prepared the restriction that I sent to you in June. The revised restriction (sent to you in June) must be filed with the county register of deeds. Failure to file the restriction may lead to further enforcement.

I would be glad to discuss this matter with you further. I can be reached at 920-303-5435.
Cheryl Laatsch

John W. Sundelius, P.E.
Deputy Director of Public Works
(920) 766-6305
(920) 766-6324 Fax
sundeliujw@kaukauna-wi.org

Kaukauna

ON THE FOX

January 3, 2003

Cheryl Laatsch
Hydrogeologist
Department of Natural Resources
625 East County Road Y, Suite 700
Oshkosh, WI 54901-9731

Subject: **Deed Restriction for Kaukauna City Waste Oil Site, Kaukauna, WI**
WDNR BRRTS #03-45-001729

Dear Ms. Laatsch:

This letter is in response to your June 27, 2002, correspondence that included a deed restriction to be signed and recorded.

The City of Kaukauna had sent Mr. Greg Tilkens, Wisconsin Department of Natural Resources, a groundwater use restriction that we intended to file. I am not sure if your June letter is in response to our February 2000, letter to Mr. Tilkens or if the original correspondence was lost.

I am enclosing copies of all the information sent along with the February 2000, letter. I request that the enclosed deed restriction be the one recorded as it has already received City Council approval and includes the restrictions requested by the DNR at that time.

Please feel free to contact me with any questions or comments you may have.

Sincerely,

John Sundelius

Enclosure

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

February 11, 2000

COPY

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: GROUNDWATER USE RESTRICTION for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

On behalf of the City of Kaukauna, FISCHER is submitting the enclosed draft groundwater use restriction, including attachments. Also enclosed is the most recent warranty deed on file with the Outagamie County Registrar of Deeds Office. Please note that the legal description on the deed is for the entire large parcel owned by the City. The City of Kaukauna provided the legal description representative of the area where groundwater contamination above enforcement standards still remains, and FISCHER inserted that legal description into the restriction.

Please review the enclosures and notify FISCHER if the restriction is acceptable to the Wisconsin Department of Natural Resources. Upon notification, the restriction will be finalized and filed with the Outagamie County Registrar of Deeds Office.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb
Enclosures
C: Mr. John Sundelius

RESOLUTION NO. 3141

RESOLUTION AUTHORIZING A WELL RESTRICTION ON CERTAIN CITY OWNED LAND IN LIEU OF FURTHER REMEDIATION ACTIVITY

WHEREAS, certain lands surrounding the fueling island adjacent to the Street Department in the Municipal Services Building have sustained some petroleum and/or lead contamination; and,

WHEREAS, remediation efforts have been completed and any remaining contamination will be naturally attenuated as approved by the Wisconsin Department of Natural Resources; and,

WHEREAS, restrictions within Wisconsin Administrative Code limit the construction of wells where certain contamination exists in the soils and the said restrictions would currently apply to the lands described below; and,

WHEREAS, it is a condition of the permission from the Wisconsin Department of Natural Resources for the use of natural attenuation that a restriction prohibiting the construction of any well upon the lands described below must be recorded with the Register of Deeds Office;

NOW, THEREFORE, BE IT RESOLVED by the Common Council of the City of Kaukauna, that the Mayor and Clerk/Treasurer are hereby authorized to execute and have recorded the attached Groundwater Use Restriction Declaration for land described as follows:

> A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows: Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point also being on the northerly Right of Way line of Third Street; also the point of beginning; thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat a distance of 78 feet to the point of beginning.

Introduced and adopted this 15th day of February, 2000.

APPROVED: John J. Lambie
John J. Lambie, Mayor

ATTEST: Susan J. Duda
Susan J. Duda, Clerk/Treasurer

Document Number	GROUNDWATER USE RESTRICTION

Declaration of Restrictions

In Re: A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows:

Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point also being on the northerly Right of Way line of Third Street; Also the Point of Beginning; Thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; Thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; Thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat a distance of 78 feet to the Point of Beginning.

Recording Area

Name and Return Address
City of Kaukauna
Attn: Mr. John Sundelius
P.O. Box 890
Kaukauna, WI 54130

32-3-0402-00-2

Parcel Identification Number (PIN)

STATE OF WISCONSIN)
) ss
COUNTY OF Outagamie)[County where this document is signed]

WHEREAS, the City of Kaukauna is the owner of the above-described property.

WHEREAS, one or more petroleum discharges have occurred on this property. Petroleum-contaminated groundwater above ch. NR 140, Wis. Adm. Code enforcement standards existed on this property on November 29, 1999 at the location of monitoring well MW-4 [benzene was detected at 260 micrograms per liter (ug/l)]. The area of groundwater contamination with contaminant concentrations exceeding ch. NR 140, Wis. Adm. Code enforcement standards is estimated on Attachment 1. One soil sample collected from the vadose zone from three feet below ground surface from the north sidewall of the final excavation had a lead concentration of 110 milligrams per kilogram (mg/kg) on February 24, 1999. The area of soil contamination in the vadose zone on the property with a lead concentration exceeding the ch. NR 720, Wis. Adm. Code residual contaminant level is estimated on Attachment 2. Attachments 1 and 2 are made part of this restriction.

WHEREAS, it is the desire and intention of the property owner to impose on the property restrictions which will make it unnecessary to conduct further groundwater or soil remediation activities on the property at the present time.

WHEREAS, natural attenuation has been approved by the Department of Natural Resources to remediate groundwater contamination exceeding ch. NR 140, Wis. Adm. Code groundwater standards within the boundaries of this property.

WHEREAS, construction of wells where the water quality does not comply with drinking water standards in ch. NR 809, Wis. Adm. Code is restricted by chs. NR 811 and NR 812, Wis. Adm. Code. Special well construction standards or water treatment requirements, or both, or well construction prohibitions may apply.

NOW THEREFORE, the owner hereby declares that all of the property described above is held and shall be held, conveyed or encumbered, leased, rented, used, occupied and improved subject to the following limitation and restrictions:

> Anyone who proposes to construct or reconstruct a well on this property is required to contact the Department of Natural Resources' Bureau of Drinking Water and Groundwater, or it successor agency, to determine what specific requirements are applicable, prior to constructing or reconstructing a well on this property. No well may be constructed on this property unless applicable requirements are met.

This restriction is hereby declared to be a covenant running with the land and shall be fully binding upon all persons acquiring the above-described property whether by descent, devise, purchase or otherwise. This restriction benefits and is enforceable by the Wisconsin Department of Natural Resources, its successors or assigns. The Department, its successors or assigns, may initiate proceedings at law or in equity against any person or persons who violate or are proposing to violate this covenant, to prevent the proposed violation or to recover damages for such violation.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Natural Resources or its successor issue a determination that one or more of the restrictions set forth in this covenant is no longer required. Upon the receipt of such a request, the Wisconsin Department of Natural Resources shall determine whether or not the restrictions contained herein can be extinguished. If the Department determines that the restrictions can be extinguished, an affidavit, attached to a copy of the Department's written determination, may be recorded to give notice that this deed restriction, or portions of this deed restriction, are no longer binding.

By signing this document, John J. Lambie, Mayor, and Susan J. Duda, Clerk/Treasurer asserts that he/she is duly authorized to sign this document on behalf of the City of Kaukauna.

IN WITNESS WHEREOF, the owner of the property has executed this Declaration of Restrictions, this _____ day of _____, 2000.

Signature: _____
Printed Name: John J. Lambie, Mayor

Signature: _____
Printed Name: Susan J. Duda, Clerk/Treasurer

Subscribed and sworn to before me
this _____ day of _____, 2000.

_____
Notary Public, State of _____
My commission _____

This document was drafted by the Wisconsin Department of Natural Resources based on information provided by Fischer Environmental, Inc. and the City of Kaukauna.

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

MW-3
MW-5
MW-4
MW-2
MW-1
MW-6
SW-1
SW-2
PP
FH
MH
GP-1

10,000 GALLON UNLEADED GASOLINE UST
FORMER UST
FORMER UST
FORMER UST
FORMER DISPENSER ISLAND

OE
C
W
UE
SIDEWALK
ASPHALT
WEST 3RD STREET
GATE
SA

N

10' 0 10' 20'

SCALE: 1" = 20'
ALL LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

NOTE:
MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER

NOT ALL UTILITIES ARE LOCATED
UTILITY LOCATIONS ARE APPROXIMATE

ATTACHMENT 1: ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING THE ENFORCEMENT STANDARDS

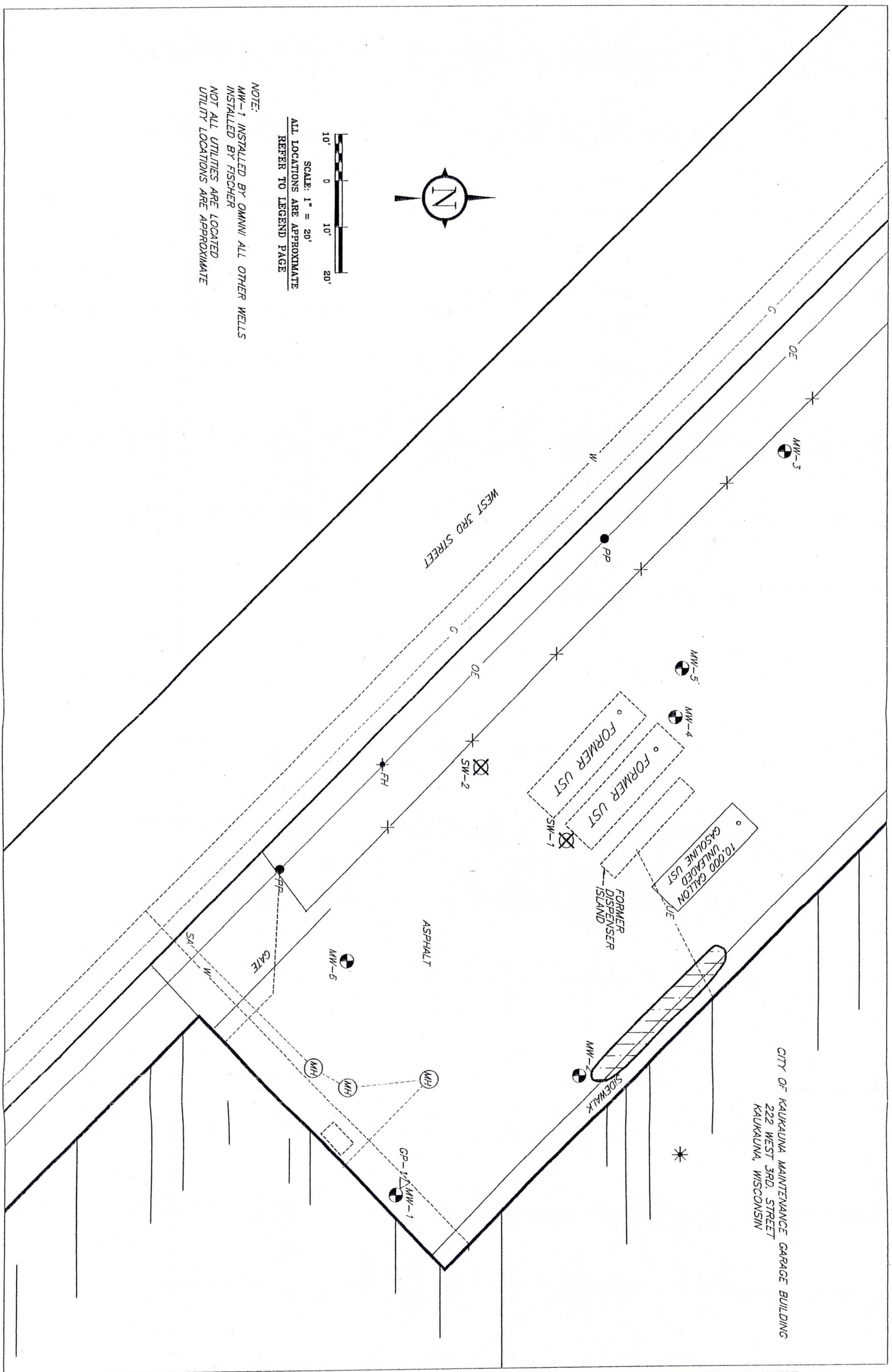
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN

398132.003

DRAWN BY: KP | REVIEWED BY:
DATE: 1/27/00 | APPROVED BY:
IDH: ATTACHMENTS\ATT-1

FISCHER

RIPON
KAUKAUNA
GREEN BAY



ATTACHMENT 2: ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING RCL IN VADOSE ZONE

FISCHER RIPON KAUKAUNA GREEN BAY

398132.003	
DRAWN BY: KP	REVIEWED BY:
DATE: 1/27/00	APPROVED BY:
IDR: ATTACHMENTS\ATT-1	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN

File

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary
Ronald W. Kazmierczak, Regional Director

Oshkosh Service Center
625 East County Road Y, STE 700
Oshkosh, Wisconsin 54901-9731
TELEPHONE 920-424-3050
FAX 920-424-4404

June 27, 2002

City of Kaukauna
Dept of Public Works
201 W Second Street
Kaukauna, WI 54130

SUBJECT: Deed Restriction for Kaukauna City Waste Oil Site, Kaukauna, WI
WDNR BRRTS #03-45-001729

To the City of Kaukauna:

Please review the enclosed deed restriction for accuracy and completeness and if you approve of the content, you should sign it, or have the appropriate property owner sign it, and have it recorded at the Outagamie County Register of Deeds Office, and then submit a copy of the recorded document to the Department. Please be aware that if a deed restriction is recorded for the wrong property because of an inaccurate legal description you have provided, you will be responsible for correcting the problem.

The Department must also receive documentation of proper abandonment of any and all monitoring wells, extraction wells, sumps, piezometers and soil venting systems if you do not intend to perform long term monitoring at your site. Documentation of proper soil disposal (i.e. landfill disposal tickets) will also need to be submitted. Once all this information has been received, the case will be conditionally closed.

If you have any additional relevant information concerning this matter which was not formerly provided to the Department, you should submit this information to the Department for reevaluation.

If you have any questions or concerns, please contact me at 920-303-5435.

Sincerely,

Cheryl Laatsch

Cheryl Laatsch
Hydrogeologist
Bureau for Remediation & Redevelopment

Enclosure

Document Number	DEED RESTRICTION

Declaration of Restrictions

In Re: the property described in Exhibit A hereby attached and made a part of this restriction.

Recording Area

Name and Return Address

STATE OF WISCONSIN)
) ss
COUNTY OF OUTAGAMIE)

Parcel Identification Number (PIN)

WHEREAS, the City of Kaukauna is the owner of the above-described property.

WHEREAS, one or more petroleum discharges have occurred on this property. Petroleum contaminated groundwater above ch. NR 140, Wis. Adm. Code enforcement standards existed on this property at the following location(s) on the following date(s): monitoring well 4 (MW-4) benzene is 260 micrograms per liter on November 29, 1999, and iron is 10 milligrams per liter on April 8, 1999; monitoring well 1 (MW-1) iron is 10 milligrams per liter on April 8, 1999 and soil contamination existed on the property at the following location(s) on the following date(s): Soil boring 6 (B-6) with 150 milligrams per kilogram (mg/kg) lead at 1 to 3 feet, B-9 with 370 mg/kg lead, 1500 micrograms per kilogram (ug/kg) benzene, 11190 ug/kg xylene at 1-3 feet on April 15, 1998 and B15 with 2200 mg/kg gasoline range organics (GRO) ethylbenzene, 3500 mg/kg diesel range organics (DRO), 13000 ug/kg benzene, 54000 ug/kg ethylbenzene, 3500 ug/kg toluene and 166800 ug/kg xylene at 2.5 to 4.5 feet on August 28, 1998.

Location of monitoring wells and soil borings are provided on Figure 3, attached and made part of this restriction.

WHEREAS, it is the desire and intention of the property owner to impose on the property restrictions which will make it unnecessary to conduct further groundwater or soil remediation activities on the property at the present time.

WHEREAS, natural attenuation has been approved by the Department of Natural Resources to remediate groundwater contamination exceeding ch. NR 140, Wis. Adm. Code groundwater standards within the boundaries of this property.

WHEREAS, construction of wells where the water quality does not comply with drinking water standards in ch. NR 809, Wis. Adm. Code is restricted by chs. NR 811 and NR 812, Wis. Adm. Code. Special well construction standards or water treatment requirements, or both, or well construction prohibitions may apply.

NOW THEREFORE, the owner hereby declares that all of the property described above is held and shall be held, conveyed or encumbered, leased, rented, used, occupied and improved subject to the following limitation and restrictions:

The following activities are prohibited on that portion of the property described above where a cap or cover has been placed as described in Figure 3, unless prior written approval has been obtained from the Wisconsin Department of Natural Resources or its successor or assign: (1) Excavating or grading of the land surface; (2) Filling on the capped area; (3) Plowing for agricultural cultivation; and (4) Construction or installation of a building of other structure with a foundation that would sit on or be places within a cap or cover. In addition, the cap or cover shall be maintained in compliance with a plan prepared and submitted to the Wisconsin Department of Natural Resources by a responsible party, as required by section NR 724.13 (2), Wis. Adm. Code (1999).

Anyone who proposes to construct or reconstruct a well on this property is required to contact the Department of Natural Resources' Bureau of Drinking Water and Groundwater, or it successor agency, to determine what specific requirements are applicable, prior to constructing or reconstructing a well on this property. No well may be constructed on this property unless applicable requirements are met.

This restriction is hereby declared to be a covenant running with the land and shall be fully binding upon all persons acquiring the above-described property whether by descent, devise, purchase or otherwise. This restriction benefits and is enforceable by the Wisconsin Department of Natural Resources, its successors or assigns. The Department, its successors or assigns, may initiate proceedings at law or in equity against any person or persons who violate or are proposing to violate this covenant, to prevent the proposed violation or to recover damages for such violation.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Natural Resources or its successor issue a determination that one or more of the restrictions set forth in this covenant is no longer required. Upon the receipt of such a request, the Wisconsin Department of Natural Resources shall determine whether or not the restrictions contained herein can be extinguished. If the Department determines that the restrictions can be extinguished, an affidavit, attached to a copy of the Department's written determination, may be recorded to give notice that this deed restriction, or portions of this deed restriction, are no longer binding.

By Signing the document, _____asserts that he/she is duly authorized to sign this document on behalf of the City of Kaukauna.

IN WITNESS WHEREOF, the owner of the property has executed this Declaration of Restrictions, this _____ day of _____, 2002.

Signature: _____
Printed Name:_____
Title: _____

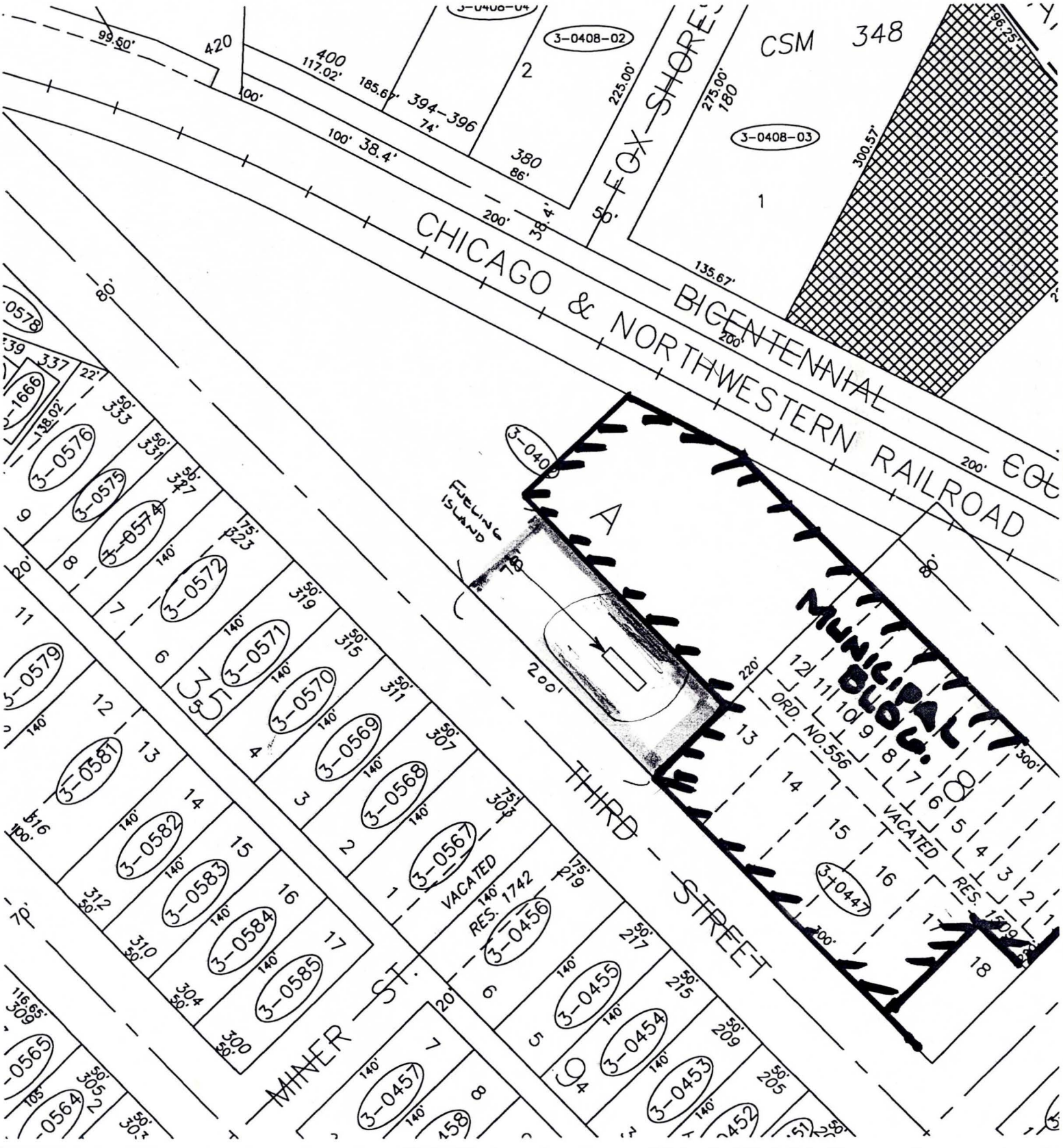
Subscribed and sworn to before me
this _____ day of _____, 2002.

_____
Notary Public, State of _____
My commission _____

This document was drafted by the Wisconsin Department of Natural Resources based on information provided by Fischer Environmental, Inc. and the City of Kaukauna.

GROUND WATER USE RESTRICTION

2/2/00 J.S.
ENGR. DEPT.



TELEPHONE LOG

SITE NAME: Kaukauna Waste Oil DATE: 11/19/00

DNR NO.: 03-45-001729 TIME: 9:15

PECFA CLAIM NO.:

TO/FROM: Karen Barkman NUMBER: (800) (920) (715) (414) 766-2069 (608)

COMPANY/AGENCY: Fischer

→ told her of closure & that I was E-mailing her the G.W. use Restr Form for her to fill out

→ told her to send Greg a copy (electronic) & hard copy of draft.

SCOTT MILLER

479-00

With additional info (Fischer rpt – 12-13-99) closure of the site was acceptable (Miller ltr – 1-19-00) however, the Miller letter only asks for a ground water use restriction, it should of asked for a soil deed restriction and ground water use rest (see closure committee comments on 11-8-99 closure package). In addition, Fischer's draft ground water use rest. (2-11-00) is not acceptable since it only describes a small portion of the entire property which does not include the entire ground water contamination plume. In February '00 I discussed this with Karen Burkman, we decided that I would draft the deed rest. to include the soil rest. language and she would supply me with a description of a portion of the entire property that included the plume (the area highlighted in Fischer's draft rest. plus the area of the Municipal building also shown in Fischer's draft rest.). Attached to this page is a disk that includes a deed restriction for the site. In it the appropriate property description must be inserted.

Another issue is that the closure committee states that a "soil deed restriction" must be filed for the contaminated soil that remains. The soil that remains is shallow (<4 ft) and exceeds our Pb RCL and in one sample the COMM 46 benzene direct contact number in another. I think there should be an institutional control deed rest. filed for the site which requires the maintenance of the asphalt over the contaminated soil. The attached rest. on the disk is written to be an institutional control rest. and ground water use rest. If you (whoever you is :-) think a general soil rest. is OK, then change the restriction.

Tilken >

Document Number

GROUNDWATER USE AND INSTITUTIONAL CONTROL RESTRICTION

Declaration of Restrictions

In Re: A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows:

Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point also being on the northerly Right of Way line of Third Street; Also the Point of Beginning; Thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; Thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; Thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat a distance of 78 feet to the Point of Beginning.

See Exhibit A

Recording Area

Name and Return Address
City of Kaukauna
Attn: Mr. John Sundelius
P.O. Box 890
Kaukauna, WI 54130

32-3-0402-00-2

Parcel Identification Number (PIN)

STATE OF WISCONSIN)
) ss
COUNTY OF OUTAGAMIE)

WHEREAS, the City of Kaukauna is the owner of the above-described property.

WHEREAS, one or more petroleum discharges have occurred on this property. Petroleum contaminated groundwater above ch. NR 140, Wis. Adm. Code enforcement standards existed on this property at the following location(s) on the following date(s): monitoring well 4 (MW-4) benzene is 260 micrograms per liter on November 29, 1999, and iron is 10 milligrams per liter on April 8, 1999; momitoring well 1 (MW-1) iron is 10 milligrams per liter on April 8, 1999 and soil contamination existed on the property at the following location(s) on the following date(s): Monoitoring Well 5 (MW-5) gasoline range orgaics are 2,200 miligrams per kilogram, diesel range organics are 3,500 milligrams per kilogram, benzene is 13,000 micrograms per kilogram, ethylbenzene is 54,000 micrograms per kilogram, toluene is 3,500 micrograms per kilogram, and xylene is 166,800 micrograms per kilogram on August 28,1998; Monitoring Well 4 (MW-4) benzene is 2,300 micrograms per kilogram on August 28, 1998; excavation confirmation sample N-Side 3 ft lead is 110 milligrams per kilogram on February 24, 1999. Location of monitoring wells and excavation confirmation sample N-Side 3 ft are provided on Figure _____ (attached) and made part of this restriction.

WHEREAS, it is the desire and intention of the property owner to impose on the property restrictions which will make it unnecessary to conduct further groundwater or soil remediation activities on the property at the present time.

WHEREAS, natural attenuation has been approved by the Department of Natural Resources to remediate groundwater contamination exceeding ch. NR 140, Wis. Adm. Code groundwater standards within the boundaries of this property.

WHEREAS, construction of wells where the water quality does not comply with drinking water standards in ch. NR 809, Wis. Adm. Code is restricted by chs. NR 811 and NR 812, Wis. Adm. Code. Special well construction standards or water treatment requirements, or both, or well construction prohibitions may apply.

NOW THEREFORE, the owner hereby declares that all of the property described above is held and shall be held, conveyed or encumbered, leased, rented, used, occupied and improved subject to the following limitation and restrictions:

PUT IN appropriate soil restriction language

Anyone who proposes to construct or reconstruct a well on this property is required to contact the Department of Natural Resources' Bureau of Drinking Water and Groundwater, or it successor agency, to determine what specific requirements are applicable, prior to constructing or reconstructing a well on this property. No well may be constructed on this property unless applicable requirements are met.

This restriction is hereby declared to be a covenant running with the land and shall be fully binding upon all persons acquiring the above-described property whether by descent, devise, purchase or otherwise. This restriction benefits and is enforceable by the Wisconsin Department of Natural Resources, its successors or assigns. The Department, its successors or assigns, may initiate proceedings at law or in equity against any person or persons who violate or are proposing to violate this covenant, to prevent the proposed violation or to recover damages for such violation.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Natural Resources or its successor issue a determination that one or more of the restrictions set forth in this covenant is no longer required. Upon the receipt of such a request, the Wisconsin Department of Natural Resources shall determine whether or not the restrictions contained herein can be extinguished. If the Department determines that the restrictions can be extinguished, an affidavit, attached to a copy of the Department's written determination, may be recorded to give notice that this deed restriction, or portions of this deed restriction, are no longer binding.

By signing this document, John J. Lambie, Mayor, and Susan J. Duda, Clerk/Treasurer asserts that he/she is duly authorized to sign this document on behalf of the City of Kaukauna.

IN WITNESS WHEREOF, the owner of the property has executed this Declaration of Restrictions, this _____ day of _____, 2000.

Signature: _____
Printed Name: John J. Lambie, Mayor

Signature: _____
Printed Name: Susan J. Duda, Clerk/Treasurer

Subscribed and sworn to before me
this _____ day of _____, 2000.

_____
Notary Public, State of _____
My commission _____

This document was drafted by the Wisconsin Department of Natural Resources based on information provided by Fischer Environmental, Inc. and the City of Kaukauna.

FISCHER

RIPON (920) 745-2200
GREEN BAY (920) 592-9540
KAUKAUNA (920) 766-2069

RECEIVED
MAR 08 2000
LMD SOLID WASTE

March 7, 2000

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: WELL ABANDONMENT for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

On February 8, 2000, groundwater monitoring wells MW-1 through MW-6 and sump well SW-2 were abandoned in accordance with Wisconsin Administrative Code Chapter NR 141. Enclosed are the well abandonment forms. Sump well SW-1 was not abandoned, since it will be used to monitor the new tank system.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb
C: Mr. John Sundelius

Corporate Office:
P. O. Box 552, Ripon, WI 54971
Fax: (920) 745-2222
kfischer@fdldotnet.com

Green Bay Office:
P.O. Box 11236, Green Bay, WI 54307
Fax: (920) 592-0259
fischerg@athenet.net

Kaukauna Office:
P.O. Box 127, Kaukauna, WI 54130
Fax: (920) 759-2669
feikauk@athenet.net

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *MW-1*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *MW-1*
WI Unique Well No.
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On (Date)

- ☒ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *9.35* Casing Diameter (ins.) *2*
(From groundsurface)

Casing Depth (ft.) *9.35*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *9.35 Feet*

(4) Depth to Water (Feet) *4.9*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☒ Yes	☐ No	☐ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain *casing removed*

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*9.35*	*1/2 bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark I by KAB* Date Signed: *3-7-00*
Street or Route: *849 Oshkosh St.* Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *MW-2*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *MW-2*
WI Unique Well No.
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

☒ Monitoring Well
☐ Water Well
☐ Drillhole
☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *12.96* Casing Diameter (ins.) *2*
(From groundsurface)

Casing Depth (ft.) *12.96*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *12.96 Feet*

(4) Depth to Water (Feet) *4.6*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☒ Yes	☐ No	☐ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain *casing removed*

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete)Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite
☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*12.96*	*1/2 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark Fischer by KDS*
Date Signed: *3-7-00*
Street or Route: *649 Oshkosh St.*
Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *MW-3*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *MW-3*
WI Unique Well No.
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

☒ Monitoring Well
☐ Water Well
☐ Drillhole
☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *8.50* Casing Diameter (ins.) *2*
(From groundsurface)

Casing Depth (ft.) *8.50*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *8.50 Feet*

(4) Depth to Water (Feet) *5.90*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☒ Yes	☐ No	☐ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain *casing removed*

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete)Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite
☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*8.50*	*1/2 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark Kay* Date Signed: *2-7-00*
Street or Route: *649 Oshkosh St.* Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY
Date Received/Inspected
District/County
Reviewer/Inspector
☐ Complying Work
☐ Noncomplying Work
Follow-up Necessary

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *MW-4*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *MW-4*
WI Unique Well No.:
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

- ☒ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *8.10* Casing Diameter (ins.) *2*
(From groundsurface)

Casing Depth (ft.) *8.10*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *8.10 Feet*

(4) Depth to Water (Feet) *4.46*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☒ No	☐ Not Applicable
Casing Left in Place?	☒ Yes	☐ No	

If No, Explain

Was Casing Cut Off Below Surface?	☒ Yes	☐ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*8.10*	*1/2 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark Fischer*
Date Signed: *3-7-00*
Street or Route: *649 Oshkosh St.*
Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *MW-5*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *MW-5*
WI Unique Well No.:
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *8/28/98*

- ☒ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug ☐ Other (Specify)

Formation Type:
☐ Unconsolidated Formation ☒ Bedrock

Total Well Depth (ft.) *17.33* Casing Diameter (ins.) *2*
(From groundsurface)

Casing Depth (ft.) *17.33*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *17.33 Feet*

(4) Depth to Water (Feet) *4.35*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☒ No	☐ Not Applicable
Casing Left in Place?	☒ Yes	☐ No	

If No, Explain

Was Casing Cut Off Below Surface?	☒ Yes	☐ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete)Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite
☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*17.33*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark I by KAS* Date Signed: *3-7-00*
Street or Route: *849 Oshkosh St.* Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *MW-6*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *MW-6*
WI Unique Well No.
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *8/28/98*

- ☒ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *6.93* Casing Diameter (ins.) *2*
(From groundsurface)

Casing Depth (ft.) *6.93*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *6.93 Feet*

(4) Depth to Water (Feet) *4.10*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☒ No	☐ Not Applicable
Casing Left in Place?	☒ Yes	☐ No	

If No, Explain

Was Casing Cut Off Below Surface?	☒ Yes	☐ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*6.93*	*1/2 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark Iby KDD* Date Signed: *3-7-00*
Street or Route: *649 Oshkosh St.* Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *SW-2*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *City of Kaukauna*
Present Well Owner: *City of Kaukauna*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *SW-2*
WI Unique Well No.:
Reason For Abandonment: *Case closure*
Date of Abandonment: *2/8/00*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *2/25/99*

- ☒ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (Specify) *Installed during backfill*

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *9.81* Casing Diameter (ins.) *4*
(From groundsurface)

Casing Depth (ft.) *9.81*

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *9.81 Feet*

(4) Depth to Water (Feet) *4.00*

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☒ No	☐ Not Applicable
Casing Left in Place?	☒ Yes	☐ No	

If No, Explain

Was Casing Cut Off Below Surface?	☒ Yes	☐ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt patch	*Surface*	*1*	*1/3 Bag*	
3/8" Bentonite Chips	*1*	*9.81*	*1 3/4 Bags*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *FISCHER*
Signature of Person Doing Work: *Mark / by KAB* Date Signed: *3-7-00*
Street or Route: *649 Oshkosh St.* Telephone Number: *(920) 745-2200*
City, State, Zip Code: *Ripon, WI 54971*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

RECEIVED
FEB 14 2000
LMD SOLID WASTE

February 11, 2000

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: GROUNDWATER USE RESTRICTION for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

On behalf of the City of Kaukauna, FISCHER is submitting the enclosed draft groundwater use restriction, including attachments. Also enclosed is the most recent warranty deed on file with the Outagamie County Registrar of Deeds Office. Please note that the legal description on the deed is for the entire large parcel owned by the City. The City of Kaukauna provided the legal description representative of the area where groundwater contamination above enforcement standards still remains, and FISCHER inserted that legal description into the restriction.

Please review the enclosures and notify FISCHER if the restriction is acceptable to the Wisconsin Department of Natural Resources. Upon notification, the restriction will be finalized and filed with the Outagamie County Registrar of Deeds Office.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb
Enclosures
C: Mr. John Sundelius

Ripon Office: P.O. Box 552, Ripon, Wisconsin 54971
Phone: (920) 745-2200 • FAX: (920) 745-2222
E-mail: kfischer@fdldotnet.com

Green Bay Office: P.O. Box 11236
Green Bay, WI 54307
Phone/Fax: (920) 592-9540

Document Number	GROUNDWATER USE RESTRICTION

Declaration of Restrictions

In Re: A parcel of land located in part of Lot "A", Ledyard Plat, City of Kaukauna, State of Wisconsin, further described as follows:

Commencing at the southwest corner of Lot 13, Block Eight (8), Ledyard Plat, said point also being on the northerly Right of Way line of Third Street; Also the Point of Beginning; Thence northwesterly along the northerly Right of Way line of Third Street 200 feet; thence northeasterly along a line perpendicular to said Right of Way line a distance of 78 feet; Thence southeasterly along a line parallel to said Right of Way line a distance of 200 feet; Thence southwesterly along the northwesterly line of Lot 13, Block 8, Ledyard Plat a distance of 78 feet to the Point of Beginning.

Must Include Both A's

Recording Area

Name and Return Address
City of Kaukauna
Attn: Mr. John Sundelius
P.O. Box 890
Kaukauna, WI 54130

32-3-0402-00-2

Parcel Identification Number (PIN)

STATE OF WISCONSIN)
) ss
COUNTY OF Outagamie)[County where this document is signed]

WHEREAS, the City of Kaukauna is the owner of the above-described property.

WHEREAS, one or more petroleum discharges have occurred on this property. Petroleum-contaminated groundwater above ch. NR 140, Wis. Adm. Code enforcement standards existed on this property on November 29, 1999 at the location of monitoring well MW-4 [benzene was detected at 260 micrograms per liter (ug/l)]. The area of groundwater contamination with contaminant concentrations exceeding ch. NR 140, Wis. Adm. Code enforcement standards is estimated on Attachment 1. One soil sample collected from the vadose zone from three feet below ground surface from the north sidewall of the final excavation had a lead concentration of 110 milligrams per kilogram (mg/kg) on February 24, 1999. The area of soil contamination in the vadose zone on the property with a lead concentration exceeding the ch. NR 720, Wis. Adm. Code residual contaminant level is estimated on Attachment 2. Attachments 1 and 2 are made part of this restriction.

WHEREAS, it is the desire and intention of the property owner to impose on the property restrictions which will make it unnecessary to conduct further groundwater or soil remediation activities on the property at the present time.

WHEREAS, natural attenuation has been approved by the Department of Natural Resources to remediate groundwater contamination exceeding ch. NR 140, Wis. Adm. Code groundwater standards within the boundaries of this property.

WHEREAS, construction of wells where the water quality does not comply with drinking water standards in ch. NR 809, Wis. Adm. Code is restricted by chs. NR 811 and NR 812, Wis. Adm. Code. Special well construction standards or water treatment requirements, or both, or well construction prohibitions may apply.

NOW THEREFORE, the owner hereby declares that all of the property described above is held and shall be held, conveyed or encumbered, leased, rented, used, occupied and improved subject to the following limitation and restrictions:

> Anyone who proposes to construct or reconstruct a well on this property is required to contact the Department of Natural Resources' Bureau of Drinking Water and Groundwater, or it successor agency, to determine what specific requirements are applicable, prior to constructing or reconstructing a well on this property. No well may be constructed on this property unless applicable requirements are met.

This restriction is hereby declared to be a covenant running with the land and shall be fully binding upon all persons acquiring the above-described property whether by descent, devise, purchase or otherwise. This restriction benefits and is enforceable by the Wisconsin Department of Natural Resources, its successors or assigns. The Department, its successors or assigns, may initiate proceedings at law or in equity against any person or persons who violate or are proposing to violate this covenant, to prevent the proposed violation or to recover damages for such violation.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Natural Resources or its successor issue a determination that one or more of the restrictions set forth in this covenant is no longer required. Upon the receipt of such a request, the Wisconsin Department of Natural Resources shall determine whether or not the restrictions contained herein can be extinguished. If the Department determines that the restrictions can be extinguished, an affidavit, attached to a copy of the Department's written determination, may be recorded to give notice that this deed restriction, or portions of this deed restriction, are no longer binding.

By signing this document, John J. Lambie, Mayor, and Susan J. Duda, Clerk/Treasurer asserts that he/she is duly authorized to sign this document on behalf of the City of Kaukauna.

IN WITNESS WHEREOF, the owner of the property has executed this Declaration of Restrictions, this _____ day of _____, 2000.

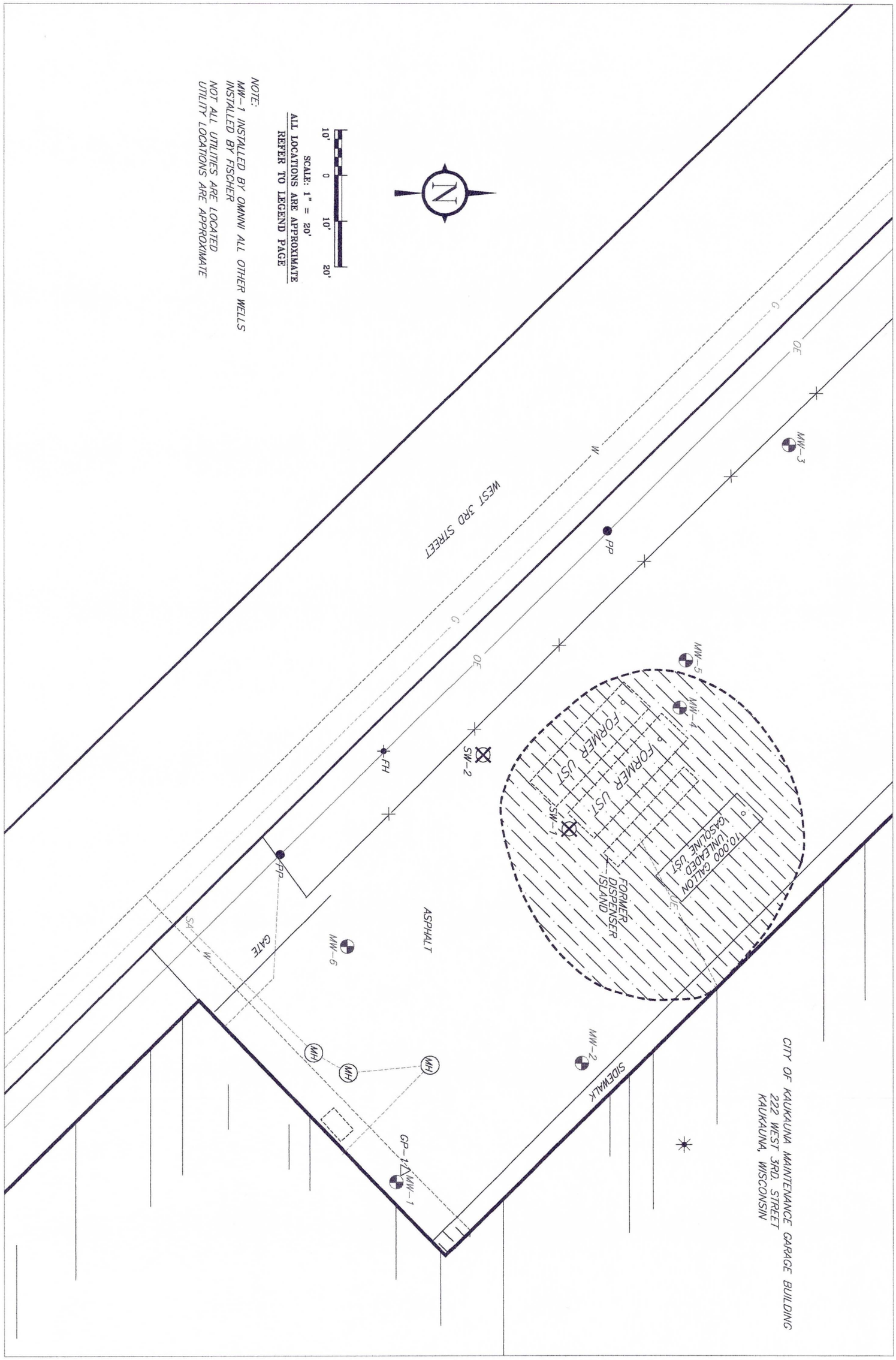
Signature: _____
Printed Name: John J. Lambie, Mayor

Signature: _____
Printed Name: Susan J. Duda, Clerk/Treasurer

Subscribed and sworn to before me
this _____ day of _____, 2000.

_____
Notary Public, State of _____
My commission _____

This document was drafted by the Wisconsin Department of Natural Resources based on information provided by Fischer Environmental, Inc. and the City of Kaukauna.

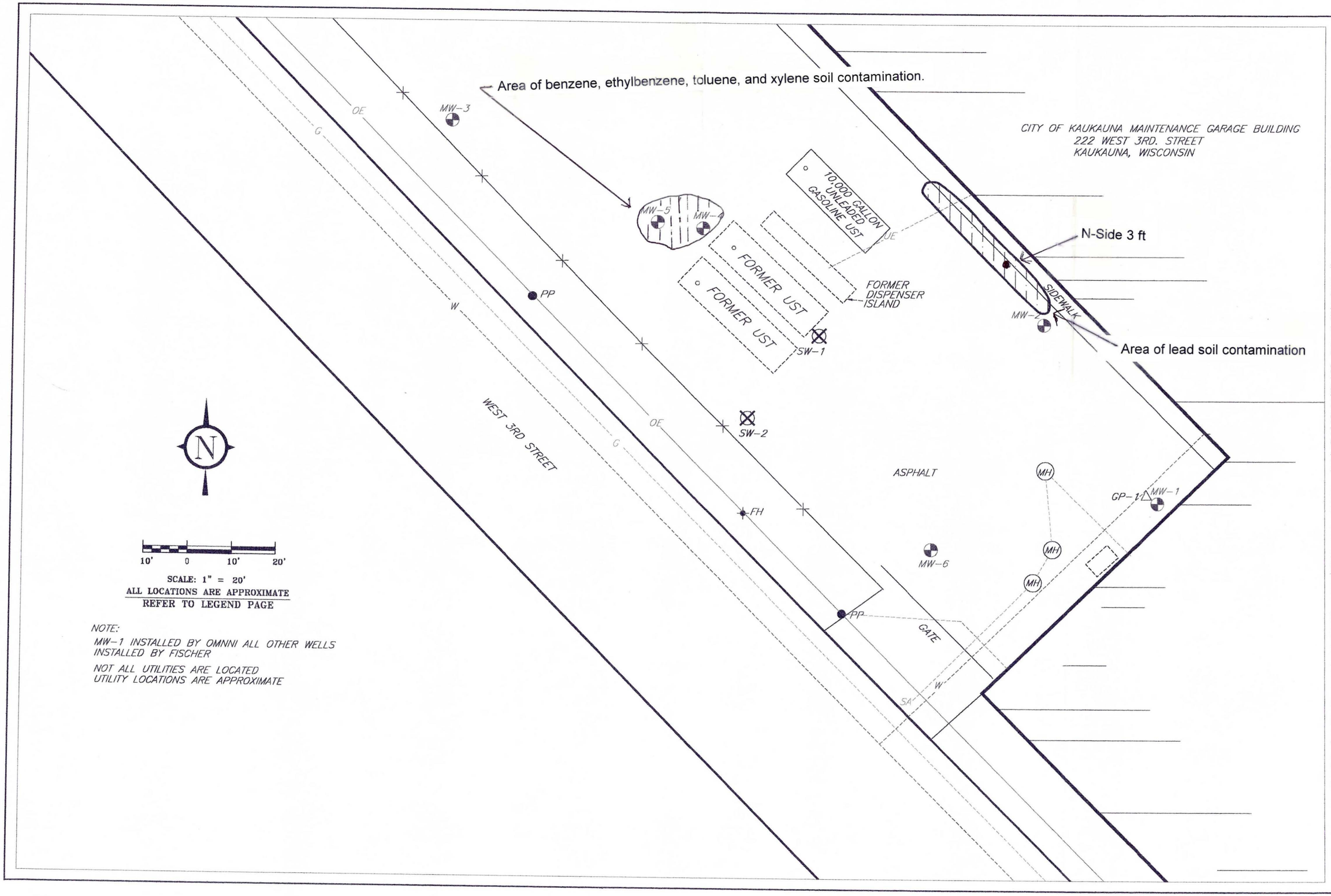


ATTACHMENT 1: ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING THE ENFORCEMENT STANDARDS

FISCHER RIPON KAUKAUNA GREEN BAY

398132.003	
DRAWN BY: KP	REVIEWED BY:
DATE: 1/27/00	APPROVED BY:
ID#: ATTACHMENTS\ATT-1	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN



ATTACHMENT 2: ESTIMATED EXTENT OF SOIL CONTAMINATION EXCEEDING RCL IN VADOSE ZONE

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN

398132.003

DRAWN BY: KP
DATE: 1/27/00
ID#: ATTACHMENTS\ATT-1
REVIEWED BY:
APPROVED BY:

FISCHER

RIPON
KAUKAUNA
GREEN BAY

File

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Ronald W. Kazmierczak, Regional Director

Northeast Region Headquarters
Green Bay Service Center
1125 N. Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448
Telephone 920-492-5800
FAX 920-492-5913
TDD 920-492-5912

January 19, 2000

City of Kaukauna
John Sundelius
201 2nd Street
Kaukauna, WI 54130

SUBJECT: Closure - Kaukauna City Waste Oil Site,
WDNR BRRTS ID #:03-45-001729

Dear Mr. Sundelius:

On December 16, 1999 the Department received your Addendum to Case Closure Request. After review the Department feels that the site meets the requests of the additional word described in the letter sent on November 10,1999.

- Soil contamination at boring location B-3 (MW-1) must be further investigated for direct contact concerns.

- A minimum of one additional round of groundwater samples analyzed for PVOC and naphthalene to evaluate post remediation contaminant trend.

Please complete the attached restriction and return a draft to this office for approval with a copy of the deed/legal description, survey map if available and a site map showing the contaminated groundwater locations. Pending Department approval the restrictions can be filed with the Outagamie County Register of Deeds. Only when the Department has received documentation that the restriction has been filed with County Register of Deeds Office and the monitoring wells abandoned according to the requirements of NR 141 Wis. Adm. Code, will the Department consider the site closed.

If you have any questions, please contact Greg Tilkens at (920) 492-5868 or Scott C. Miller at (920) 492-5871.

Sincerely,

Scott C. Miller
Hydrogeologist
Remediation & Redevelopment Program

cc: Karen Burkman; Fischer; PO Box 127, Kaukauna, WI 54130

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

RECEIVED
DEC 16 1999
LMD SOLID WASTE

DNR Jurisdiction

December 13, 1999

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: ADDENDUM TO CASE CLOSURE REQUEST for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

On behalf of the City of Kaukauna, FISCHER has completed the attached addendum to the closure request dated September 1, 1999.

FISCHER understands the Wisconsin Department of Natural Resources (WDNR) denied closure for two reasons. The WDNR requested another round of groundwater sampling to verify the contaminant concentrations detected after remediation. The WDNR was also concerned about a comment listed on OMNNI's soil boring log for boring B-3. On this log, it states, "solvent/paint odor" associated with the two to four foot soil sample. The WDNR questioned whether or not chlorinated solvents were present at the location of boring B-3, based on this comment. Since OMNNI did not analyze the soil sample reportedly emitting a solvent odor, the WDNR requested a sample be collected and analyzed for volatile organic compounds (VOC).

Attached is the groundwater analytical report associated with the sampling event conducted on November 29, 1999. MW-4 in the only monitoring well with contaminants above Wisconsin Administrative Code (WAC) Chapter NR 140 enforcement standards. The analyte was benzene at 260 micrograms per liter (ug/l). However, this concentration is significantly lower than the previous analytical concentration of 1,100 ug/l and continues to show a downward trend. Also attached is a summary of the groundwater analytical results to-date. Based on the these results, it is FISCHER's opinion that:

- remedial activities and natural attenuation have reduced contaminant concentrations in groundwater,
- the most recent analytical results verify the initial post-remediation results,
- and contaminant trends are decreasing.

A soil probe (GP-1) was advanced approximately one foot west of boring B-3 (well MW-1) on November 24, 1999. The probe, located on Figure 1 (attached), was advanced to four feet (ft)

below ground surface (bgs) with continuous soil sampling and field screening. Unusual odors or elevated photoionization detector (PID) readings were not detected. A soil boring log and borehole abandonment form are attached. The soil sample was collected from three ft bgs for VOC analysis. Attached is the soil analytical report. Only m,p-xylenes were detected, at a concentration of 320 milligrams per kilogram (mg/kg), which is below the WAC Chapter NR 720 generic residual contaminant level (RCL). Chlorinated solvents were not detected in the soil sample.

In conclusion, source control has been implemented to essentially eliminate the "environmental factor" and enhance remediation by natural attenuation. The site does not appear to pose additional risk. Therefore, it is FISCHER's opinion this site meets the criteria for closure with a groundwater use restriction.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb
Attachments
c: Mr. John Sundelius

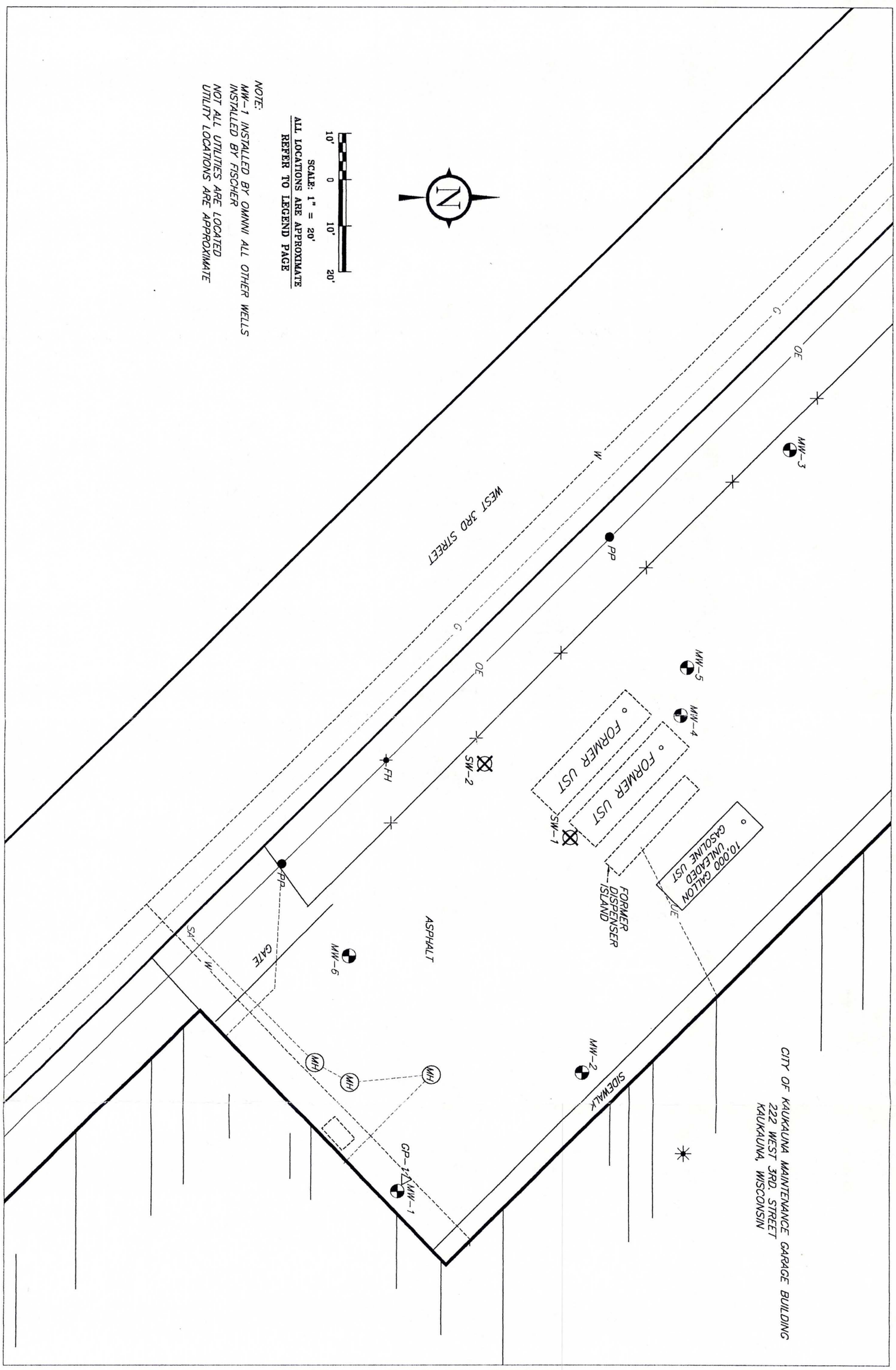


FIGURE 1: POST-REMEDIAL SITE MAP

FISCHER RIPON KAUKAUNA GREEN BAY

398132.003	
DRAWN BY: KP	REVIEWED BY:
DATE: 12/7/99	APPROVED BY:
ID#: CLOSURE	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

TABLE 1 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sump Well	NR 140		SW-1		SW-2	
Sampling Date	ES	PAL	4/8/99*	11/29/99*	4/15/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)						
Benzene	5	0.5	1.2	<0.26	<0.26	<0.26
Ethylbenzene	700	140	2.3	<0.24	<0.24	<0.24
Methyl-tert-butyl-ether	60	12	0.66Q	<0.22	<0.22	<0.22
Toluene	343	68.6	0.51Q	<0.21	<0.21	<0.21
1,2,4-Trimethylbenzene	484	96	5.9	<0.86	<0.86	<0.86
1,3,5-Trimethylbenzene			2.8	<0.54	<0.54	<0.54
Xylenes, m + p	620	124	12	<0.97	<0.97	<0.97
Xylene, o			1.8	<0.37	<0.37	<0.37

All concentrations in ug/l - micrograms per liter
ES = Enforcement Standard (exceedances shaded)
PAL = Preventive Action Limit
NA = not analyzed for parameter
Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
NE = NR 140 enforcement standard (ES) not established
* Post-remedial samples.

TABLE 1 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 140		MW-5			MW-6		
Sampling Date	ES	PAL	8/31/98	4/15/99*	11/29/99*	8/31/98	4/8/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)								
Benzene	5	0.5	5.5	<0.26	<0.26	<0.27	<0.26	<0.26
Ethylbenzene	700	140	8.2	<0.24	<0.24	<0.32	<0.24	<0.24
Methyl-tert-butyl-ether	60	12	<0.32	<0.22	<0.22	<0.32	<0.22	<0.22
Toluene	343	68.6	0.63	<0.21	<0.21	<0.27	<0.21	<0.21
1,2,4-Trimethylbenzene	484	96	14	<0.86	<0.86	<0.22	<0.86	<0.86
1,3,5-Trimethylbenzene			5.0	<0.54	<0.54	<0.27	<0.54	<0.54
Xylenes, m + p	620	124	23	<0.97	<0.97	<0.43	<0.97	<0.97
Xylene, o			1.3	<0.37	<0.37	<0.24	<0.37	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)								
s-Butylbenzene	NE	NE	0.53Q	NA	NA	<0.29	NA	NA
n-Butylbenzene	NE	NE	1.4	NA	NA	<0.29	NA	NA
Chloroform	6	0.6	0.68Q	NA	NA	<0.35	NA	NA
Naphthalene	40	8	3.2	<0.89	<0.89	<0.35	NA	NA
Isopropylbenzene	NE	NE	0.90	NA	NA	<0.26	NA	NA
n-Propylbenzene	NE	NE	2.8	NA	NA	<0.76	NA	NA
LEAD								
Lead	15	1.5	<1.6	NA	NA	<1.6	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)

Shading indicates anaytical result above NR 140 enforcement standards

All concentrations in micrograms per liter (ug/l).

* Post-remedial samples. All other samples are pre-remedial.

NA = Parameter not analyzed

NE = NR 140 enforcement standard (ES) not established

PAL = NR 140 Preventive Action Limit

TABLE 1 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-3				MW-4			
Sampling Date	ES	PAL	4/21/98	6/5/98	4/8/99*	11/29/99*	4/21/98	6/5/98	4/8/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)										
Benzene	5	0.5	<0.27	<0.27	<0.26	<0.26	**2400**	**2300**	**1100**	**260**
Ethylbenzene	700	140	<0.32	<0.32	<0.24	<0.24	560	470	230	76
Methyl-tert-butyl-ether	60	12	<0.32	<0.32	<0.22	<0.22	15Q	20	6.7Q	<0.55
Toluene	343	68.6	<0.27	<0.27	<0.21	<0.21	67	58	27	2.2
1,2,4-Trimethylbenzene	484	96	<0.22	<0.22	<0.86	<0.86	**660**	**480**	160	17
1,3,5-Trimethylbenzene			<0.27	<0.27	<0.54	<0.54	**160**	**110**	26Q	<1.4
Xylenes, m + p	620	124	<0.43	<0.43	<0.97	<0.97	**1700**	**1300**	370	20
Xylene, o			<0.24	<0.24	<0.37	<0.37	**41**	**40**	15Q	1.8Q
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)										
n-Butylbenzene	NE	NE	<0.29	NA	NA	NA	23	NA	NA	NA
Naphthalene	40	8	<0.35	NA	NA	NA	**130**	**110**	37Q	6.6Q
s-Butylbenzene	NE	NE	<0.29	NA	NA	NA	11Q	NA	NA	NA
Isopropylbenzene	NE	NE	<0.26	NA	NA	NA	43	NA	NA	NA
p-Isopropyltoluene	NE	NE	<0.24	NA	NA	NA	7.0Q	NA	NA	NA
n-Propylbenzene	NE	NE	<0.76	NA	NA	NA	110	NA	NA	NA
LEAD and CADMIUM (ug/L)										
Lead	15	1.5	<1.6	NA	NA	NA	<1.6	NA	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA	NA	NA
DETECTED POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)										
Fluorene	400	880	NA	NA	NA	NA	2.0Q	NA	NA	NA
1-methylnaphthalene	NE	NE	NA	NA	NA	NA	30	NA	NA	NA
2-methylnaphthalene	NE	NE	NA	NA	NA	NA	41	NA	NA	NA
Naphthalene	40	8	NA	NA	NA	NA	**60**	NA	NA	NA
Phenanthrene	NE	NE	NA	NA	NA	NA	15	NA	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates analytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial samples. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

TABLE 1

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-1							MW-2			
Sampling Date	ES	PAL	4/12/94	1/23/95	9/26/95	4/21/98	6/5/98	4/8/99*	11/29/99*	4/21/98	6/5/98	4/8/99*	11/29/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)													
Benzene	5	0.5	1.2	<0.6	<0.6	<0.27	<0.27	<0.27	<0.27	150	170	<0.26	<0.26
Ethylbenzene	700	140	3.6	<1.0	<1.0	<0.32	<0.32	<0.32	<0.32	11	38	<0.24	<0.24
Methyl-tert-butyl-ether	60	12	17	5.2	9.6	6.4	6.7	2.8	2.8	19	17	11	7.5
Toluene	343	68.6	<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	<0.27	5.5	1.9	0.33Q	<0.21
1,2,4-Trimethylbenzene	484	96	<1.0	<1.0	<1.0	<0.22	<0.22	<0.22	<0.22	3.7	15	<0.86	<0.86
1,3,5-Trimethylbenzene			<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	<0.27	<0.27	0.32Q	<0.54	<0.54
Xylenes, m + p	620	124	23	<1.0	<1.0	<0.43	<0.43	<0.43	<0.43	8.6	26	<0.97	<0.97
Xylene, o			<1.0	<1.0	<1.0	<0.24	<0.24	<0.24	<0.24	0.78	0.37Q	<0.37	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)													
1,2-Dichloroethane	5	0.5	4.9	4.7	7.8	NA	4.0	3.3	3.9	<0.37	NA	<0.24	NA
Isopropylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	NA	1.4	NA	NA	NA
n-Propylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	NA	1.2Q	NA	NA	NA
LEAD and CADMIUM													
Lead	15	1.5	NA	NA	NA	NA	NA	NA	NA	<1.6	NA	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)

Shading indicates analytical result above NR 140 enforcement standards

All concentrations in micrograms per liter (ug/l).

* Post-remedial samples. All other samples are pre-remedial.

NA = Parameter not analyzed

NE = NR 140 enforcement standard (ES) not established

PAL = NR 140 Preventive Action Limit

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.003	*N/A*	*GP-1*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
BEST *Brian*	*11/24/99*	*11/24/99*	*Geoprobe*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	*N/A*		*Feet MSL*	*Feet MSL*	*2 inches*

Boring Location		Local Grid Location (If applicable)
State Plane *N, E* *NI/4 of Gov. Lot 22, T 21N, R 18E*	Lat *N44° 0' 38"* Long *W88° 32'33"*	*Feet S* *Feet W*

County	DNR County Code	Civil Town/City/ or Village
Outagamie	*45*	*Kaukauna*

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
SS-1			2	Asphalt Brown, Silty **SAND AND GRAVEL**, moist. Basecourse. (Fill)				0 0 0						
			4	Black, Silty **CLAY**, with cinders, trace gravel and sand, moist. (Fill) End of probe at 4.0 feet.				0						
			6											
			8											
			10											
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Karen A Burkman Firm FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *Kaukauna Maintenance Garage*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*
Present Well Owner: *Same as above*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *GP-1*
WI Unique Well No.:
Reason For Abandonment: *No longer needed*
Date of Abandonment: *11/24/99*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *11/7/99*

- ☐ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☒ Borehole

Construction Report Available? ☐ Yes ☒ No

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☒ Other (Specify) *direct push*

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) _____ Casing Diameter (ins.) _____
(From groundsurface)

Casing Depth (ft.) _____

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet) _____

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☐ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☒ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Bentonite Crumbles	*Surface*	*4*	*1/10 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *BEST*
Signature of Person Doing Work: *Brian Boy KAB*
Date Signed: *12-13-99*
Street or Route: *P.O Box 12494*
Telephone Number: *1-800-326-1889*
City, State, Zip Code: *Green Bay, WI 54307-2429*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436 • 1-800-736-2436
FAX 920-469-8827

525 Science Drive
Madison, WI 53711
608-232-3300 • 1-888-536-2436
FAX: 608-233-0502

1423 N. 8th Street, Suite 122
Superior, WI 54880
715-392-5844 • 1-800-837-8238
FAX 715-392-5843

CHAIN OF CUSTODY

43164

Page ____ of ____

P.O. # ____ Quote # ____

Company Name: FISCHER
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: 920-766-2069
Project Number: 398132.002
Project Name: Kaukauna Garage
Project State: WI
Sampled By (Print): Beth / Ron

Regulatory Program *(circle)*: UST RCRA CLP SDWA NPDES/WPDES CAA NR____
Other ____

Mail Report To: Karen Burkman
Company: FISCHER
Address: Po Box 127 Kaukauna, WI 54130-2404

Invoice To: Kaukauna Garage
Company: C/o FISCHER
Address: ____

Mail Invoice To: Karen Burkman

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	FILTERED? (YES/NO)	PRESERVATION (CODE)*	ANALYSES REQUESTED: PVOC	Naphthalene	1,2-DCA	FIELD SCREEN	MATRIX	SHADED AREA FOR LABORATORY USE ONLY: GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
	mw-1	11/29	AM	N	B	X			NA	GW	✓	3-40ml		001
	mw-2										✓			002
	mw-3										✓	9-40ml		003
	mw-4					X						3-40ml		004
	mw-5					X								005
	mw-6													006
	SW-1					—								007
	SW-2													008
	Duplicate					X	X							009
	Trip Blank					X	X					1-40ml		010

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
Beth A. Erdman	11/29/99	B Kempen	11/30/99 1350
B Kempen	11/30/99 1540		
		[illegible]	11/30/99 1545

En Chem Project No.: 897319
Sample Receipt Temp.: ROI
Sample Receipt pH (Wet/Metals):
Custody Seal:

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.002

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
897319-001	MW-1	11/29/99			
897319-002	MW-2	11/29/99			
897319-003	MW-3	11/29/99			
897319-004	MW-4	11/29/99			
897319-005	MW-5	11/29/99			
897319-006	MW-6	11/29/99			
897319-007	SW-1	11/29/99			
897319-008	SW-2	11/29/99			
897319-009	DUPLICATE	11/29/99			
897319-010	TRIP BLANK	11/29/99			

Please visit our Internet homepage at: www.encheminc.com

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.

J. Durocher — 12/9/99

Approval Signature — Date

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.002
Field ID : MW-1
Lab Sample Number : 897319-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/6/99
Collection Date : 11/29/99
Matrix Type : WATER

Organic Results

PVOC + 1,2-DICHLOROETHANE - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/3/99 **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		12/3/99	SW846 8260B
1,2-Dichloroethane	3.9	0.37	1.2		ug/L		12/3/99	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		12/3/99	SW846 8260B
Methyl-tert-butyl-ether	2.8	0.32	1.0		ug/L		12/3/99	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		12/3/99	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		12/3/99	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		12/3/99	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		12/3/99	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		12/3/99	SW846 8260B
Dibromofluoromethane	89				%Recov		12/3/99	SW846 8260B
Toluene-d8	96				%Recov		12/3/99	SW846 8260B
4-Bromofluorobenzene	84				%Recov		12/3/99	SW846 8260B

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.002
Field ID : MW-2
Lab Sample Number : 897319-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/9/99
Collection Date : 11/29/99
Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** msb

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		12/3/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		12/3/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		12/3/99	MOD 8021B
Methyl-tert-butyl-ether	7.5	0.22	0.70		ug/l		12/3/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		12/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		12/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		12/3/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		12/3/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		12/3/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.002
Field ID : MW-3
Lab Sample Number : 897319-003
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/9/99
Collection Date : 11/29/99
Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** msb

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		12/3/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		12/3/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		12/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		12/3/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		12/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		12/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		12/3/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		12/3/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		12/3/99	MOD 8021B

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Project Name : KAUKAUNA GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-4

Report Date : 12/7/99

Lab Sample Number : 897319-004

Collection Date : 11/29/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC + NAPHT - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** MSB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	98				%Recov		12/6/99	MOD 8021B
Benzene	260	0.65	2.1		ug/l		12/6/99	MOD 8021B
Ethylbenzene	76	0.60	1.9		ug/l		12/6/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.55	0.55	1.8		ug/l		12/6/99	MOD 8021B
Naphthalene	6.6	2.2	7.0		ug/l	Q	12/6/99	MOD 8021B
Toluene	2.2	0.53	1.7		ug/l		12/6/99	MOD 8021B
1,3,5-Trimethylbenzene	< 1.4	1.4	4.5		ug/l		12/6/99	MOD 8021B
1,2,4-Trimethylbenzene	17	2.1	6.7		ug/l		12/6/99	MOD 8021B
Xylenes, -m, -p	20	2.4	7.6		ug/l		12/6/99	MOD 8021B
Xylene, -o	1.8	0.92	2.9		ug/l	Q	12/6/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-6

Report Date : 12/9/99

Lab Sample Number : 897319-006

Collection Date : 11/29/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** msb

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		12/3/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		12/3/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		12/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		12/3/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		12/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		12/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		12/3/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		12/3/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		12/3/99	MOD 8021B

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Project Name : KAUKAUNA GARAGE
Project Number : 398132.002
Field ID : MW-5
Lab Sample Number : 897319-005
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/6/99
Collection Date : 11/29/99
Matrix Type : WATER

Organic Results

PVOC + NAPHT - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** MSB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	105				%Recov		12/3/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		12/3/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		12/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		12/3/99	MOD 8021B
Naphthalene	< 0.89	0.89	2.8		ug/l		12/3/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		12/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		12/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		12/3/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		12/3/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		12/3/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.002
Field ID : SW-1
Lab Sample Number : 897319-007
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/9/99
Collection Date : 11/29/99
Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** msb

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		12/3/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		12/3/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		12/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		12/3/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		12/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		12/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		12/3/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		12/3/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		12/3/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : SW-2

Report Date : 12/3/99

Lab Sample Number : 897319-008

Collection Date : 11/29/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/1/99 **Analyst:** MSB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		12/3/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		12/3/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		12/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		12/3/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		12/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		12/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		12/3/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		12/3/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		12/3/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.002
Field ID : DUPLICATE
Lab Sample Number : 897319-009
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/8/99
Collection Date : 11/29/99
Matrix Type : WATER

Organic Results

PVOC + NAPHTHALENE - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/7/99 **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	98				%Recov		12/8/99	SW846 8260B
Dibromofluoromethane	88				%Recov		12/8/99	SW846 8260B
4-Bromofluorobenzene	89				%Recov		12/8/99	SW846 8260B
Benzene	320	0.68	2.2		ug/L		12/8/99	SW846 8260B
Ethylbenzene	100	0.80	2.5		ug/L		12/8/99	SW846 8260B
Methyl-tert-butyl-ether	4.6	0.80	2.5		ug/L		12/8/99	SW846 8260B
Toluene	2.1	0.68	2.2		ug/L	Q	12/8/99	SW846 8260B
1,2-Dichloroethane	< 0.92	0.92	2.9		ug/L		12/8/99	SW846 8260B
Naphthalene	7.0	0.87	2.8		ug/L		12/8/99	SW846 8260B
1,2,4-Trimethylbenzene	22	0.55	1.8		ug/L		12/8/99	SW846 8260B
1,3,5-Trimethylbenzene	< 0.68	0.68	2.2		ug/L		12/8/99	SW846 8260B
Xylenes, -m, -p	23	1.1	3.5		ug/L		12/8/99	SW846 8260B
Xylene, -o	1.7	0.60	1.9		ug/L	Q	12/8/99	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK

Report Date : 12/6/99

Lab Sample Number : 897319-010

Collection Date : 11/29/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC + NAPHTHALENE - WATER **Prep Method:** SW846 5030B **Prep Date:** 12/3/99 **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	97				%Recov		12/3/99	SW846 8260B
Dibromofluoromethane	85				%Recov		12/3/99	SW846 8260B
4-Bromofluorobenzene	85				%Recov		12/3/99	SW846 8260B
Benzene	< 0.27	0.27	0.86		ug/L		12/3/99	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		12/3/99	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0		ug/L		12/3/99	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		12/3/99	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		12/3/99	SW846 8260B
Naphthalene	< 0.35	0.35	1.1		ug/L		12/3/99	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		12/3/99	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		12/3/99	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		12/3/99	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		12/3/99	SW846 8260B

Company Name: FISCHER

Branch or Location: Kaukauna

Project Contact: Karen Burkman

Telephone: (920)766-2069

Project Number: 398132.003

Project Name: Kauk. Maint. Garage

Project Location: Kaukauna

Sampled By (Print): Karen Burkman

Regulatory Program *(circle)*: (UST) RCRA CLP SDWA
NPDES/WPDES CAA NR_____
Other PRCTEA

NR720 Confirmation Analysis Required? *(circle)*: (Y) N
(En Chem will not confirm unless otherwise instructed.)

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Page 1 of 1

P.O. # _____ Quote # _____

Mail Report To: Karen Burkman

Company: FISCHER

Address: PO Box 127
Kaukauna, WI 54130

Invoice To: City of Kaukauna

Company: c/o FISCHER

Address: _____

Mail Invoice To: Karen Burkman

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	ANALYSES REQUESTED: VOC (FILTERED? N; PRESERVATION (CODE)* F)	FIELD SCREEN	MATRIX	SHADED AREA FOR LABORATORY USE ONLY: GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
GP-1, 3 ft		11/24/99	10	X	-	S	X	1-5g 2-20gm		001
TB		↓	↓	X		F	↓	1-20ml		002

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
Karen Burkman	11/24/99	[illegible]	11/24/99 300
[illegible] 11/24/99	1545		
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By (En Chem):	Date/Time:

En Chem Project No. 997256

Sample Receipt Temp. 10 I

Sample Receipt pH (Wet/Metals)

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- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
897256-001	GP-1, 3FT	11/24/99			
897256-002	TB	11/24/99			

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The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.

J. Duraceau — 12/3/99

Approval Signature — **Date**

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- Analytical Report -

Project Name : KAUK. MAINT. GARAGE
Project Number : 398132.003
Field ID : GP-1, 3FT
Lab Sample Number : 897256-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/3/99
Collection Date : 11/24/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	80.5				%		11/29/99	SM2540G	SM2540G	DJB

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL Prep Method: SW846 5030B Prep Date: 11/29/99 Analyst: RJN

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromoform	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chloroform	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Dichlorodifluoromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60		ug/kg		12/1/99	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : GP-1, 3FT **Report Date :** 12/3/99

Lab Sample Number : 897256-001 **Collection Date :** 11/24/99

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

1,2-Dichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1-Dichloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,3-Dichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
2,2-Dichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1-Dichloropropene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Ethylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Isopropylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
p-Isopropyltoluene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Methylene chloride	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Naphthalene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
n-Propylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Styrene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,1,2-Tetrachloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Toluene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Trichloroethene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Vinyl chloride	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Xylenes, -m, -p	320	31	74	ug/kg	12/1/99	SW846 8260B
Xylene, -o	< 25	25	60	ug/kg	12/1/99	SW846 8260B
4-Bromofluorobenzene	83			%Recov	12/1/99	SW846 8260B
Dibromofluoromethane	82			%Recov	12/1/99	SW846 8260B
Toluene-d8	89			%Recov	12/1/99	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TB

Report Date : 12/1/99

Lab Sample Number : 897256-002

Collection Date : 11/24/99

WI DNR LAB ID : 405132750

Matrix Type : METHANOL

Organic Results

EPA 8260 VOLATILE LIST - METHANOL **Prep Method:** SW846 5030B **Prep Date:** 11/29/99 **Analyst:** RJN

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromochloromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromoform	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromomethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chloroform	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chloroethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chloromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/L		11/30/99	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Dibromomethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/L		11/30/99	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Dichlorodifluoromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dichloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,1-Dichloroethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,3-Dichloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B
2,2-Dichloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B

En Chem Inc.

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920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TB

Report Date : 12/1/99

Lab Sample Number : 897256-002

Collection Date : 11/24/99

WI DNR LAB ID : 405132750

Matrix Type : METHANOL

1,1-Dichloropropene	< 25	25	60	ug/L	11/30/99	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/L	11/30/99	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/L	11/30/99	SW846 8260B
Ethylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Isopropylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
p-Isopropyltoluene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Methylene chloride	< 25	25	60	ug/L	11/30/99	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/L	11/30/99	SW846 8260B
Naphthalene	< 25	25	60	ug/L	11/30/99	SW846 8260B
n-Propylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Styrene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,1,2-Tetrachloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Toluene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,4-Trimethylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Trichloroethene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,3,5-Trimethylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Vinyl chloride	< 25	25	60	ug/L	11/30/99	SW846 8260B
Xylenes, -m, -p	< 25	25	60	ug/L	11/30/99	SW846 8260B
Xylene, -o	< 25	25	60	ug/L	11/30/99	SW846 8260B
4-Bromofluorobenzene	103			%Recov	11/30/99	SW846 8260B
Dibromofluoromethane	92			%Recov	11/30/99	SW846 8260B
Toluene-d8	99			%Recov	11/30/99	SW846 8260B

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

RECEIVED
DEC 14 1999
LMD SOLID WASTE

December 9, 1999

COPY

Mr. James Moser
Wisconsin Department of Commerce
P.O. Box 7838
Madison, WI 53707-7838

RE: RESPONSE TO NOVEMBER 8, 1999 LETTER, Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, Wisconsin
FISCHER Project #398132.003
WDNR BRRT's #03-45-1729
PECFA #54130-2406-22

Dear Mr. Moser:

On behalf of Mr. John Sundelius, representative of the City of Kaukauna, FISCHER is responding to your November 8, 1999 letter where you indicate the Department of Commerce (COMM) "has determined that there are two occurrences at this site."

Based on our telephone conversation, it appears you are of the opinion that groundwater at the location of well MW-1 is impacted from another source and not the waste oil system or the gasoline and diesel fuel systems. You also indicated well MW-1 is not side gradient or down gradient of the gasoline/diesel fuel underground storage tanks (USTs).

Upon review of your letter, FISCHER contacted Mr. Greg Tilkens, project manager at the Wisconsin Department of Natural Resources (WDNR). Mr. Tilkens did not receive a copy of your letter and indicated you did not contact him to discuss your determination of two contaminant plumes. Therefore, FISCHER explained the contents of your letter and telephone conversation. Based on our brief conversation, Mr. Tilkens did not appear to agree with the determination that two plumes are present. Perhaps Mr. Tilkens, COMM, the client, and FISCHER should openly discuss your concerns.

OMNNI Associates (OMNNI) conducted an initial site investigation at the subject site near the waste oil UST. OMNNI's investigation did not center on the gasoline/diesel fuel USTs. OMNNI installed well MW-1 at a location OMNNI believed to be down gradient of the waste oil tank bed. Well MW-1 was initially sampled on April 12, 1994. The following compounds were detected in the groundwater sample: benzene, 1,2-dichloroethane (1,2-DCA), ethylbenzene, methyl-tert-butyl-ether (MTBE), m,p-xylenes, cadmium, and diesel range organics (DRO).

The following comments are based on FISCHER's experience at other petroleum-contaminated sites.

- The waste oil, gasoline, and/or diesel USTs could be the source of benzene. However, the most likely source is the gasoline USTs.

- The gasoline USTs are the most likely source of the 1,2-DCA, ethylbenzene, MTBE, and m,p-xylene contamination.

- The waste oil UST is the most likely source of the cadmium contamination.

- The diesel fuel and/or waste oil USTs are the most likely source of the DRO contamination.

Based on the initial groundwater analytical results associated with well MW-1, another source of contamination, in addition to the waste oil UST, appeared to be present. FISCHER was then contracted to investigate potential contamination associated with the gasoline and/or diesel fuel USTs. Soil and groundwater contamination associated with the gasoline and diesel fuel USTs were detected.

As part of FISCHER's investigation, three additional on-site groundwater monitoring wells and one bedrock piezometer were installed and sampled. Petroleum volatile organic compounds (PVOC), other volatile organic compounds (VOC) often detected at petroleum-contaminated sites, and polynuclear aromatic hydrocarbons (PAH) often associated with waste oil and/or diesel fuel USTs were detected in groundwater samples collected from the monitoring wells, except wells MW-3 and MW-6.

It is FISCHER's opinion, based on the analytical results for groundwater samples collected from the on-site wells, that the gasoline, diesel fuel, and waste oil USTs are all a source of contamination and that one co-mingled plume exists.

You expressed the opinion that well MW-1 was not side gradient or down gradient of the gasoline/diesel fuel USTs and therefore, groundwater contamination detected in well MW-1 could not have migrated from these USTs. Since you also expressed the opinion that the waste oil UST is not the source of some of the contaminants detected in well MW-1, specifically 1,2-DCA, you concluded another source of contamination exists.

FISCHER disagrees with your assessment of groundwater flow direction. The April 21, 1998 groundwater flow map presented in FISCHER's *Site Investigation Report*, dated October 2, 1998, portrayed groundwater flow to be southeasterly. Another FISCHER hydrogeologist subsequently reviewed this assessment and determined groundwater flow on that day to be more easterly. Therefore, based on groundwater levels measured on April 21, 1998, well MW-2 is down gradient of the gasoline/diesel fuel USTs but whether or not well MW-1 is side gradient or down gradient of the gasoline/diesel fuel USTs is not conclusive.

The September 16, 1998 groundwater flow map presented in FISCHER's *Site Investigation Report* portrayed groundwater flow to be easterly and southeasterly. Another FISCHER hydrogeologist subsequently reviewed this assessment and determined groundwater flow on that day to be more northeasterly. Therefore, based on groundwater levels measured on September 16, 1998, well MW-2 is down gradient of the gasoline/diesel fuel USTs but whether or not well MW-1 is side gradient or down gradient of the gasoline/diesel fuel USTs is not conclusive.

The April 8, 1999 groundwater flow map presented in FISCHER's *Remediation Documentation Report*, dated July 21, 1999, portrayed groundwater flow to be northeasterly. Therefore, based on groundwater levels measured on that day, well MW-2 is down gradient and well MW-1 is side gradient of the gasoline/diesel fuel USTs.

The site investigation area consists of fill overlying bedrock, and in some instances overlying clay over bedrock. Groundwater flow direction in an urban area, especially in fill areas, can be variable. The Fox River is located approximately 600 feet northeast of the site investigation area. Groundwater flow direction and levels may fluctuate due to variations in seasonal precipitation, including the elevation of the nearby river, lateral drainage conditions, and soil permeability characteristics. Groundwater contour maps depict groundwater flow direction representative of one time on one day. Groundwater flow direction can change.

Borings B-1 and B-11 were advanced between the gasoline/diesel fuel USTs and the waste oil UST. One soil sample was collected for laboratory analysis from the water table interface in boring B-1. Benzene and MTBE were detected. A soil sample was collected for laboratory analysis from the vadose zone in boring B-11. DRO and toluene were detected. Boring B-3 was converted to monitoring well MW-1. A soil sample was collected for laboratory analysis from the water table interface in boring B-3. M,p-xylenes were detected. Therefore, based on these analytical results, there is no data indicating "clean" soil or groundwater between the gasoline/diesel fuel USTs and well MW-1.

Related to the issue of contaminant sources, the WDNR recently denied case closure for two reasons. The WDNR requested another round of groundwater sampling to verify the contaminant concentrations detected after remediation. The WDNR was also concerned about a comment listed on OMNNI's soil boring log for boring B-3. On this log, it states, "solvent/paint odor" associated with the two to four foot soil sample. The WDNR questioned whether or not chlorinated solvents were present at the location of boring B-3, based on this comment. Since OMNNI did not analyze the soil sample reportedly emitting a solvent odor, the WDNR requested a sample be collected.

FISCHER recently collected a soil sample at three feet (ft) below ground surface (bgs) from a location one foot west of boring B-3 (well MW-1). The soil probe extended to four ft bgs and soil samples were field screened with a photoionization detector (PID). PID readings above background and unusual odors were not detected. A soil boring log indicates the presence of fill at the location of probe GP-1. The soil sample collected from probe GP-1, at three ft bgs, was analyzed for VOC. Only m,p-xylenes were detected above the laboratory's LOD. A copy of the analytical report is attached. Therefore, based on the PID and analytical results associated with the soil sample collected from the probe, solvents are not present. This verifies a separate non-petroleum related source of contamination is not present in the area of boring B-3. In addition, non-petroleum related VOC have not been detected in any of the groundwater samples collected.

Based on the soil and groundwater analytical results and assessments of groundwater flow direction, it is FISCHER's opinion that the waste oil, gasoline, and diesel fuel USTs are all sources of contaminants detected in well MW-1. Therefore, it is FISCHER's opinion that one co-mingled plume exists and that one WDNR BRRT's number is appropriate. Since only one plume exists, only one PECFA claim number and one PECFA claim deductible applies.

If you have questions or comments, please contact FISCHER.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb
Enclosures
C: Mr. John Sundelius – City of Kaukauna
Mr. Greg Tilkens - WDNR

Company Name: FISCHER

Branch or Location: Kaukauna

Project Contact: Karen Burkman

Telephone: (920)766-2069

Project Number: 398132.003

Project Name: Kauk. Maint. Garage

Project Location: Kaukauna

Sampled By (Print): Karen Burkman

Regulatory Program *(circle)*: UST RCRA CLP SDWA NPDES/WPDES CAA NR_____ Other PRCT-A

NR720 Confirmation Analysis Required? *(circle)*: Y N

(En Chem will not confirm unless otherwise instructed.)

EN CHEM INC.

1241 Bellevue St., Suite 9, Green Bay, WI 54302, 920-469-2436 • 1-800-736-2436, FAX 920-469-8827

525 Science Drive, Madison, WI 53711, 608-232-3300 • 1-888-536-2436, FAX: 608-233-0502

1423 N. 8th Street, Suite 122, Superior, WI 54880, 715-392-5844 • 1-800-837-8238, FAX 715-392-5843

CHAIN OF CUSTODY

24094

Page 1 of 1

P.O. # _____ Quote # _____

Mail Report To: Karen Burkman

Company: FISCHER

Address: PO Box 127, Kaukauna, WI 54130

Invoice To: City of Kaukauna

Company: c/o FISCHER

Address: _____

Mail Invoice To: Karen Burkman

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	ANALYSES REQUESTED: VOC (FILTERED? N; PRESERVATION (CODE)* F)	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
GP-1, 3 ft		11/24/99	10	X	-	S	X	1-5g 2-2oz		001
TB		↓	↓	X		F	↓	1-2oz		002

SHADED AREA FOR LABORATORY USE ONLY

*Preservation Code

A=None B=HCL C=H2SO4

D=HN03 E=EnCore F=Methanol**

G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
Karen Burkman	11/24/99	[illegible]	11/24/99 R01
[illegible] 11/24/99	1545		
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By (En Chem):	Date/Time:

En Chem Project No.: 99256

Sample Receipt Temp.: 10 I

Sample Receipt pH (Wet/Metals):

ENCHEM INC.

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Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
897256-001	GP-1, 3FT	11/24/99			
897256-002	TB	11/24/99			

Please visit our Internet homepage at: www.encheminc.com

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.

J. Duraccan — Approval Signature

12/3/99 — Date

En Chem Inc.

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Green Bay, WI 54302
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800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. MAINT. GARAGE
Project Number : 398132.003
Field ID : GP-1, 3FT
Lab Sample Number : 897256-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/3/99
Collection Date : 11/24/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	80.5				%		11/29/99	SM2540G	SM2540G	DJB

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL Prep Method: SW846 5030B Prep Date: 11/29/99 Analyst: RJN

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromoform	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
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n-Butylbenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chloroform	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		12/1/99	SW846 8260B
Dichlorodifluoromethane	< 25	25	60		ug/kg		12/1/99	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60		ug/kg		12/1/99	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

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Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax 920-469-8827

- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : GP-1, 3FT

Report Date : 12/3/99

Lab Sample Number : 897256-001

Collection Date : 11/24/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,2-Dichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1-Dichloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,3-Dichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
2,2-Dichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1-Dichloropropene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Ethylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Isopropylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
p-Isopropyltoluene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Methylene chloride	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Naphthalene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
n-Propylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Styrene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,1,2-Tetrachloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Toluene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Trichloroethene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/kg	12/1/99	SW846 8260B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Vinyl chloride	< 25	25	60	ug/kg	12/1/99	SW846 8260B
Xylenes, -m, -p	320	31	74	ug/kg	12/1/99	SW846 8260B
Xylene, -o	< 25	25	60	ug/kg	12/1/99	SW846 8260B
4-Bromofluorobenzene	83			%Recov	12/1/99	SW846 8260B
Dibromofluoromethane	82			%Recov	12/1/99	SW846 8260B
Toluene-d8	89			%Recov	12/1/99	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. MAINT. GARAGE
Project Number : 398132.003
Field ID : TB
Lab Sample Number : 897256-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 12/1/99
Collection Date : 11/24/99
Matrix Type : METHANOL

Organic Results

EPA 8260 VOLATILE LIST - METHANOL — Prep Method: SW846 5030B — Prep Date: 11/29/99 — Analyst: RJN

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromochloromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromoform	< 25	25	60		ug/L		11/30/99	SW846 8260B
Bromomethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chloroform	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chloroethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Chloromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/L		11/30/99	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
Dibromomethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/L		11/30/99	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/L		11/30/99	SW846 8260B
Dichlorodifluoromethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,2-Dichloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,1-Dichloroethane	< 25	25	60		ug/L		11/30/99	SW846 8260B
1,3-Dichloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B
2,2-Dichloropropane	< 25	25	60		ug/L		11/30/99	SW846 8260B

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- Analytical Report -

Project Name : KAUK. MAINT. GARAGE

Project Number : 398132.003 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : TB **Report Date :** 12/1/99

Lab Sample Number : 897256-002 **Collection Date :** 11/24/99

WI DNR LAB ID : 405132750 **Matrix Type :** METHANOL

1,1-Dichloropropene	< 25	25	60	ug/L	11/30/99	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/L	11/30/99	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/L	11/30/99	SW846 8260B
Ethylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Isopropylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
p-Isopropyltoluene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Methylene chloride	< 25	25	60	ug/L	11/30/99	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/L	11/30/99	SW846 8260B
Naphthalene	< 25	25	60	ug/L	11/30/99	SW846 8260B
n-Propylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Styrene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,1,2-Tetrachloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Toluene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,4-Trimethylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Trichloroethene	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/L	11/30/99	SW846 8260B
1,3,5-Trimethylbenzene	< 25	25	60	ug/L	11/30/99	SW846 8260B
Vinyl chloride	< 25	25	60	ug/L	11/30/99	SW846 8260B
Xylenes, -m, -p	< 25	25	60	ug/L	11/30/99	SW846 8260B
Xylene, -o	< 25	25	60	ug/L	11/30/99	SW846 8260B
4-Bromofluorobenzene	103			%Recov	11/30/99	SW846 8260B
Dibromofluoromethane	92			%Recov	11/30/99	SW846 8260B
Toluene-d8	99			%Recov	11/30/99	SW846 8260B

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Ronald W. Kazmierczak, Regional Director

Northeast Region Headquarters
Green Bay Service Center
1125 N. Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448
Telephone 920-492-5800
FAX 920-492-5913
TDD 920-492-5912

November 10, 1999

City of Kaukauna
John Sundelius
201 2nd Street
Kaukauna, WI 54130

SUBJECT: Closure - Kaukauna City Waste Oil Site, WDNR BRRTS ID #: 03-45-001729

Dear Mr. Sundelius:

Your case file was recently submitted to the Bureau for Remediation and Redevelopment's Northeast Region Closeout Committee. This panel reviews environmental remediation cases for compliance with state laws, standards and guidelines to maintain consistency in the closeout of cases. After careful review, the panel has decided this case cannot be closed at this time. We believe the following additional work must be completed before the case is further reviewed for closure.

- Soil contamination at boring location B-3 (MW-1) must be further investigated for direct contact concerns.

- A minimum of one additional round of groundwater samples analyzed for PVOC and naphthalene to evaluate post remediation contaminant trend.

If you have additional relevant information concerning this matter which was not formerly provided to the Department, and which you feel would significantly impact the Department's closure decision, you may submit that information for our re-evaluation of case closure.

If you have any questions, please contact me at (920) 492-5868.

Sincerely,

Greg Tilkens, P.G.
Hydrogeologist
Remediation & Redevelopment Program

cc: Karen Burkman; Fischer; PO Box 127; Kaukauna, WI 54130
Dale Ziege RR/3

TO: Tilkens

FROM: NER Closure Committee

DATE: 11-8-99

_____ Closure Approved - No Restrictions

_____ Closure Approved With Restrictions

X Closure Denied

Send Appropriate Letter

Final 11-1-99

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
CASE SUMMARY AND CLOSE OUT FORM

Form4400-202
Rev. 5/98

WDNR BRRTS Case #: 03-45-001729 WDNR Site Name: ~~Kaukauna Maintenance Garage~~ Kaukauna City - Waste Oil

NOTE: Use of this form is required by the Department for any case close out application filed pursuant to ch. 292, Wis. Stats. and ch. NR 726, Wis. Adm. Code. Completion of this form is mandatory for the applications case closure. The Department will not consider or act upon your application unless you complete and submit this application form. It is not the Department's intention to use any personally identifiable information from this form for any purpose other than reviewing close out requests and determining the need for additional response action.

I certify that, to the best of my knowledge, the information presented on and attached to this form is true and accurate. This recommendation for case closure is based upon all available data as of _____(date). I have read the Case Summary and Close Out Form Instructions and all required information has been included.

Form Completed By: Karen A Burkman 9/1/99
(Signature) (Date)

Printed Name: Karen A. Burkman Company Name: FISCHER Environmental

If not site owner, relationship to site owner: contracted environmental consultant

Address: P. O. Box 127, Kaukauna, WI 54130

Telephone Number: (920) 766-2069 FAX Number: (920) 759-2669

Environmental Consultant (if different then above)_____

Address:_____

Telephone Number: (____) _____ FAX Number: (____) _____

FOR DEPARTMENT USE ONLY

Type of Case: LUST Spill ER Land Recycling Other_____ DNR Reviewer: Tilkens

WDNR Site Name: ~~Kaukauna Maintenance Garage~~ City - Waste Oil Collection Site

Complete Site Address: 222 3rd Street, Kaukauna, Wisconsin

WDNR BRRTS Case #: 0 3 - 4 5 - 0 0 1 7 2 9 FID #: 3 9 6 0 0 5 4 7 9

PECFA Claim #: 5 4 1 3 0 - 2 4 0 6 - 2 2

Responsible Party Name: City of Kaukauna - Mr. John Sundelius

Complete Responsible Party Address: 201 2nd Street, Kaukauna, WI 54130

Site Legal Description : NE ¼, Gov Lot 22, T 21N, R 18 E Town: City of Kaukauna

County: Outagamie Latitude: ___° ___'___ ___.___" Longitude: ___° ___'___ ___.___"

Type Of Closure Requested: Soil

Groundwater

_X_ < NR 720.09/720.11 Generic RCLs ____ < NR 140.10 Table 1 & Table 2 Values
___ NR 720.19(2) Soil Performance Stds. ___ NR 140.28(2) PAL Exemption
___ NR 720.19(3) Site Specific Stds. _X_ NR 726.05(2)(b) Natural Attenuation

WDNR BRRTS Case #: 03-45-001729 WDNR Site Name: Kaukauna Maintenance Garage

Contaminant Type(s): petroleum Quantity Released: unknown

Date of Incident/Discovery: 12/93 Zoning of Property: Institutional
Enforcement Actions Closed Out? ___Yes ___No __X__NA Permits Closed Out? ? ___Yes ___No __X__NA

1. CASE HISTORY AND JUSTIFICATION FOR CLOSURE ATTACHED? __X__Yes ___No

2. SOIL PRE-REMEDIATION OR INVESTIGATION ANALYTICAL RESULTS
Extent Defined? __X__Yes ___No Soil Type(s): fill over clay (CL) – $2.2x10^{-7}$ cm/sec Depth to Bedrock: 8.5 feet

Potential Receptors for Direct Contact (i.e. vapor migration, contaminated soil left in place): none known

Tables of Pre-remedial Analytical Results Attached? __X__Yes ___No Maps of Pre-remedial Sample Locations Attached? __X__Yes ___No

3. SOIL POST REMEDIATION ANALYTICAL RESULTS
Remedial Action Completed? __X__Yes ___No 720.19 Analysis? ___Yes __X__No (If yes, attach supporting documentation)

Were Soils Excavated? __X__Yes ___No Quantity: 1389.75 tons Disposal Method: bioremediation treatment

Final Confirmation Sampling Methods: by hand – backhoe bucket

Soil Disposal Form Attached? __X__Yes ___No Final Disposal Location: Ridgeview BioSite in Whitelaw, WI

Estimated volume of insitu soils exceeding NR 720 RCLs: lead limited in vadose zone (see Case Summary)

Tables for Post Remedial Analytical Results Attached? __X__Yes ___No Maps of Post Remedial Sample Locations Attached? __X__Yes ___No
Brief Description of Remedial Action Taken: soil excavation

4. GROUNDWATER ANALYTICAL RESULTS
Potential Receptors for Groundwater Migration Pathway: none known

Extent of Contamination Defined? __X__Yes ___No ___NA Remedial Action Completed? ___Yes ___No __X__NA

# of Sample Rounds: 6 Depth(s) to GW/Flow Direction(s): approx. 3.4-4.5 feet ; generally interpreted to be southeasterly

Field Analyses? ___Yes __X__No Lab Analyses? __X__Yes ___No # of Sampling Points: 8

NR 141 Monitoring Wells Sampled: 5 # Temporary Groundwater Sampling Points Sampled: 0

Recovery Sumps Sampled: 2(sump wells) # Municipal Wells Sampled: 0 # Private Wells Sampled: 0

Has DNR Been Notified of Substances in Groundwater w/o Standards? __X__Yes ___No

Any Potable Wells Within 1200 Feet of Site? ___Yes __X__No If Yes, How Many?

Have They Been Sampled? ___Yes ___No Have Well Owners/Occupants Been Notified of Results? ___Yes ___No

Preventive Action Limit Exceeded? __X__Yes ___No (If Yes, identify location(s) most recent results = MW-1, MW-4, SW-1

Enforcement Standard Exceeded? __X__Yes ___No (If Yes, identify location(s) most recent results = MW-4

Tables of Analytical Results Attached? __X__Yes ___No Map of Groundwater Sample Locations Attached? __X__Yes ___No

Brief Description of Remedial Action Taken: remediation by natural attenuation

WDNR BRRTS Case #: 03-45- 001729 WDNR Site Name: Kaukauna Maintenance Garage

FOR DEPARTMENT USE ONLY

FIRST REVIEW DATE: 11-1-99 **[ ] Approved [X] Denied**

(Signature) (Signature) (Signature) (Signature)

SECOND REVIEW DATE: _____ **[ ] Approved [ ] Denied**

(Signature) (Signature) (Signature) (Signature)

COMMITTEE RECOMMENDATION:

_____ **Closure Approved Per:**

- _____ No Restrictions
- _____ Groundwater Use Restriction
- _____ Zoning Verification
- _____ Deed Restriction
- _____ Deed Affidavit
- _____ Site Specific Close Out Letter Necessary
- _____ Well Abandonment Documentation
- _____ Soil Disposal Documentation
- _____ Public Notice Needed
- _____ NR 140 Exemption For: _____
- _____ Specific Comments: _____

X **Closure Denied, Needs More:**

- X Investigation of soils at MW-1/B-3 location to establish PVOC direct contact concerns
- X Groundwater Monitoring minimum of one additional round PVOC & Napthalene to establish post remediation trend for NA closure
- _____ Soil Remediation
- _____ Groundwater Remediation
- _____ Documentation Of Soil Landspreading Or Biopile Destiny
- X Specific Comments: Closure will require soil deed restrictions at MW-5/B-15 for BETX; MW-2/B-6 for lead and at excavation north side for lead

Will also need well use restriction ~~at~~ MW-4 (Benzene, Napthalene and Iron) Also MW-1 (Iron) ~~dependent~~ dependent upon further monitoring.

TO: Closure Committee
FROM: Tilkens

Soil is fill to approximately 8 ft, then weathered bedrock grading to competent rock (dolomite). Watertable is at approximately 5 ft bgs One soil sample was tested for lab perm. at 10^{-7} (no field tests done), all boring logs indicate soil type as "fill" except B-15 which indicates a large percentage sand. Considering that together with the fact that bedrock is very near the surface, I think this site should be considered "permeable" (note that the consultant considers the site to be low permeability based on the one lab perm test).

Release reported as part of underground waste oil tank piping upgrade. Leak from piping found through tightness testing.

5 borings installed, 1 monitoring well Pgs 7-10

High PID response at B-3 2-4 ft bgs, soils were noted to smell of solvent, not waste oil. Note soil from 4-6 ft bgs was lab analyzed rather than the contaminated surface soils from the boring.

Other tanks on site investigated (pg 11) Tanks contained diesel and gas.

11 more borings installed (pg 12)

Field screening and boring sample analysis Pgs 13-15

Borings B-6, B-9, and B-15 only locations with unsaturated soil with high PIDs above the watertable

Borings B-6, B-8, B-9, and B-15 have RCL exceedances above watertable.

Note high PID response at B-8 at depth , yet a shallow sample is lab analyzed. In fact, this shallow sample was only one analyzed for PAHs

Pg 16 - Their map of soil contamination extent

Pg 17 - X-section. Note soil sample RCL exceedances above watertable

Remediation

Three tanks identified on pg 18 were removed from the site and 1 upgraded. The consultant acknowledges that contaminated soil my remain under the upgraded tank.

Excavation as shown on pg 19

Soil went to Ridgeview LF biopile (receipts submitted)

Pg 20-21 is soil confirmation sample results.

From closure rpt. " only one sidewall sample could be collected before the waste oil excavation required backfilling in order to prevent damage to utilities". Note that the ones sample was taken from the opposite side of the tank from the adjacent boring location where high PID and solvent odor were noticed.

The consultant states that "water rapidly flowed into the excavation" and pictures show a pool of water during excavation – further evidence that these soils are not low permeability.

So, soil contamination remains at MW-1 where a PID response of 1,000 and soils that smelled of solvent were present from 2-4 ft bgs (pg 8); at MW-5 (B-15) where all BTEX exceed the RCL 2.5 – 4.5 ft bgs, in fact benzene exceeds the COMM 46 # (pg 15); at MW-2 (B-6) where Pb exceeds RCL 1-3 ft bgs (pg 14); and excavation confirmation point N-Side where Pb exceeds RCL at 3 ft bgs (pg 21)

Pj 22 is a post remediation x-section.

Pj 23 is post remediation site map.

Groundwater

Pgs 24-16 are groundwater flow maps. The April '99 flow direction is disturbing, but is based on measurements taken 2 months after excavation backfilling (possibly before groundwater is in equilibrium) so may not be representative. The NA data from wells MW-1 and 6 indicates they are down gradient wells as shown on the other 2 maps. I think the April '98 and September '98 maps are representative of groundwater flow.

Groundwater data is pgs 27-32

Regarding equilibrium, note there is only one groundwater sample taken after the excavation (2 months after). I don't think that sample result should be considered representative either.

SW-1 and SW-2 are sumps installed during excavation backfilling (on pg 23).

NA parameters between the upgradient well (MW-3) and contaminated well MW-4 indicate NA is happening although there is very little DO available from upgradient. Since MW-1, 4, and 6 all have elevated methane, and MW-1 and 4 have elevated Fe, it looks like methanogenesis and Fe reduction may be the dominant NA mechanisms at the site.

Note that Fe in MW-4 and MW-1 is way over the Fe ES (33 times the ES).

The concentration trends in the contaminated wells is favorable, but is based on only 3 rounds of data (MW-2 and 4) one of which was collected 2 months after excavation that may not be representative of static conditions.

COMM 46

Environmental Factors –

Expanding plume - From data provided plume looks receding, but there are few rounds and the last data point may not represent static conditions.

Potable well PAL exceedance - No wells reported to be in area.

Contamination within 1 meter of bedrock – Yes. Groundwater is at 4-5 ft bgs, bedrock is at approximately 10, so any groundwater contamination is likely within 1 meter of bedrock. There is a well in bedrock/weathered bedrock (MW-5) which in the most recent round tested clean, I have static conditions concern again, but before excavation the only exceedance in the well was 5.5 benzene.

Free product - None reported.

Surface Water or Wetland discharge - None reported.

Risk Criteria

Off-site Contamination - None reported. Contamination seems contained within area bounded by site buildings.

Direct Contact - Yes. At MW-1 where a PID response of 100 and soils that smelled of solvent were present from 2-4 ft bgs (pg 8); MW-5 (B-15) where all BTEX exceed the RCL 2.5 – 4.5 ft bgs, in fact benzene exceeds the COMM 46 # (pg 15); MW-2 (B-6) where Pb exceeds RCL 1-3 ft bgs (pg 14); and excavation confirmation point N-Side where Pb exceeds RCL at 3 ft bgs (pg 21)

Contamination > ESx300 - N/A since I don't think the site meets low permeability criteria.

5 Foot separation to developable groundwater/decreasing concentration with depth - The deepest boring in the contaminated area contains decreasing soil contamination with depth.

Impacts to receptors - None reported.

ES exceedance within 1000 feet of Public well - Not reported.

ES exceedance within 100 feet of Private well - No well reported present on site

Recommendation

Deny closure. Request:

Investigation of soil contamination in area of MW-1 (B-3) (Note that a groundwater sample from MW-1 was analyzed for VOCs and no compounds except for BTEX + 1,2 DCA were detected)

Collect additional groundwater samples to document contamination status after excavation when site is in equilibrium

Excavate soils which pose a direct contact threat. See "Direct Contact", above, minus the soils at MW-1(B-3)

Define extent of Fe down gradient, monitor groundwater to show NA of Fe

If committee chooses closure:

Deed restriction requiring institutional control (cap) for soils that pose direct contact threat for soils identified under "Direct Contact", above, minus the soils at MW-1 (B-3)

General deed restriction for soils at MW-1(B-3)

Groundwater use restriction for benzene and Fe at MW-4, and Fe at MW-1

CASE SUMMARY
KAUKAUNA MAINTENANCE GARAGE

The Kaukauna Maintenance Garage is located at 222 West 3rd Street, Kaukauna, Wisconsin (WI). The subject site is owned and operated by the City of Kaukauna and is currently used as a municipal maintenance garage. Five underground storage tanks (USTs) are registered with the Department of Commerce (COMM) for the site: two 10,000-gallon diesel fuel, one 10,000-gallon leaded gasoline, one 10,000-gallon unleaded gasoline, and one 550-gallon waste oil UST. The 10,000-gallon unleaded gasoline UST was upgraded and left in place and one new 10,000-gallon diesel fuel UST was installed. The remaining three USTs were removed from the site during the remedial excavation activities.

OMNNI Associates (OMNNI) previously conducted a site investigation during which five soil borings were advanced at the site and one boring was converted into groundwater monitoring well MW-1. Based on a review of OMNNI's *Site Investigation Report*, dated June 1994, it was FISCHER's opinion that the extent of contamination from the other site USTs was not adequately defined.

The City of Kaukauna contracted FISCHER on February 18, 1998 to perform a site investigation to further define the extent of contamination. As part of the site investigation activities, 11 soil borings were advanced at the site; four were converted into groundwater monitoring wells and one was converted into a bedrock piezometer.

The vertical and horizontal extent of soil and groundwater contamination on-site was defined for the purposes of the site investigation. Contamination was detected within one meter of bedrock, and, therefore, an "environmental factor", as defined in COMM 47, was present.

FISCHER evaluated remedial alternatives and submitted a *Remedial Action Plan* (RAP), dated October 5, 1998. FISCHER proposed to address the "environmental factor" and contaminants by excavating a portion of the impacted soil and conducting additional groundwater monitoring.

From February 23 through 25, 1999, 1,389.75 tons of petroleum-impacted soil were excavated from two areas on the site and transported to the Ridgeview BioSite for bioremediation treatment. In order to excavate soil to bedrock to eliminate the "environmental factor", 203,985 gallons of groundwater were pumped from the largest excavation and transported to the Heart of the Valley municipal treatment plant located in Kaukauna. Two sump wells were installed during remedial excavation backfill operations.

Closure soil samples were collected from the base and sidewalls of the final excavations to verify any remaining contaminant concentrations. Analytical results indicate the majority of soil with contaminant concentrations exceeding Wisconsin Administrative Code (WAC) Chapter NR 720 generic residual contaminant levels (RCLs) has been excavated. One post-excavation groundwater monitoring event has been performed and the analytical results indicate soil remediation and natural attenuation have reduced contaminant concentrations in the groundwater.

JUSTIFICATION FOR CLOSURE
KAUKAUNA MAINTENANCE GARAGE

In accordance with rule COMM 47, FISCHER evaluated five "environmental factors". Prior to source removal (excavation and off-site bioremediation treatment of 1,389.75 tons of impacted soil), one "environmental factor" appeared to be present. Impacted soil was located within one meter of bedrock. The "environmental factor" was eliminated during remedial activities, with the exception of impacted soil possibly located beneath the UST that was upgraded.

Closure soil samples were collected during remedial excavation activities. Only one of the 16 closure samples had a contaminant concentration (lead) exceeding generic RCLs and was collected from the vadose zone. It is FISCHER's opinion that a deed restriction is not warranted for the following reasons.

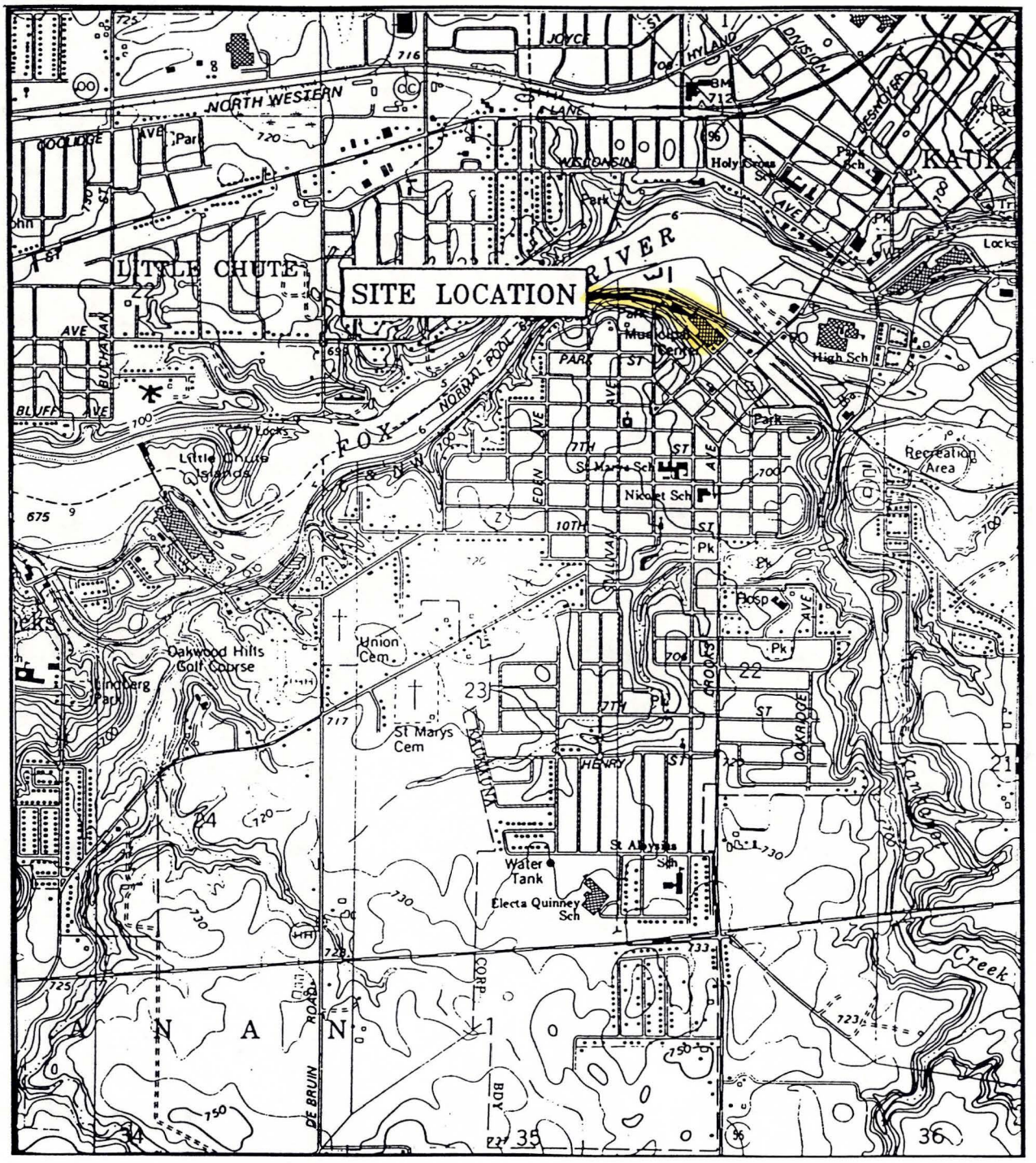
- only one sample collected from the vadose zone exceeded the generic RCL;
- only the RCL for lead was exceeded in the closure sample;
- the excavation could not extend laterally beyond the closure sample location where an RCL exceedance was detected due to the presence of the building;
- the site is currently paved;
- the site will remain paved in the foreseeable future; and
- exposure by direct contact is not anticipated.

Laboratory analytical results of groundwater samples from monitoring wells MW-1, MW-2, MW-3, MW-5 and MW-6, and sump wells SW-1 and SW-2 during April 1999 did not have contaminant concentrations exceeding NR 140 enforcement standards. Prior to soil remediation, benzene was detected in monitoring well MW-2 and piezometer MW-5 at concentrations above the NR 140 enforcement standard. Therefore, remedial activities and natural attenuation appear to have reduced contaminant concentrations in groundwater at the locations of well MW-2 and bedrock piezometer MW-5.

Only benzene was detected at a concentration above the NR 140 enforcement standard in the groundwater sample collected from well MW-4 during April 1999. The benzene concentrations detected in groundwater samples collected from well MW-4 have decreased by approximately 50% subsequent to the remedial excavation activities. Prior to soil remediation, naphthalene, trimethylbenzenes, and xylenes had also been detected in groundwater samples collected from well MW-4 at levels above the NR 140 enforcement standards. Therefore, remedial activities and natural attenuation appear to have reduced contaminant concentrations in groundwater at the location of well MW-4.

FISCHER reviewed COMM 46 as it relates to the remediation status of this site. Based on the most recent groundwater analytical results, only benzene in well MW-4 is present at a concentration exceeding the NR 140 enforcement standard. The benzene concentration, 1,100 micrograms per liter (ug/l), is less than 300 times the NR 140 enforcement standard of 5 ug/l. Groundwater contamination has not been detected off-site.

Source control has been implemented to essentially eliminate the "environmental factor" and enhance remediation by natural attenuation. The site does not appear to pose additional risk. Therefore, it is FISCHER's opinion that this site meets the criteria for closure with a groundwater use restriction.



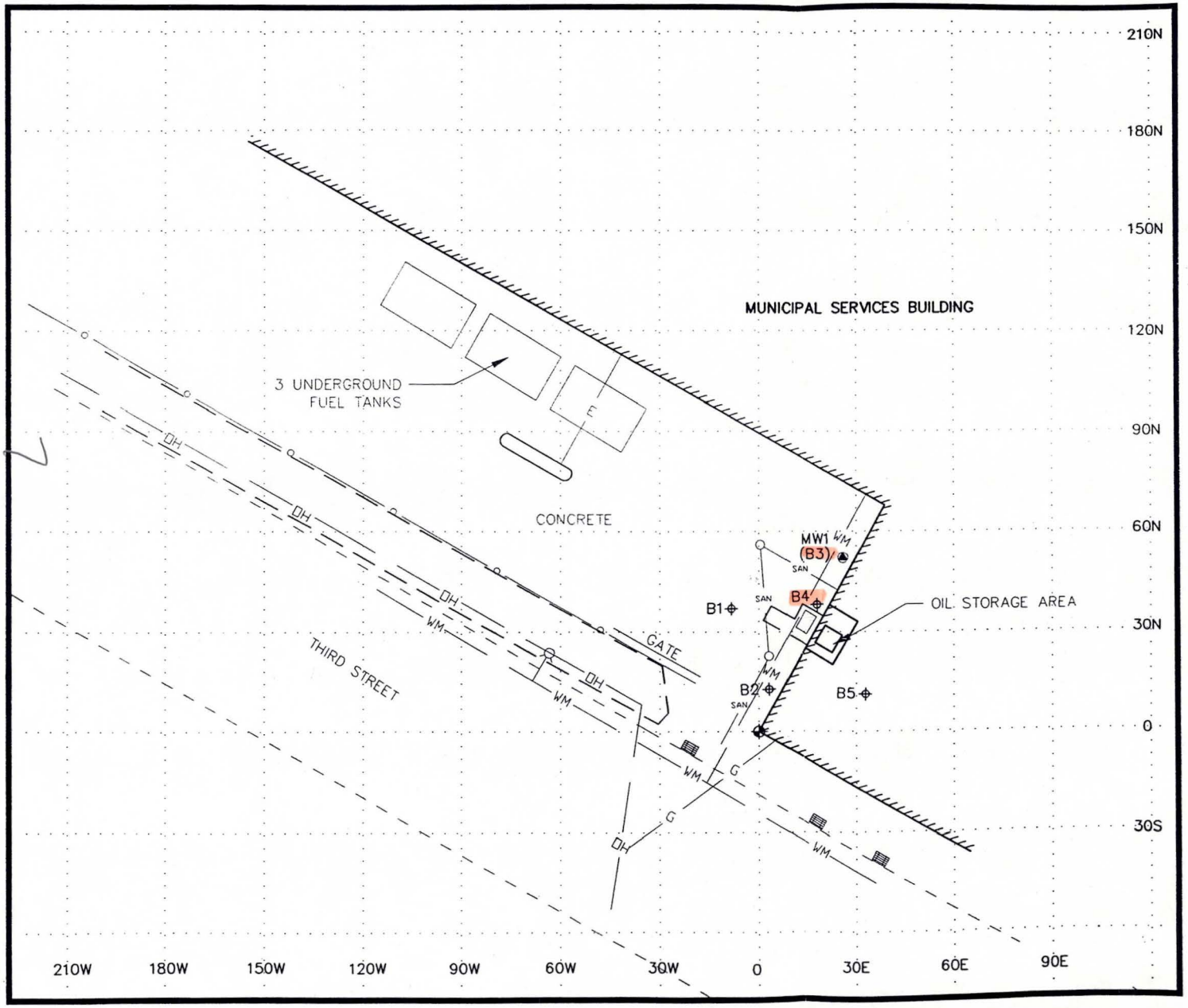
KAUKAUNA QUADRANGLE
U.S.G.S. 7.5 MINUTE SERIES
(TOPOGRAPHIC) OUTAGAMIE COUNTY
WISCONSIN

N

SCALE: 1:24,000

FIGURE 1: SITE LOCATION MAP

FISCHER RIPON OFFICE P.O. BOX 552, RIPON, WI 54971 KAUKAUNA OFFICE P.O. BOX 127, KAUKAUNA, WI 54130	JOB #:398132.003 DATE: 5/12/99 ID#: RAP\FIG1	**KAUKAUNA MAINTENANCE GARAGE** **KAUKAUNA, WISCONSIN** **CLOSURE REQUEST**



LOCAL GRID NORTH
N

0' 8' 15' 30'
SCALE: 1" = 30'

LEGEND:

- MW1 ▲ WELL LOCATION AND I.D. No.
- B1 ⌖ SOIL BORING LOCATION AND I.D. No.
- APPROXIMATE LOCATION OF 550 GALLON WASTE OIL TANK
- PUMP ISLAND
- SAN —○— SANITARY SEWER AND MANHOLE
- G — NATURAL GAS
- WM — WATERMAIN
- OH — OVERHEAD UTILITIES
- E — ELECTRICAL LINE
- HYDRANT
- EDGE OF ASPHALT
- EDGE OF STREET
- FENCE
- BUILDING FACE
- 30N GRID LINE (30' INTERVAL)
- REFERENCE POINT

FIGURE 2
SITE DETAIL MAP

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

303 SOUTH BLUEMOUND DRIVE APPLETON, WI 54914
PHONE : (414) 739-7814 FAX : (414) 739-7765

PROJECT :	N1019B
CAD FILE:	N1019B3.DWG
DRAWN :	DLD
DATE :	3/1/94
REVIEWED :	

TABLE 1
SUMMARY OF FIELD HEADSPACE ANALYSIS
SOIL BORING SAMPLES
CONCENTRATION IN PPM (ISOBUTYLENE EQUIVALENTS)
MARCH 21, 1994, SAMPLING EVENT

SAMPLE ID	SAMPLE LOCATION	DEPTH (FEET)	PID	SOIL CHARACTERISTICS
B1–1	Boring B1	2.0 – 4.0	4.0	Black silt with gravel fill. Slight odor?
* B1–2		4.0 – 6.0	10.0	Brown sand with silt and gravel. No odor.
B1–3		6.0 – 8.0	10.0	Brown clay. No odor.
B1–4		8.0 – 10.0	5.0	Brown clay with gravel.
B2–1	Boring B2	2.0 – 4.0	4.0	Brown silt with some gravel and cinders. No odor.
B2–2		4.0 – 6.0	3.0	Brown clay with gravel. No odor.
* B2–3		6.0 – 8.0	3.0	Brown clay with gravel. No odor.
B2–4		8.0 – 10.0	3.0	Tight red brown clay with no gravel. No odor.
B3–1	Monitoring Well MW1	2.0 – 4.0	1000	Black silt (fill) with cinders and gravel. Solvent/paint odor
* B3–2		4.0 – 6.0	93.0	Brown clay with some tan sand and gravel. No odor.
B3–3		6.0 – 8.0	3.0	Brown clay with gravel. No odor.
B3–4		8.0 – 10.0	1.0	Brown clay with gravel. No odor.
B4–1	Boring B4	2.0 – 4.0	0.0	Black silt with cinders (fill) and gravel. No odor.
B4–2		4.0 – 6.0	111	Clay with gravel and sand. Waste oil odor at tip.
* B4–3		6.0 – 8.0	15.0	Clay with gravel and sand. Some waste oil odor to 7 feet.
B4–4		8.0 – 10.0	0.0	Red brown clay. No odor.
B5–1	Boring B5	1	0.0	Silt with sand. No odor.
* B5–2		2.0 – 4.0	0.0	Silt with some gravel. No odor.
B5–3		4.0 – 6.0	0.0	Silt with wood organics. No odor.
B5–4		6.0 – 8.0	0.0	Silt. No odor.

* = sample sent in for laboratory analysis

TABLE 2
SUMMARY OF LABORATORY ANALYSIS
SOIL BORING SAMPLES
MARCH 21, 1994 SAMPLING EVENT

PARAMETER	GUIDE	B1-2	B2-3	B3-2	B4-3	B5-2
SAMPLE DEPTH (feet)	-	4.0 - 6.0	6.0 - 8.0	4.0 - 6.0	6.0 - 8.0	2.0 - 4.0
DIESEL RANGE ORGANICS (mg/kg)	250	ND	ND	ND	280	12
DETECTED PCBs (µg/kg)	-	NA	NA	NA	ND	NA
CADMIUM (mg/kg)	-	NA	NA	NA	0.03	NA
LEAD (mg/kg)	50	NA	NA	NA	4.4	NA
DETECTED PAHs (µg/kg)	-	NA	NA	NA	ND	NA
DETECTED PVOCs (µg/kg)						
BENZENE	5.5	1.7	ND	ND	ND	ND
ETHYLBENZENE	2900	ND	ND	ND	2.4	ND
MTBE	-	3.1	ND	ND	ND	ND
m,p-XYLENE	4100	ND	ND	380	12	ND
o-XYLENE	4100	ND	ND	ND	1.1	ND

NA = not analyzed
ND = not detected
[ ] = sample concentrations detected over the DNR guideline

TABLE 3
SUMMARY OF LABORATORY ANALYSIS
GROUNDWATER
APRIL 12, 1994, SAMPLING EVENT

PARAMETER (µg/L)	ES	PAL	MW1
DETECTED VOCs			
BENZENE	5	0.5	1.2
1,2-DICHLOROETHANE	5	0.5	4.9
ETHYLBENZENE	700	140	3.6
MTBE	65	12	17
m,p-XYLENE	620	124	23
DIESEL RANGE ORGANICS	-	-	690
CADMIUM	5	0.5	0.1

ES = enforcement standard
PAL = preventive action limit
[ ] = sample concentrations detected over the preventive action limit

Analyzed for full VOCs
Cadmium & Lead

No PAHs ?

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN
WEST 3RD STREET
PP
W
E
G
FH
FILL PIPES
10,000 GALLON UST
DISPENSER ISLAND
SA
B-1
B-2
B-3
B-5
MW-1
550 GALLON WASTE OIL TANK
GATE
N
1'5' 0 15' 30'
SCALE: 1" = 30'
NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE
SUMP WELLS BY OTHERS
MONITORING WELL BY OMNNI
SOIL BORING BY OMNNI
FIGURE 2: SITE PLAN
300132.002
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION
Fischer Environmental, Inc.

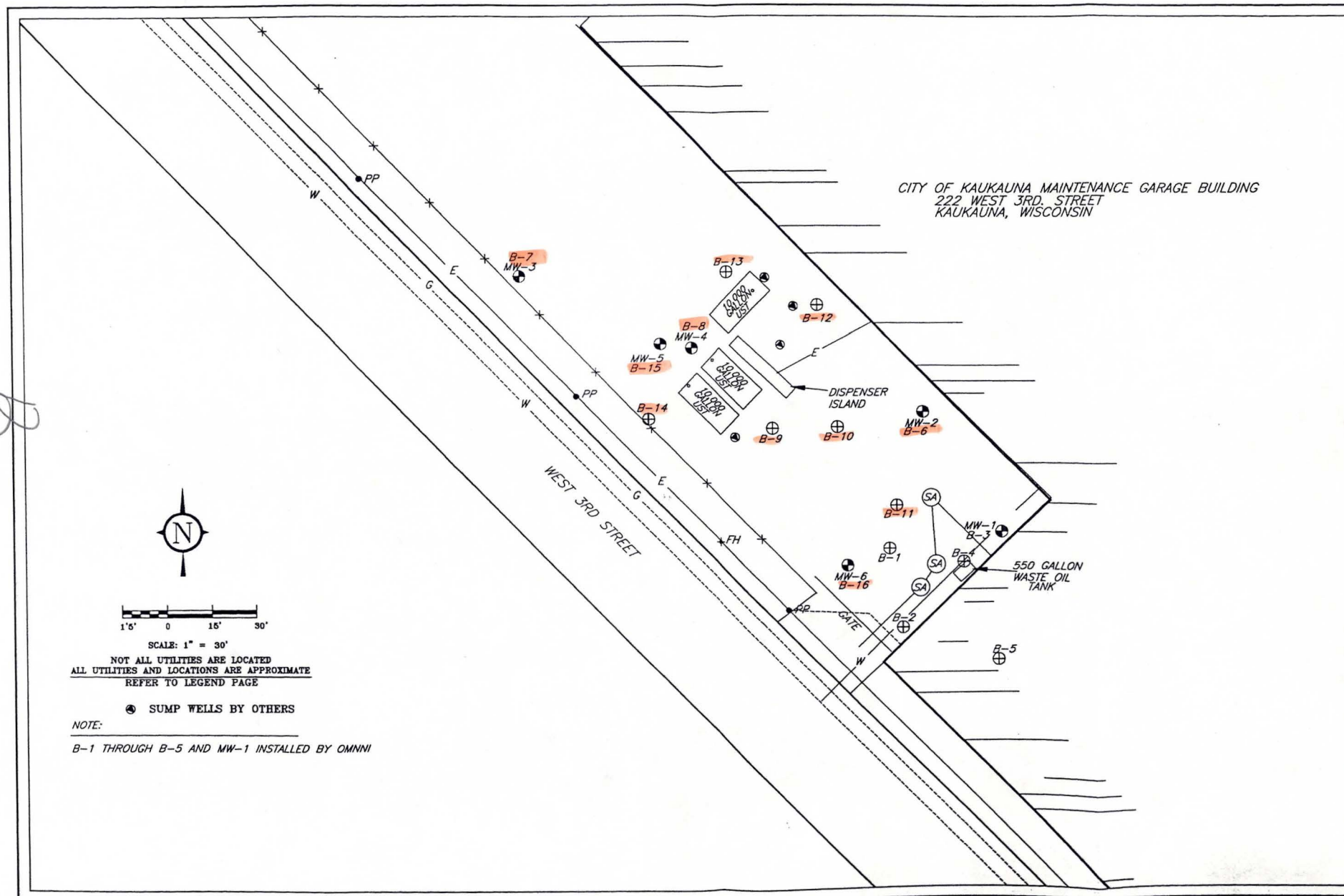


FIGURE 3: SOIL BORING AND MONITORING WELL LOCATIONS

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

398132.002

DRAWN BY: KP | REVIEWED BY: JF
DATE: 6/16/98 | APPROVED BY: KB
ID#: CITY-KAU-1

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL (920) 766-2649 • FAX (920) 759-2649

Field Screening PID Response

Depth	1-3	3-5	5-7	7-9	9-11	11-13	13-15	15-17	17-19
B-6	9 *	4	7	2	3	3	EOB		
B-7	-	0 *	1	-	EOB				
B-8	- *	-	789	105	EOB				
B-9	245 *	62 *	EOB						
B-10	0 *	0	10 *	EOB					
B-11	0 *	0 *	EOB						
B-12	4 *	-	781 *	EOB					
B-13	0 *	0	2 *	EOB					
B-14	0 *	0 *	EOB						
B-15	137	679 *	614 *	112	38	5	12	-	EOB
B-16	1	0	4 *	0	EOB				

unsaturated ← → saturated

- - no sample
EOB – end of boring
* - Sample lab analyzed

Water Table 5 ft bgs

Water Table

Post Remediation Site Configuration

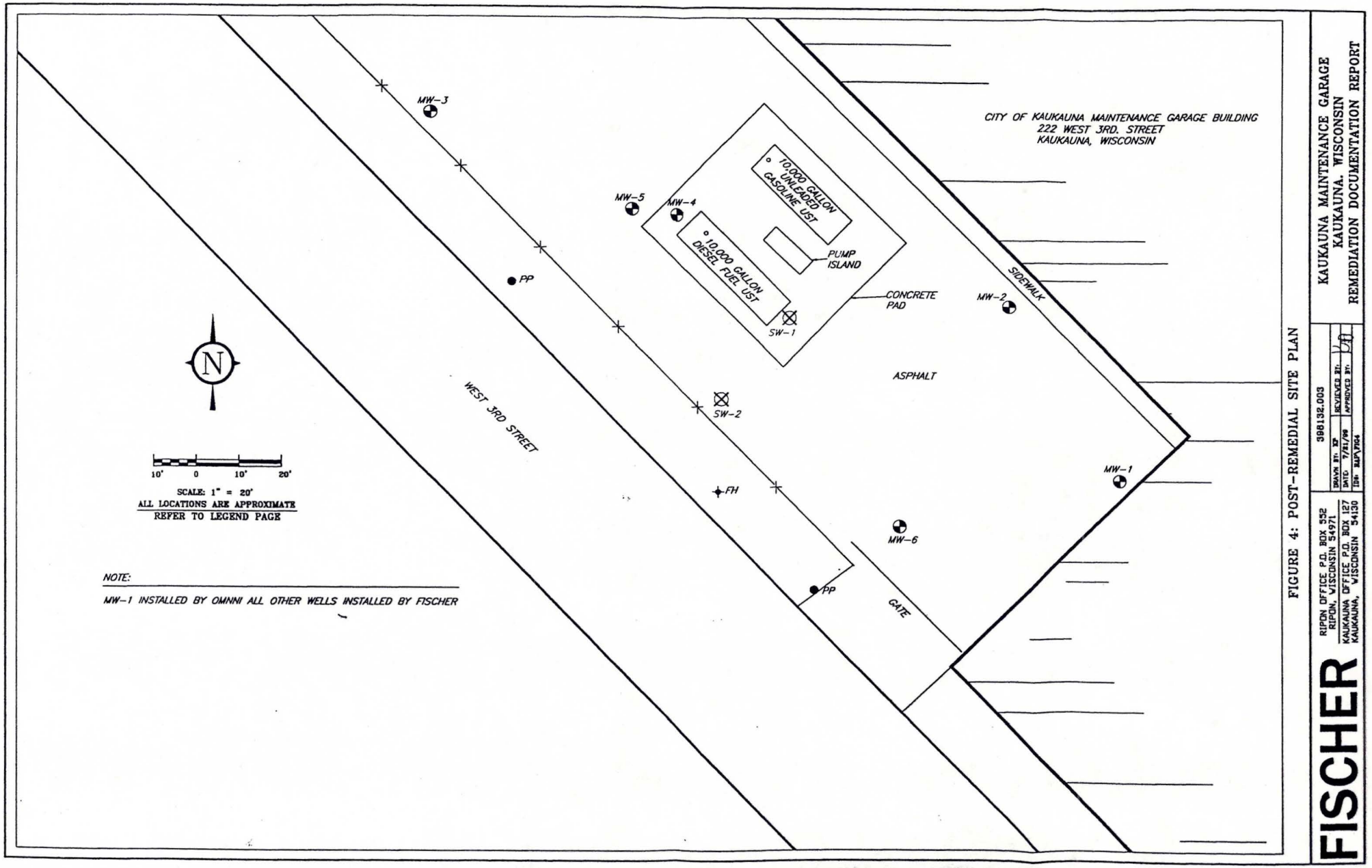


FIGURE 4: POST-REMEDIAL SITE PLAN

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

398132.003
DRAWN BY: RP
DATE: 7/21/99
REVIEWED BY:
APPROVED BY:
DWG: BMP\FIG4

Waterfable 4-~~4~~5 ft bgs

TABLE 1

Soil Analytical Results - April 15, 1998 and August 28, 1998

Kaukauna Maintenance Garage - FISCHER Project #398132.002

Saturated

Parameter	B-6 1-3'	B-7 3-5'	B-8 1-3'	B-9 1-3'	B-9 3-5'	B-10 1-3'	B-10 5-7'	B-11 1-3'	B-11 2-5'	RCL
GRO (mg/kg)	<3.9	<2.8	22	85	16	<2.9	3.3	<2.9	<3.2	250
DRO (mg/kg)	19	<4.0	47	27	<4.3	9.0	12	8.0	<4.4	250
Lead (mg/kg)	150		40	370						50
Naphthalene (ug/kg)				48						NE
1,2-Dichloroethane (ug/kg)				<25						4.9
s-Butylbenzene (ug/kg)				47						NE
n-Butylbenzene (ug/kg)				74						NE
Isopropylbenzene (ug/kg)				340						NE
p-Isopropylbenzene (ug/kg)				42						NE
n-Propylbenzene (ug/kg)				330						NE
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOCs) ug/kg										
Benzene	<25	<25	2300	1500	190	<25	71	<25	<25	5.5
Ethylbenzene	<25	<25	550	1900	460	30	<25	<25	<25	2900
Methyl-Tert-Butyl-Ether	<25	<25	<25	<25	<25	<25	<25	<25	<25	NE
Toluene	<25	<25	160	160	<25	92	<25	110	<25	1500
1,2,4-Trimethylbenzene	45	<25	590	2600	2200	65	300	<25	<25	NE
1,3,5-Trimethylbenzene	44	<25	230	1600	610	<25	73	<25	<25	NE
Xylenes, Total	110	<25	1600	11190	2200	136	130	<25	<25	4100
POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) ug/kg (Compounds Detected)										
Benzo(a)anthracene			16							NE 88
Fluoranthene			27							500,000 NE
1-Methylnaphthalene			430							23,000 NE
2-Methylnaphthalene			790							20,000 NE
Naphthalene			630							400 NE
Phenanthrene			23							1,800 NE
Pyrene			17							50,000 NE

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
Blank - not analyzed for parameter
GRO - Gasoline Range Organics

DRO - Diesel Range Organics
RCL - Residual Contaminant Levels (WDNR NR 720)
NE - RCL not established

(Guidance RCL's

71

Watertable 4-5 ft Bgs

TABLE 1 (Continued)

Soil Analytical Results - April 15, 1998 and August 28, 1998

Kaukauna Maintenance Garage - FISCHER Project #398132.002

Saturated

Saturated

Parameter	B-12 1-3'	B-12 5-7'	B-13 1-3'	B-13 5-7'	B-14 1-3'	B-14 3-5'	B-15 2.5-4.5'	B-15 4.5-6.5'	B-16 4.5-6.5'	RCL
GRO (mg/kg)	<3.0	100	<2.7	<2.9	3.9	<2.9	**2200**	**1100**	<2.9	250
DRO (mg/kg)	33	48	56	<3.7	23	<4.1	**3500**	**920**	140	250
Lead (mg/kg)		6.5								50
Naphthalene (ug/kg)		6400								NE
1,2-Dichloroethane (ug/kg)		<250								4.9
p-Isopropyltoluene (ug/kg)		1400								NE
s-Butylbenzene (ug/kg)		1400								NE
n-Butylbenzene (ug/kg)		4400								NE
Isopropylbenzene (ug/kg)		2100								NE
p-Isopropyltoluene (ug/kg)		750								NE
n-Propylbenzene (ug/kg)		8400								NE
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOCs) ug/kg										
Benzene	<25	**2100**	<25	<25	<25	<25	**13000**	**7100**	<25	5.5
Ethylbenzene	<25	**15000**	36	<25	<25	<25	**54000**	**32000**	<25	2900
Methyl-Tert-Butyl-Ether	<25	<250	<25	<25	<25	<25	<1000	3200	<25	NE
Toluene	34	1500	30	<25	<25	<25	**3500**	850	<25	1500
1,2,4-Trimethylbenzene	47	45000	70	<25	55	<25	120000	69000	<25	NE
1,3,5-Trimethylbenzene	<25	14000	27	<25	38	<25	39000	23000	<25	NE
Xylenes, Total	69	**55000**	153	<25	86	<25	**166800**	**94800**	66	4100

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
Blank - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - Residual Contaminant Levels (WDNR NR 720)
NE - RCL not established

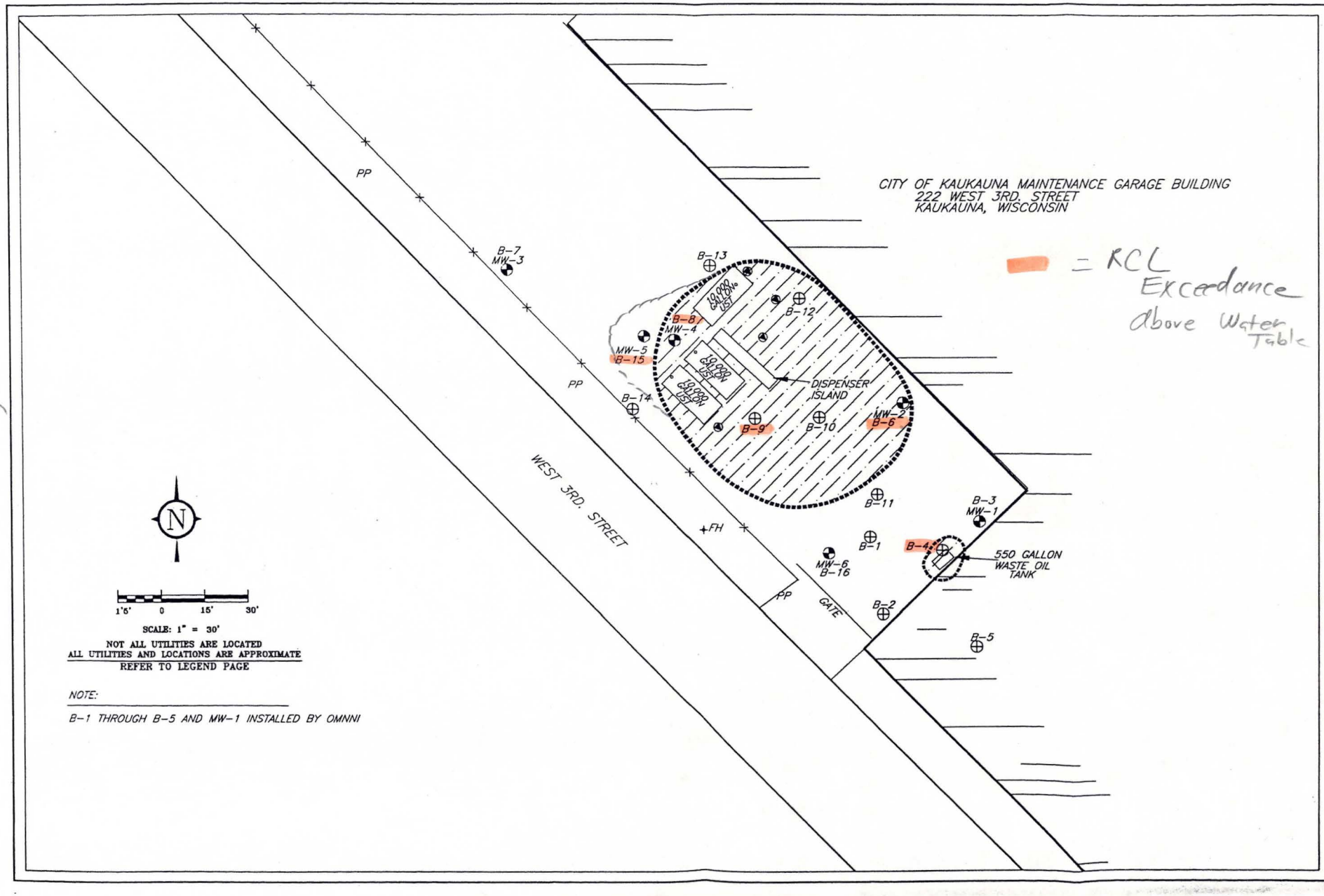


FIGURE 7: ESTIMATED EXTENT OF CONTAMINATION EXCEEDING RCLs IN THE VADOSE AND SMEAR ZONES

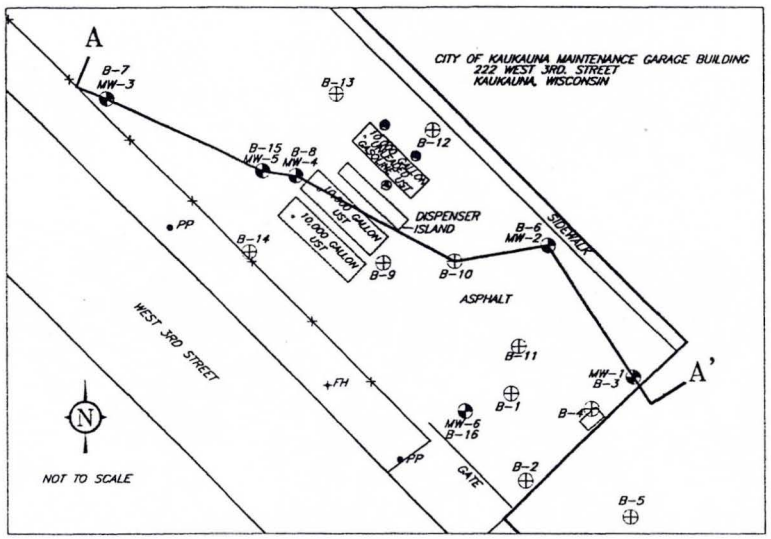
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

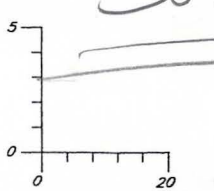
398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 8/15/08	APPROVED BY: KD
ISE: CITY-EAU-1	

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-0569 • FAX (920) 766-0569

Soil Results





EXPLANATION		
SOILS CLASSIFICATION		MONITORING WELL
ASPHALT	See bore logs	Bentonite Seal
FILL	See bore logs	Water table measured on 9/16/98
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Well Screen
GM	Silty gravels, gravel-sand-silt mixtures.	
BEDROCK	See bore logs	
WEATHERED BEDROCK	See bore logs	
	Not observed	

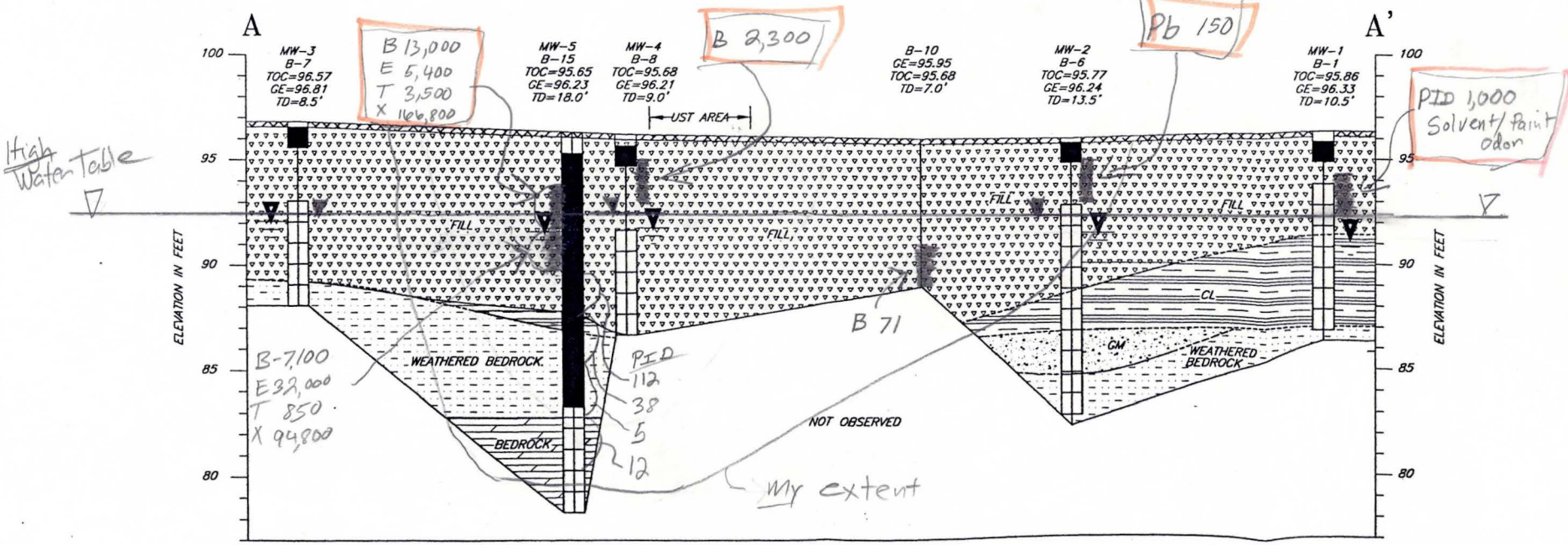


FIGURE 4: PRE-REMEDIAL GEOLOGIC CROSS -SECTION A-A'

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

398132.003
DRAWN BY: KP
DATE: 7/30/98
REVIEWED BY:
APPROVED BY:
TDH CLOSURE\CROSS

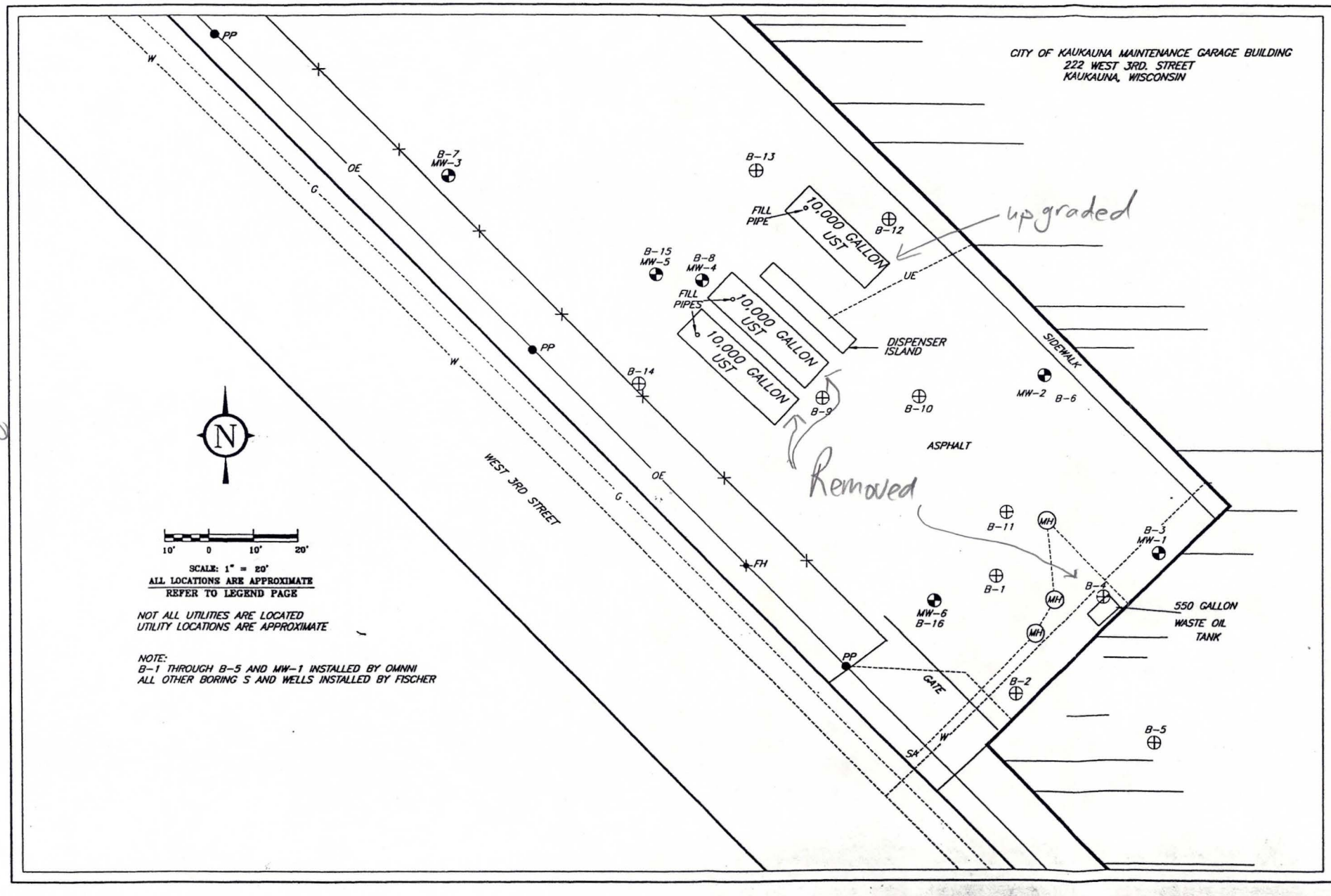


FIGURE 2: SITE PLAN PRIOR TO REMEDIATION

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

398132.003

DRAWN BY: KP
DATE: 7/21/99
REVIEWED BY:
APPROVED BY:
IDN: RAP\PGS

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

18

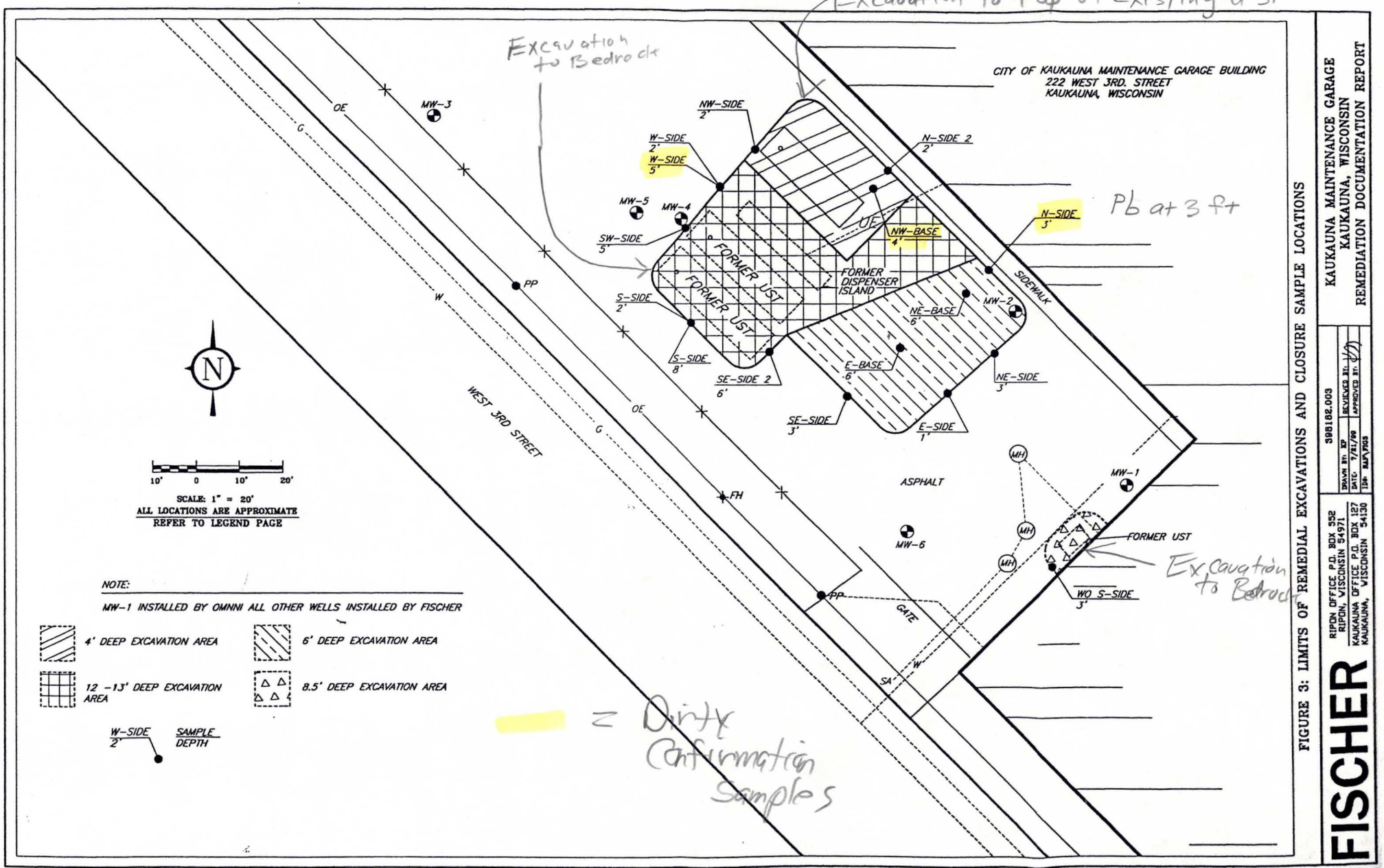


FIGURE 3: LIMITS OF REMEDIAL EXCAVATIONS AND CLOSURE SAMPLE LOCATIONS

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

398182.003
DRAWN BY: KP
DATE: 7/21/99
REVIEWED BY:
APPROVED BY:
ID#: RAP\FIG3

High W.T. at ≈ 4 ft

TABLE 1 (Continued)

SUMMARY OF SOIL ANALYTICAL RESULTS - REMEDIAL EXCAVATION
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

High Watertable ≈ 4 ft bgs

Sampling Date	2/25/99	2/25/99	3/1/99	3/1/99	3/1/99	3/1/99	2/23/99	3/1/99	RCL
Parameter	**N-Side 2 2 ft**	**NW-Base 4 ft**	**NW-Side 2 ft**	**W-Side 2 ft**	**SW-Side 5 ft**	**SE-Side 2 6 ft**	**WO S-Side 3 ft**	**W-Side 5 ft**	
DRO (mg/kg)	<4.2	<4.4	<4.0	<4.3	<4.1	4.9	22	**1800**	250
GRO (mg/kg)	<2.7	12	<2.7	<2.7	9.0	7.6	<2.8	**700**	250
Lead (mg/kg)	NA	8.3Q	3.7Q	NA	<3.9	NA	NA	NA	50
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg									
Benzene	<25	**200**	<25	<25	<25	<25	<25	**1700**	5.5
Ethylbenzene	<25	400	<25	<25	<25	31Q	<25	**11000**	2900
Methyl-Tert-Butyl-Ether	<25	<25	<25	<25	<25	<25	<25	890Q	NE
Toluene	<25	52Q	<25	<25	<25	<25	<25	620Q	1500
1,2,4-Trimethylbenzene	<25	930	<25	<25	100	370	<25	42000	NE
1,3,5-Trimethylbenzene	<25	290	<25	<25	39Q	38Q	<25	15000	NE
m,p-Xylenes	<25	1200	<25	<25	55Q	73	<25	**37000**	4100
o-Xylenes	<25	46Q	<25	<25	<25	<25	<25	**2800**	

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

From Soil that was disposed of

High WT. ≈ 4 ft

TABLE 1

SUMMARY OF SOIL ANALYTICAL RESULTS - REMEDIAL EXCAVATION
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

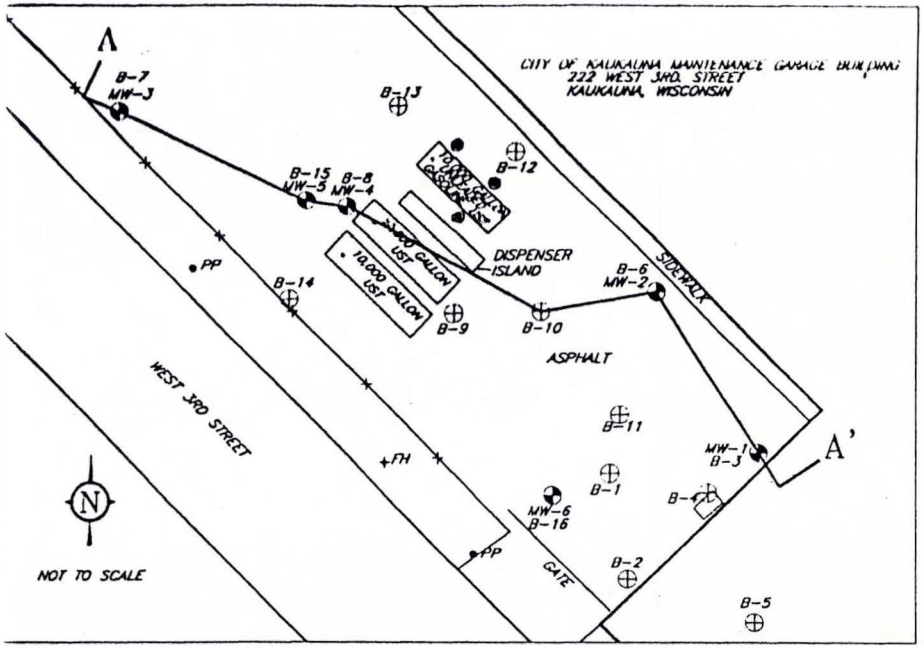
Sampling Date	2/23/99	2/23/99	2/23/99	2/23/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99	RCL
Parameter	Confirmation #1	Confirmation #2	S-Side 2 ft	S-Side 8 ft	NE-Base 6 ft	N-Side 3 ft	NE-Side 3 ft	E-Side 1 ft	E-Base 6 ft	SE-Side 3 ft	
DRO (mg/kg)	1300	<4.7	<4.6	<3.9	<3.8	110	57	<3.8	<3.7	210	250
GRO (mg/kg)	120	<3.1	<3.1	<2.9	<2.8	<3.4	3.4	<2.6	<2.7	12	250
Lead (mg/kg)	NA	NA	NA	NA	<3.9	110	NA	NA	4.6Q	NA	50
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg											
Benzene	<50	<25	<25	<25	<25	<25	<25	<25	<25	<25	5.5
Ethylbenzene	130Q	<25	<25	<25	<25	<25	44	<25	<25	<25	2900
Methyl-Tert-Butyl-Ether	60Q	<25	<25	<25	<25	98	<25	<25	<25	140	NE
Toluene	<50	<25	<25	<25	<25	<25	<25	<25	<25	<25	1500
1,2,4-Trimethylbenzene	1800	60Q	<25	<25	<25	66Q	150	<25	<25	<25	NE
1,3,5-Trimethylbenzene	360	<25	<25	<25	<25	<25	59	<25	<25	<25	NE
m,p-Xylenes	<50	70Q	<25	<25	<25	180	180	27Q	<25	65Q	4100
o-Xylenes	110Q	<25	<25	<25	<25	45Q	50Q	<25	<25	<25	

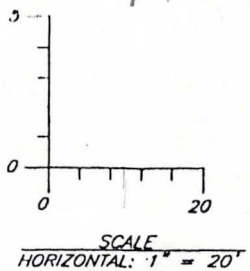
mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

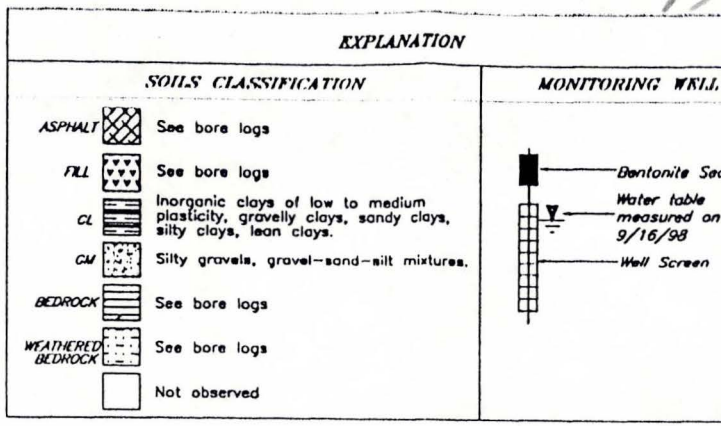
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

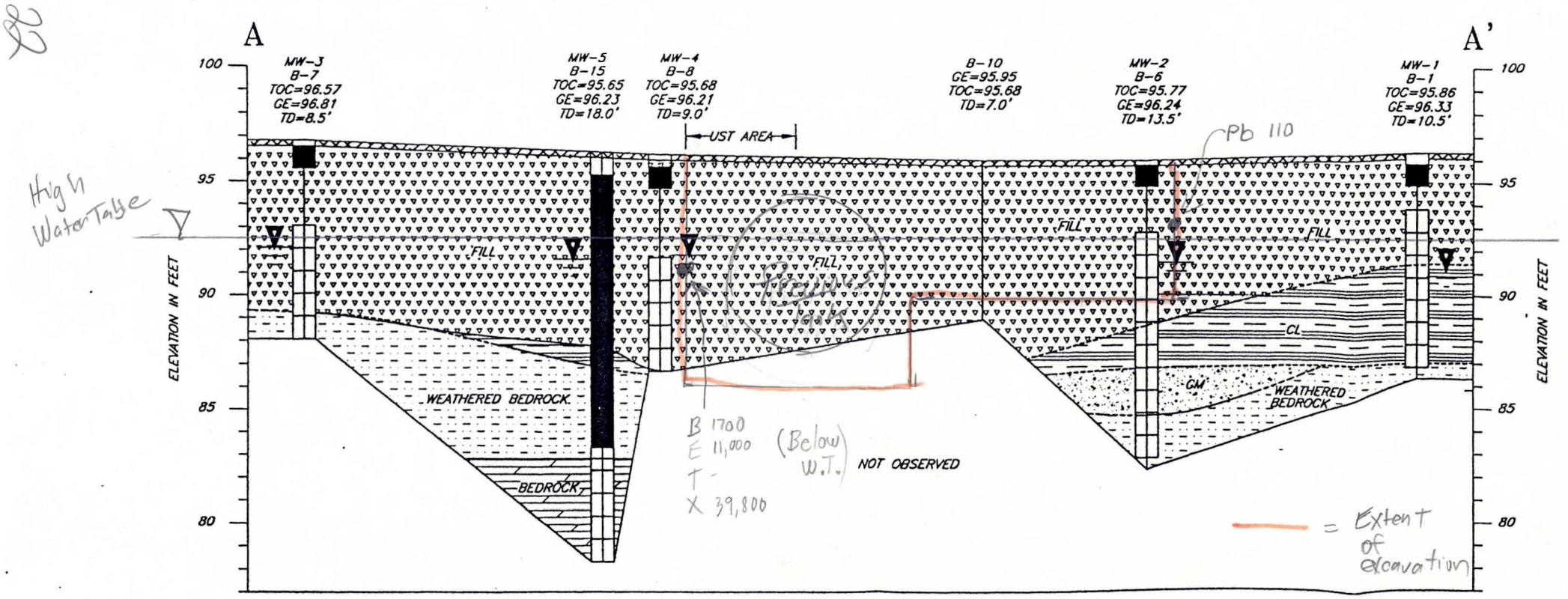
2

Results from Excavation Conf. Sample









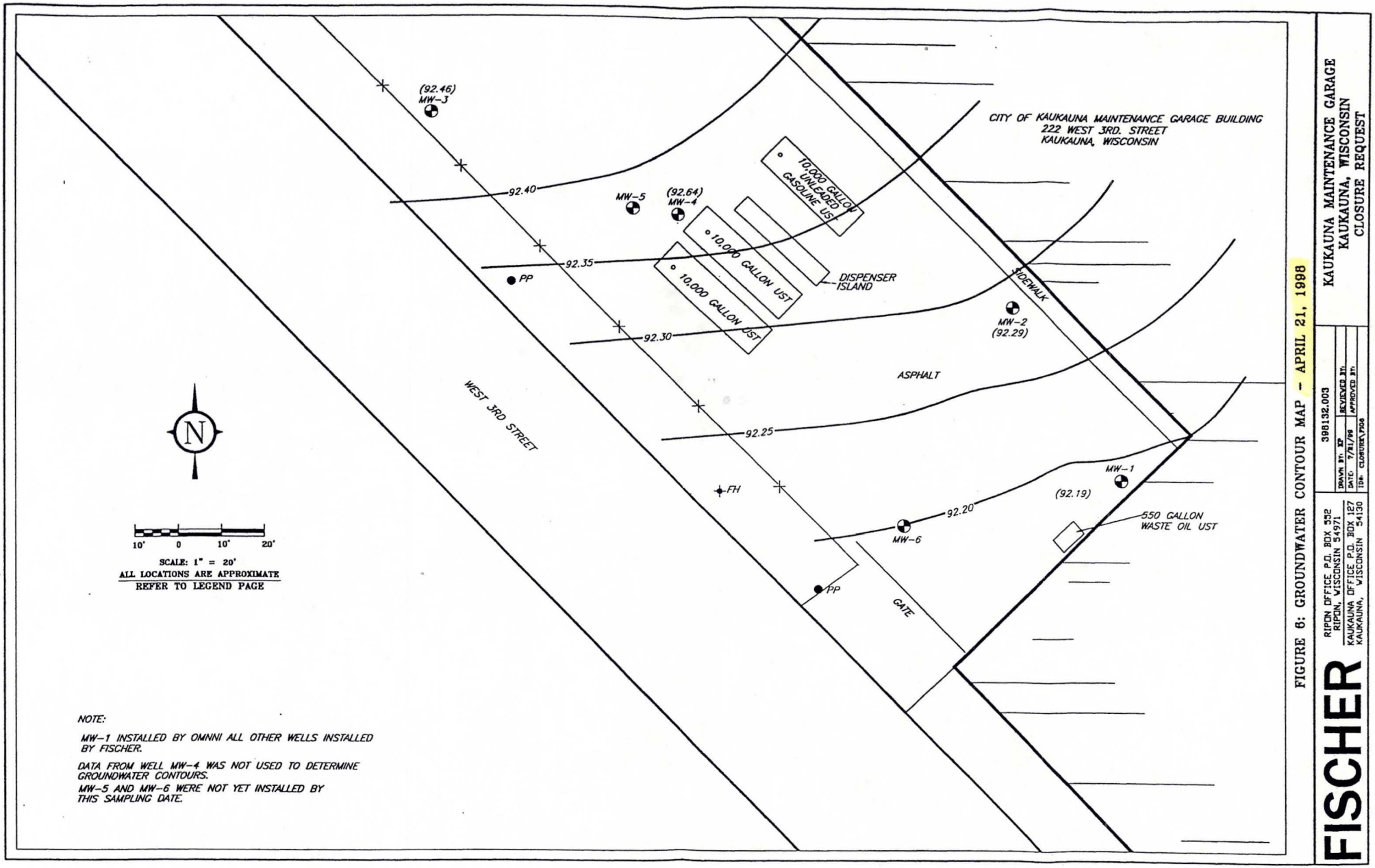


FIGURE 6: GROUNDWATER CONTOUR MAP - APRIL 21, 1998

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

398132.003

DRAWN BY: KP
DATE: 7/21/99
REVIEWED BY:
APPROVED BY:
IDS: CLOSURE\FIG6

24

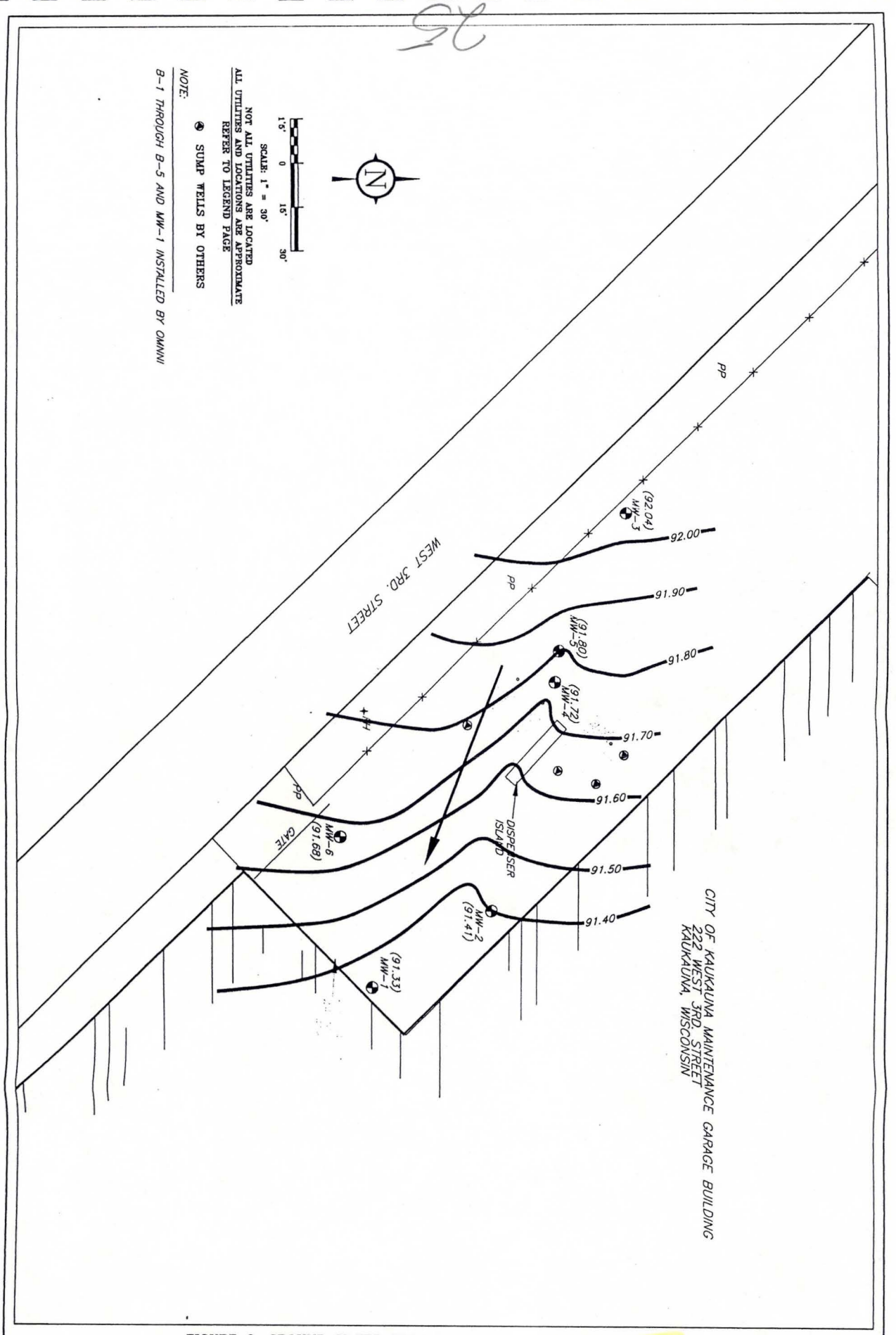


FIGURE 6: GROUND-WATER FLOW DIRECTION - SEPTEMBER 16,1998

Fischer Environmental, Inc. P.O. BOX 127, KAUKAUNA, WI 54130 TEL. (920) 766-2069 • FAX (920) 739-2649	398132.002	KAUKAUNA MAINTENANCE GARAGE KAUKAUNA, WISCONSIN SITE INVESTIGATION
	DRAWN BY: KP / REVIEWED BY: JF	
	DATE: 6/16/98 / APPROVED BY: KB	
	ID#: CITY-KAU-1	

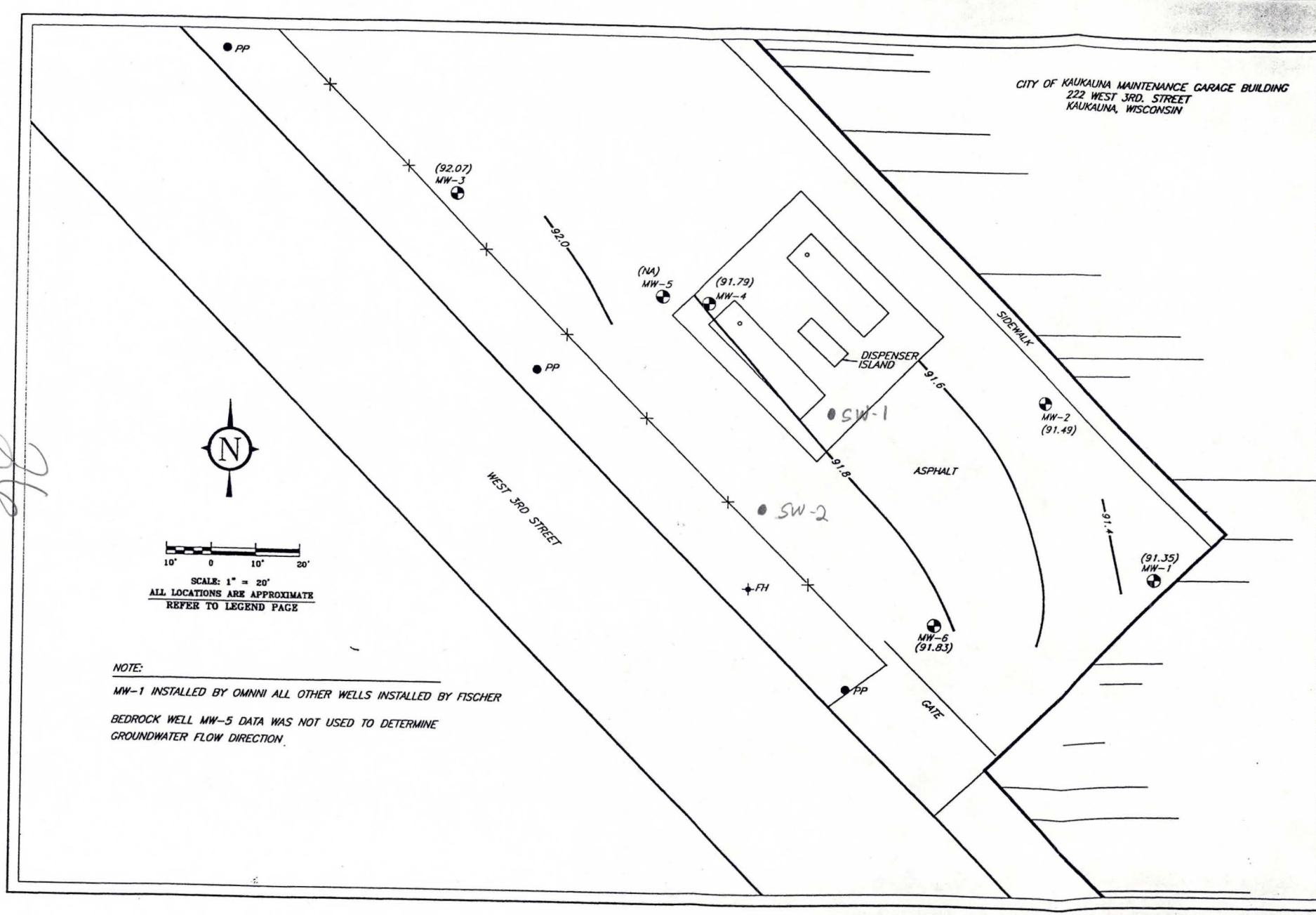


FIGURE 5: GROUNDWATER ELEVATION CONTOURS ON APRIL 8, 1999

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

FISCHER
RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

398132.003
DRAWN BY: KP
DATE: 7/21/99
REVIEWED BY:
APPROVED BY:
IDs: RAP\FIG7

Remediation 2/99

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-1						MW-2		
Sampling Date	ES	PAL	4/12/94	1/23/95	9/26/95	4/21/98	6/5/98	4/8/99*	4/21/98	6/5/98	4/8/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)											
Benzene	5	0.5	1.2	<0.6	<0.6	<0.27	<0.27	<0.27	150	170	<0.26
Ethylbenzene	700	140	3.6	<1.0	<1.0	<0.32	<0.32	<0.32	11	38	<0.24
Methyl-tert-butyl-ether	60	12	17	5.2	9.6	6.4	6.7	2.8	19	17	11
Toluene	343	68.6	<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	5.5	1.9	0.33Q
1,2,4-Trimethylbenzene	484	96	<1.0	<1.0	<1.0	<0.22	<0.22	<0.22	3.7	15	<0.86
1,3,5-Trimethylbenzene			<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	<0.27	0.32Q	<0.54
Xylenes, m + p	620	124	23	<1.0	<1.0	<0.43	<0.43	<0.43	8.6	26	<0.97
Xylene, o			<1.0	<1.0	<1.0	<0.24	<0.24	<0.24	0.78	0.37Q	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)											
1,2-Dichloroethane	5	0.5	4.9	4.7	7.8	NA	4.0	3.3	<0.37	38	<0.24
Isopropylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	1.4	NA	NA
n-Propylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	1.2Q	NA	NA
LEAD and CADMIUM											
Lead	15	1.5	NA	NA	NA	NA	NA	NA	<1.6	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA	NA	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates analytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial sample. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

TABLE 3 (Continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-3			MW-4		
Sampling Date	ES	PAL	4/21/98	6/5/98	4/8/99*	4/21/98	6/5/98	4/8/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)								
Benzene	5	0.5	<0.27	<0.27	<0.26	2400	2300	1100
Ethylbenzene	700	140	<0.32	<0.32	<0.24	560	470	230
Methyl-tert-butyl-ether	60	12	<0.32	<0.32	<0.22	15Q	20	6.7Q
Toluene	343	68.6	<0.27	<0.27	<0.21	67	58	27
1,2,4-Trimethylbenzene	484	96	<0.22	<0.22	<0.86	660	480	160
1,3,5-Trimethylbenzene			<0.27	<0.27	<0.54	160	110	26Q
Xylenes, m + p	620	124	<0.43	<0.43	<0.97	1700	1300	370
Xylene, o			<0.24	<0.24	<0.37	41	40	15Q
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)								
n-Butylbenzene	NE	NE	<0.29	NA	NA	23	NA	NA
Naphthalene	40	8	<0.35	NA	NA	130	110	37Q
s-Butylbenzene	NE	NE	<0.29	NA	NA	11Q	NA	NA
Isopropylbenzene	NE	NE	<0.26	NA	NA	43	NA	NA
p-Isopropyltoluene	NE	NE	<0.24	NA	NA	7.0Q	NA	NA
n-Propylbenzene	NE	NE	<0.76	NA	NA	110	NA	NA
LEAD and CADMIUM (ug/L)								
Lead	15	1.5	<1.6	NA	NA	<1.6	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA
DETECTED POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)								
Fluorene	400	880	NA	NA	NA	2.0Q	NA	NA
1-methylnaphthalene	NE	NE	NA	NA	NA	30	NA	NA
2-methylnaphthalene	NE	NE	NA	NA	NA	41	NA	NA
Naphthalene	40	8	NA	NA	NA	60	NA	NA
Phenanthrene	NE	NE	NA	NA	NA	15	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates analytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial sample. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

Remediation 2/99

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 140		MW-5		MW-6	
Sampling Date	ES	PAL	8/31/98	4/15/99*	8/31/98	4/8/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)						
Benzene	5	0.5	5.5	<0.26	<0.27	<0.26
Ethylbenzene	700	140	8.2	<0.24	<0.32	<0.24
Methyl-tert-butyl-ether	60	12	<0.32		<0.32	<0.22
Toluene	343	68.6	0.63	<0.21	<0.27	<0.21
1,2,4-Trimethylbenzene	484	96	14	<0.86	<0.22	<0.86
1,3,5-Trimethylbenzene			5.0	<0.54	<0.27	<0.54
Xylenes, m + p	620	124	23	<0.97	<0.43	<0.97
Xylene, o			1.3	<0.37	<0.24	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)						
s-Butylbenzene	NE	NE	0.53Q	NA	<0.29	NA
n-Butylbenzene	NE	NE	1.4	NA	<0.29	NA
Chloroform	6	0.6	0.68Q	NA	<0.35	NA
Naphthalene	40	8	3.2	<0.89	<0.35	NA
Isopropylbenzene	NE	NE	0.90	NA	<0.26	NA
n-Propylbenzene	NE	NE	2.8	NA	<0.76	NA
LEAD						
Lead	15	1.5	<1.6	NA	<1.6	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates anaytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial sample. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

29

→ Post

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sump Well	NR 140		SW-1	SW-2
Sampling Date	ES	PAL	4/8/99*	4/15/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)				
Benzene	5	0.5	1.2	<0.26
Ethylbenzene	700	140	2.3	<0.24
Methyl-tert-butyl-ether	60	12	0.66Q	<0.22
Toluene	343	68.6	0.51Q	<0.21
1,2,4-Trimethylbenzene	484	96	5.9	<0.86
1,3,5-Trimethylbenzene			2.8	<0.54
Xylenes, m + p	620	124	12	<0.97
Xylene, o			1.8	<0.37

All concentrations in ug/l - micrograms per liter
ES = Enforcement Standard (exceedances shaded)
PAL = Preventive Action Limit
NA = not analyzed for parameter
Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
NE = NR 140 enforcement standard (ES) not established
* Post-remedial sample.

Post Post Post

TABLE 4

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-1			MW-2			MW-3		
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99
Nitrate/Nitrite	mg/l	NA	NA	0.061*	NA	NA	0.087*	NA	NA	0.57*
Sulfate	mg/l	NA	NA	64	NA	NA	160	NA	NA	170
Methane	ug/l	NA	NA	270	NA	NA	<0.9	NA	NA	7.4
FIELD TEST										
Temperature	°C	10.4	15.1	10.8	9.7	13.6	10.2	7.0	12.9	7.1
Conductivity	uS/cm	1200	2680	NA	1120	1460	NA	2090	3760	NA
pH	units	7.34	6.72	NA	7.44	6.49	NA	7.20	6.55	NA
Dissolved Oxygen	ppm	1.3	0.37	0.31	2.2	0.50	0.21	6.1	0.80	0.24
ORP	mV	NA	NA	15	NA	NA	-70	NA	NA	20
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	0.5	NA	NA	0.5

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

TABLE 4 (Continued)

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-4			MW-5			MW-6			SW-1	SW-2
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/15/9	4/21/98	6/5/98	4/8/99	4/8/99	4/15/99
Nitrate/Nitrite	mg/l	NA	NA	0.069*	NA	NA	NA	NA	NA	0.066*	NA	NA
Sulfate	mg/l	NA	NA	85	NA	NA	NA	NA	NA	81	NA	NA
Methane	ug/l	NA	NA	430	NA	NA	NA	NA	NA	530	NA	NA
FIELD TEST												
Temperature	°C	8.6	14.1	8.0	15.3	NA	NA	19.4	NA	7.9	7.9	NA
Conductivity	uS/cm	2210	2870	NA	780	NA	NA	5490	NA	NA	NA	NA
pH	units	7.37	6.58	NA	5.72	NA	NA	5.27	NA	NA	NA	NA
Dissolved Oxygen	ppm	4.3	0.53	0.17	0.22	NA	NA	0.24	NA	0.14	0.12	NA
ORP	mV	NA	NA	-65	130	NA	NA	-60	NA	OR	-75	NA
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	NA	NA	NA	0.5	0.5	NA

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Ronald W. Kazmierczak, Regional Director

Northeast Region Headquarters
Green Bay Service Center
1125 N. Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448
Telephone 920-492-5800
FAX 920-492-5913
TDD 920-492-5912

file

September 22, 1999

City of Kaukauna
John Sundelius
201 2nd Street
Kaukauna, WI 54130

SUBJECT: Acknowledgment of Receipt/Request for Closure Review, Kaukauna Maintenance Garage; 222 3rd Street; Kaukauna; Outagamie County, Wisconsin
WDNR BRRTS ID #: 03-45-001729

Dear Mr. Sundelius:

The Department received your request for closeout review on September 17, 1999. Due to staffing levels and the backlog of non-emergency cases, requests for closure are logged and reviewed in the order they are received. However, we hope to be able to review your request within two months. After Department review of the case, a letter will notify you either that closure is approved or that additional work is required.

If you have any questions, please contact me at (920) 492-5868.

Sincerely,

Greg Tilkens
Hydrogeologist
Remediation & Redevelopment Program

cc: Karen Burkman; Fischer; PO Box 127; Kaukauna, WI 54130

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

RECEIVED
SEP 17 1999
LMD SOLID WASTE

September 15, 1999

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: PAYMENT FOR REVIEW OF CASE CLOSURE REQUEST for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

Please accept the enclosed check as payment for review of the closure request previously submitted to you for the above-referenced site.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincereiy,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/kb

FEE RECEIVED
Date 9-17-99
WDNR - NER

Ripon Office: P.O. Box 552, Ripon, Wisconsin 54971
Phone: (920) 745-2200 • FAX: (920) 745-2222
E-mail: kfischer@fdldotnet.com

Green Bay Office: P.O. Box 11236
Green Bay, WI 54307
Phone/Fax: (920) 592-9540

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@athenet.net

RECEIVED
SEP 0 3 1999
LMD SOLID WASTE

September 1, 1999

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: **CASE CLOSURE REQUEST for Kaukauna Maintenance Garage,** 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Dear Mr. Tilkens:

On behalf of the City of Kaukauna, FISCHER has completed the attached closure request for the above-referenced site.

If you have questions or require additional information, please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

KAB/dd/rle
c: Mr. John Sundelius

Ripon Office: P.O. Box 552, Ripon, Wisconsin 54971
Phone: (920) 745-2200 • FAX: (920) 745-2222
E-mail: kfischer@fdldotnet.com

Green Bay Office: P.O. Box 11236
Green Bay, WI 54307
Phone/Fax: (920) 592-9540

CASE SUMMARY
KAUKAUNA MAINTENANCE GARAGE

The Kaukauna Maintenance Garage is located at 222 West 3rd Street, Kaukauna, Wisconsin (WI). The subject site is owned and operated by the City of Kaukauna and is currently used as a municipal maintenance garage. Five underground storage tanks (USTs) are registered with the Department of Commerce (COMM) for the site: two 10,000-gallon diesel fuel, one 10,000-gallon leaded gasoline, one 10,000-gallon unleaded gasoline, and one 550-gallon waste oil UST. The 10,000-gallon unleaded gasoline UST was upgraded and left in place and one new 10,000-gallon diesel fuel UST was installed. The remaining three USTs were removed from the site during the remedial excavation activities.

OMNNI Associates (OMNNI) previously conducted a site investigation during which five soil borings were advanced at the site and one boring was converted into groundwater monitoring well MW-1. Based on a review of OMNNI's *Site Investigation Report*, dated June 1994, it was FISCHER's opinion that the extent of contamination from the other site USTs was not adequately defined.

The City of Kaukauna contracted FISCHER on February 18, 1998 to perform a site investigation to further define the extent of contamination. As part of the site investigation activities, 11 soil borings were advanced at the site; four were converted into groundwater monitoring wells and one was converted into a bedrock piezometer.

The vertical and horizontal extent of soil and groundwater contamination on-site was defined for the purposes of the site investigation. Contamination was detected within one meter of bedrock, and, therefore, an "environmental factor", as defined in COMM 47, was present.

FISCHER evaluated remedial alternatives and submitted a *Remedial Action Plan* (RAP), dated October 5, 1998. FISCHER proposed to address the "environmental factor" and contaminants by excavating a portion of the impacted soil and conducting additional groundwater monitoring.

From February 23 through 25, 1999, 1,389.75 tons of petroleum-impacted soil were excavated from two areas on the site and transported to the Ridgeview BioSite for bioremediation treatment. In order to excavate soil to bedrock to eliminate the "environmental factor", 203,985 gallons of groundwater were pumped from the largest excavation and transported to the Heart of the Valley municipal treatment plant located in Kaukauna. Two sump wells were installed during remedial excavation backfill operations.

Closure soil samples were collected from the base and sidewalls of the final excavations to verify any remaining contaminant concentrations. Analytical results indicate the majority of soil with contaminant concentrations exceeding Wisconsin Administrative Code (WAC) Chapter NR 720 generic residual contaminant levels (RCLs) has been excavated. One post-excavation groundwater monitoring event has been performed and the analytical results indicate soil remediation and natural attenuation have reduced contaminant concentrations in the groundwater.

JUSTIFICATION FOR CLOSURE
KAUKAUNA MAINTENANCE GARAGE

In accordance with rule COMM 47, FISCHER evaluated five "environmental factors". Prior to source removal (excavation and off-site bioremediation treatment of 1,389.75 tons of impacted soil), one "environmental factor" appeared to be present. Impacted soil was located within one meter of bedrock. The "environmental factor" was eliminated during remedial activities, with the exception of impacted soil possibly located beneath the UST that was upgraded.

Closure soil samples were collected during remedial excavation activities. Only one of the 16 closure samples had a contaminant concentration (lead) exceeding generic RCLs and was collected from the vadose zone. It is FISCHER's opinion that a deed restriction is not warranted for the following reasons.

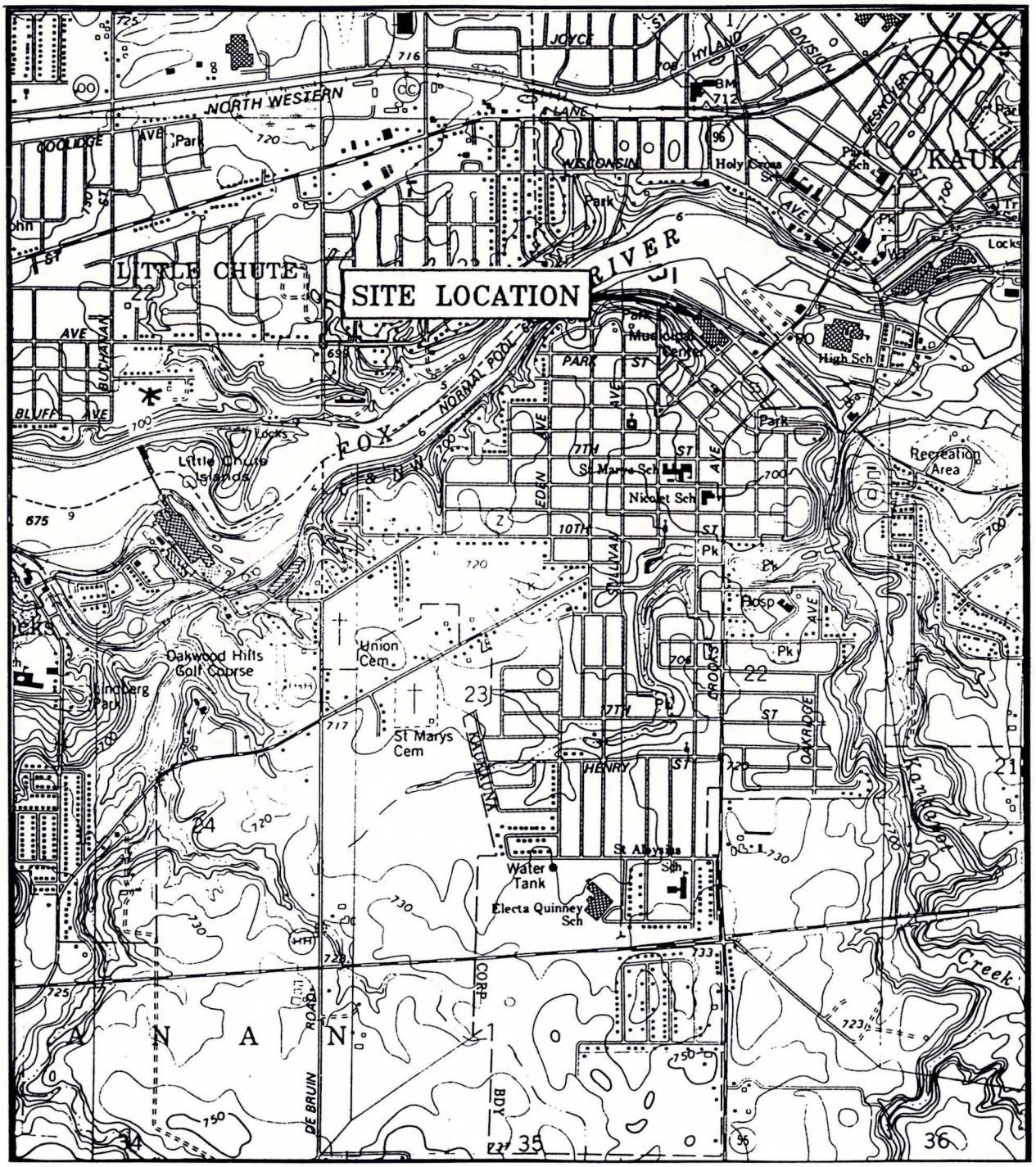
- only one sample collected from the vadose zone exceeded the generic RCL;
- only the RCL for lead was exceeded in the closure sample;
- the excavation could not extend laterally beyond the closure sample location where an RCL exceedance was detected due to the presence of the building;
- the site is currently paved;
- the site will remain paved in the foreseeable future; and
- exposure by direct contact is not anticipated.

Laboratory analytical results of groundwater samples from monitoring wells MW-1, MW-2, MW-3, MW-5 and MW-6, and sump wells SW-1 and SW-2 during April 1999 did not have contaminant concentrations exceeding NR 140 enforcement standards. Prior to soil remediation, benzene was detected in monitoring well MW-2 and piezometer MW-5 at concentrations above the NR 140 enforcement standard. Therefore, remedial activities and natural attenuation appear to have reduced contaminant concentrations in groundwater at the locations of well MW-2 and bedrock piezometer MW-5.

Only benzene was detected at a concentration above the NR 140 enforcement standard in the groundwater sample collected from well MW-4 during April 1999. The benzene concentrations detected in groundwater samples collected from well MW-4 have decreased by approximately 50% subsequent to the remedial excavation activities. Prior to soil remediation, naphthalene, trimethylbenzenes, and xylenes had also been detected in groundwater samples collected from well MW-4 at levels above the NR 140 enforcement standards. Therefore, remedial activities and natural attenuation appear to have reduced contaminant concentrations in groundwater at the location of well MW-4.

FISCHER reviewed COMM 46 as it relates to the remediation status of this site. Based on the most recent groundwater analytical results, only benzene in well MW-4 is present at a concentration exceeding the NR 140 enforcement standard. The benzene concentration, 1,100 micrograms per liter (ug/l), is less than 300 times the NR 140 enforcement standard of 5 ug/l. Groundwater contamination has not been detected off-site.

Source control has been implemented to essentially eliminate the "environmental factor" and enhance remediation by natural attenuation. The site does not appear to pose additional risk. Therefore, it is FISCHER's opinion that this site meets the criteria for closure with a groundwater use restriction.



KAUKAUNA QUADRANGLE
U.S.G.S. 7.5 MINUTE SERIES
(TOPOGRAPHIC) OUTAGAMIE COUNTY
WISCONSIN

N

SCALE: 1:24,000

FIGURE 1: SITE LOCATION MAP

FISCHER RIPON OFFICE P.O. BOX 552, RIPON, WI 54971 KAUKAUNA OFFICE P.O. BOX 127, KAUKAUNA, WI 54130	JOB #:398132.003 DATE: 5/12/99 IDB: RAP\FIG1	**KAUKAUNA MAINTENANCE GARAGE** **KAUKAUNA, WISCONSIN** **CLOSURE REQUEST**

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/23/99	261411	FRED641	BR474171						0.00	28.680	$544.92
		CITY OF KAUKAUNA			890	0.00	$544.92	T			
2/23/99	261413	FRED658	BR474171						0.00	29.170	$554.23
		CITY OF KAUKAUNA			890	0.00	$554.23	T			
2/23/99	261414	FRED656	BR474171						0.00	27.660	$525.54
		CITY OF KAUKAUNA			890	0.00	$525.54	T			
2/23/99	261416	FRED661	BR474171						0.00	28.970	$550.43
		CITY OF KAUKAUNA			890	0.00	$550.43	T			
2/23/99	261420	FRED647	BR474171						0.00	30.430	$578.17
		CITY OF KAUKAUNA			890	0.00	$578.17	T			
2/23/99	261440	FRED656	BR474171						0.00	27.620	$524.78
		CITY OF KAUKAUNA			890	0.00	$524.78	T			
2/23/99	261443	FRED641	BR474171						0.00	29.210	$554.99
		CITY OF KAUKAUNA			890	0.00	$554.99	T			
2/23/99	261474	FRED656	BR474171						0.00	24.290	$461.51
		CITY OF KAUKAUNA			890	0.00	$461.51	T			
2/23/99	261477	FRED658	BR474171						0.00	28.820	$547.58
		CITY OF KAUKAUNA			890	0.00	$547.58	T			
2/23/99	261481	FRED647	BR474171						0.00	28.860	$548.34
		CITY OF KAUKAUNA			890	0.00	$548.34	T			
2/23/99	261484	FRED641	BR474171						0.00	30.750	$584.25
		CITY OF KAUKAUNA			890	0.00	$584.25	T			
2/23/99	261485	FRED661	BR474171						0.00	21.900	$416.10
		CITY OF KAUKAUNA			890	0.00	$416.10	T			
2/23/99	261508	FRED656	BR474171						0.00	25.120	$477.28
		CITY OF KAUKAUNA			890	0.00	$477.28	T			
2/23/99	261511	FRED645	BR474171						0.00	24.640	$468.16
		CITY OF KAUKAUNA			890	0.00	$468.16	T			

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/23/99	261513	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	27.810	$528.39
					890	0.00	$528.39	T			
2/23/99	261523	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	34.330	$652.27
					890	0.00	$652.27	T			
2/23/99	261524	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	26.000	$494.00
					890	0.00	$494.00	T			
2/23/99	261525	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	27.160	$516.04
					890	0.00	$516.04	T			
2/23/99	261533	FRED645	BR474171								
		CITY OF KAUKAUNA							0.00	26.270	$499.13
					890	0.00	$499.13	T			
2/23/99	261537	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	30.660	$582.54
					890	0.00	$582.54	T			
2/23/99	261539	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	28.190	$535.61
					890	0.00	$535.61	T			
2/23/99	261541	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	29.080	$552.52
					890	0.00	$552.52	T			
2/24/99	77499	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	25.730	$488.87
					890	0.00	$488.87	T			
2/24/99	77500	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	28.900	$549.10
					890	0.00	$549.10	T			
2/24/99	261558	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	25.910	$492.29
					890	0.00	$492.29	T			
2/24/99	261559	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	28.330	$538.27
					890	0.00	$538.27	T			
2/24/99	261561	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	24.070	$457.33
					890	0.00	$457.33	T			
2/24/99	261562	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	22.490	$427.31
					890	0.00	$427.31	T			

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile / Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/24/99	261570	FRED658	BR474171							
		CITY OF KAUKAUNA						0.00	21.890	$415.91
				890	0.00	$415.91	T			
2/24/99	261584	FRED661	BR474171							
		CITY OF KAUKAUNA						0.00	23.810	$452.39
				890	0.00	$452.39	T			
2/24/99	261589	FRED656	BR474171							
		CITY OF KAUKAUNA						0.00	25.060	$476.14
				890	0.00	$476.14	T			
2/24/99	261590	FRED647	BR474171							
		CITY OF KAUKAUNA						0.00	28.280	$537.32
				890	0.00	$537.32	T			
2/24/99	261592	FRED641	BR474171							
		CITY OF KAUKAUNA						0.00	26.620	$505.78
				890	0.00	$505.78	T			
2/24/99	261598	FRED658	BR474171							
		CITY OF KAUKAUNA						0.00	26.510	$503.69
				890	0.00	$503.69	T			
2/24/99	261609	FRED661	BR474171							
		CITY OF KAUKAUNA						0.00	31.390	$596.41
				890	0.00	$596.41	T			
2/24/99	261619	FRED656	BR474171							
		CITY OF KAUKAUNA						0.00	33.520	$636.88
				890	0.00	$636.88	T			
2/24/99	261621	FRED641	BR474171							
		CITY OF KAUKAUNA						0.00	31.670	$601.73
				890	0.00	$601.73	T			
2/24/99	261627	FRED647	BR474171							
		CITY OF KAUKAUNA						0.00	27.730	$526.87
				890	0.00	$526.87	T			
2/24/99	261629	FRED645	BR474171							
		CITY OF KAUKAUNA						0.00	26.430	$502.17
				890	0.00	$502.17	T			
2/24/99	261630	FRED658	BR474171							
		CITY OF KAUKAUNA						0.00	27.190	$516.61
				890	0.00	$516.61	T			
2/24/99	261648	FRED661	BR474171							
		CITY OF KAUKAUNA						0.00	28.940	$549.86
				890	0.00	$549.86	T			
2/25/99	261710	FRED656	BR474171							
		CITY OF KAUKAUNA						0.00	26.040	$494.76
				890	0.00	$494.76	T			

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/25/99	261718	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	26.560	$504.64
					890	0.00	$504.64	T			
2/25/99	261725	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	30.570	$580.83
					890	0.00	$580.83	T			
2/25/99	261741	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	29.160	$554.04
					890	0.00	$554.04	T			
2/25/99	261747	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	28.990	$550.81
					890	0.00	$550.81	T			
2/25/99	261777	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	32.300	$613.70
					890	0.00	$613.70	T			
2/25/99	261781	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	22.980	$436.62
					890	0.00	$436.62	T			
2/25/99	261782	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	30.010	$570.19
					890	0.00	$570.19	T			
2/25/99	261803	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	33.050	$627.95
					890	0.00	$627.95	T			
	50				Totals:				0.00	1,389.750	$26,405.25

LEGEND

- Property Line
- Centerline of Roadway
- Sanitary Sewer Line (SA)
- Storm Sewer Line (ST)
- Water Line (W)
- Gas Line (G)
- Overhead Electric Lines (OE)
- Underground Electric Lines (UE)
- Overhead Communication Lines (OC)
- Underground Communication Lines (UC)
- Groundwater Contour Line and Elevation (1015.1)
- Surface Contour Line and Elevation (1015.1)
- GW Extraction Piping (GWE)
- SVE Extraction Piping (SVE)
- Air Sparging Piping (AS)
- Manhole (MH)
- Utility Power Pole (PP)
- Fire Hydrant (FH)
- Light Pole
- Traffic Signal
- PID Reading (000)

- Estimated Limits of Groundwater Contamination
- Estimated Limits of Soil Contamination
- Soil Sample (S-2)
- Existing UST or AST (UST/AST)
- Removed UST or AST (UST/AST)
- Limits of Excavation
- Proposed Monitoring Well (MW-2)
- Monitoring Well (MW-2)
- Proposed Soil Boring (B-2)
- Soil Boring (B-2)
- Proposed Soil Probe (SP-2)
- Soil Probe (SP-2)
- Temporary Monitoring Well (TW-2)
- Extraction/Recovery Sump/Well
- Private Well (PW)
- Abandoned Well
- Backhoe Test Pit

REVISED 3/31/99

RIPON OFFICE
P.O. BOX 552
RIPON, WI 54971
TEL. (920) 745-2200
FAX (920) 745-2222

FISCHER

KAUKAUNA OFFICE
P.O. BOX 127
KAUKAUNA, WI 54130
TEL. (920) 766-2069
FAX (920) 759-2669

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

MW-3
MW-5
MW-4
MW-2
MW-1
MW-6
10,000 GALLON UNLEADED GASOLINE UST
10,000 GALLON DIESEL FUEL UST
PUMP ISLAND
CONCRETE PAD
ASPHALT
SIDEWALK
WEST 3RD STREET
OE
G
W
UE
PP
FH
MH
GATE
SA

N

10' 0 10' 20'

SCALE: 1" = 20'
ALL LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

NOTE:

MW-1 INSTALLED BY OMNNI
ALL OTHER WELLS INSTALLED BY FISCHER

NOT ALL UTILITIES ARE LOCATED
UTILITY LOCATIONS ARE APPROXIMATE

✶ CONTAMINANT CONCENTRATIONS DETECTED IN GROUNDWATER ON APRIL 8, 1999 EXCEEDING NR140 ENFORCEMENT STANDARDS

FIGURE 2: POST-REMEDIAL SITE PLAN

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003

DRAWN BY: KP | REVIEWED BY:
DATE: 7/21/99 | APPROVED BY:
ID#: CLOSURE\FIG2

FISCHER
RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

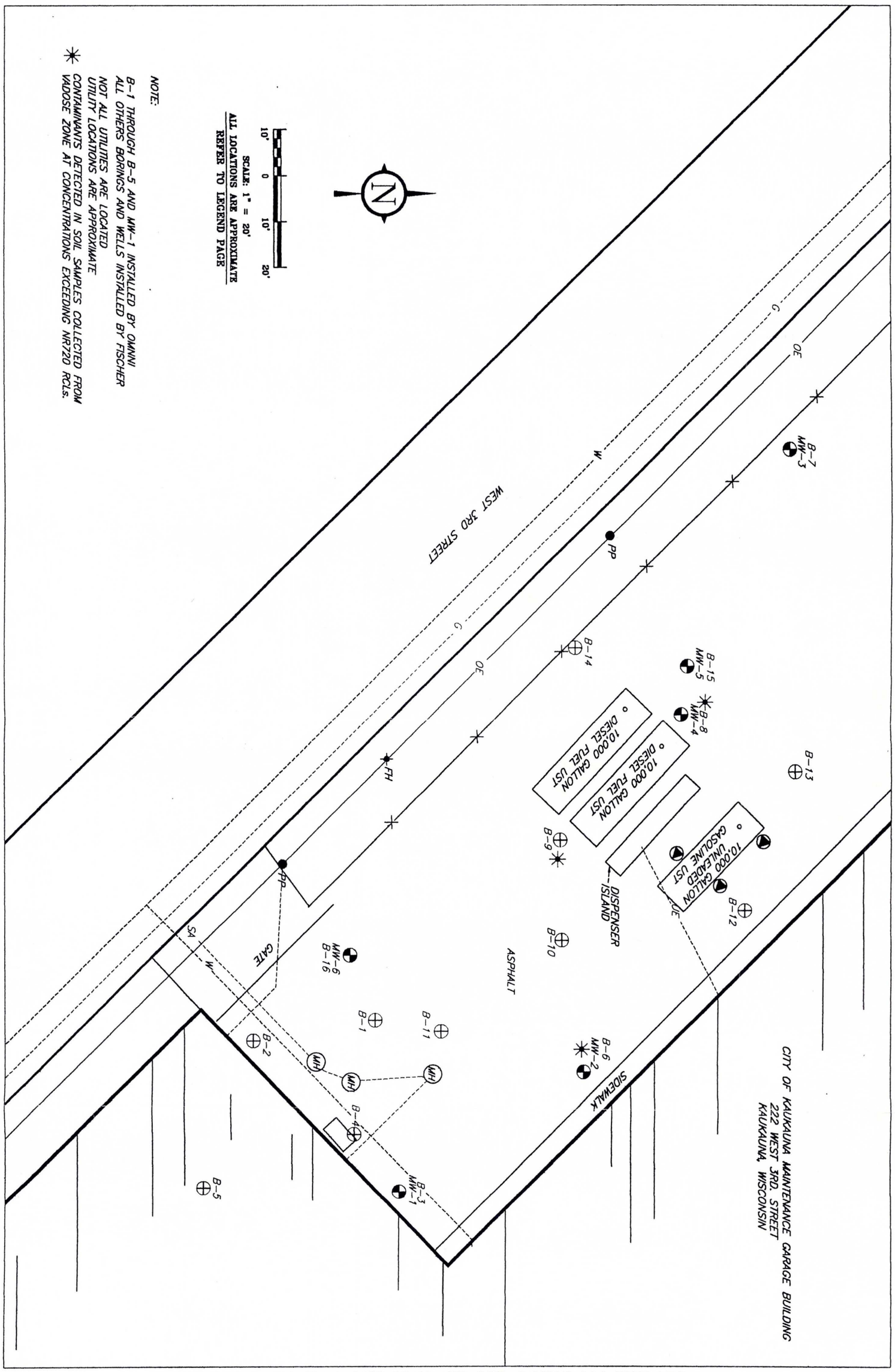


FIGURE 3: PRE-REMEDIAL SITE PLAN AND SOIL SAMPLE LOCATION MAP

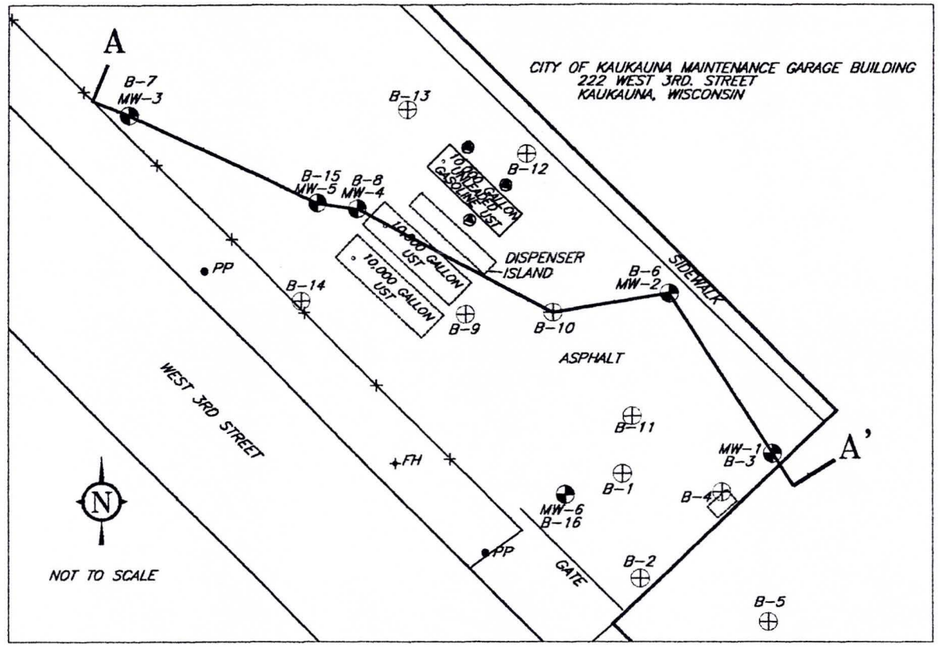
FISCHER

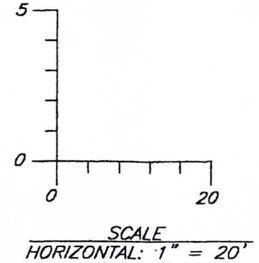
RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971

KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

398132.003	
DRAWN BY: KP	REVIEWED BY:
DATE: 7/21/99	APPROVED BY:
ID#: CLOSURE\FIG6	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST





EXPLANATION

SOILS CLASSIFICATION		MONITORING WELL
ASPHALT	See bore logs	Bentonite Seal
FILL	See bore logs	Water table measured on 9/16/98
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Well Screen
GM	Silty gravels, gravel–sand–silt mixtures.	
BEDROCK	See bore logs	
WEATHERED BEDROCK	See bore logs	
	Not observed	

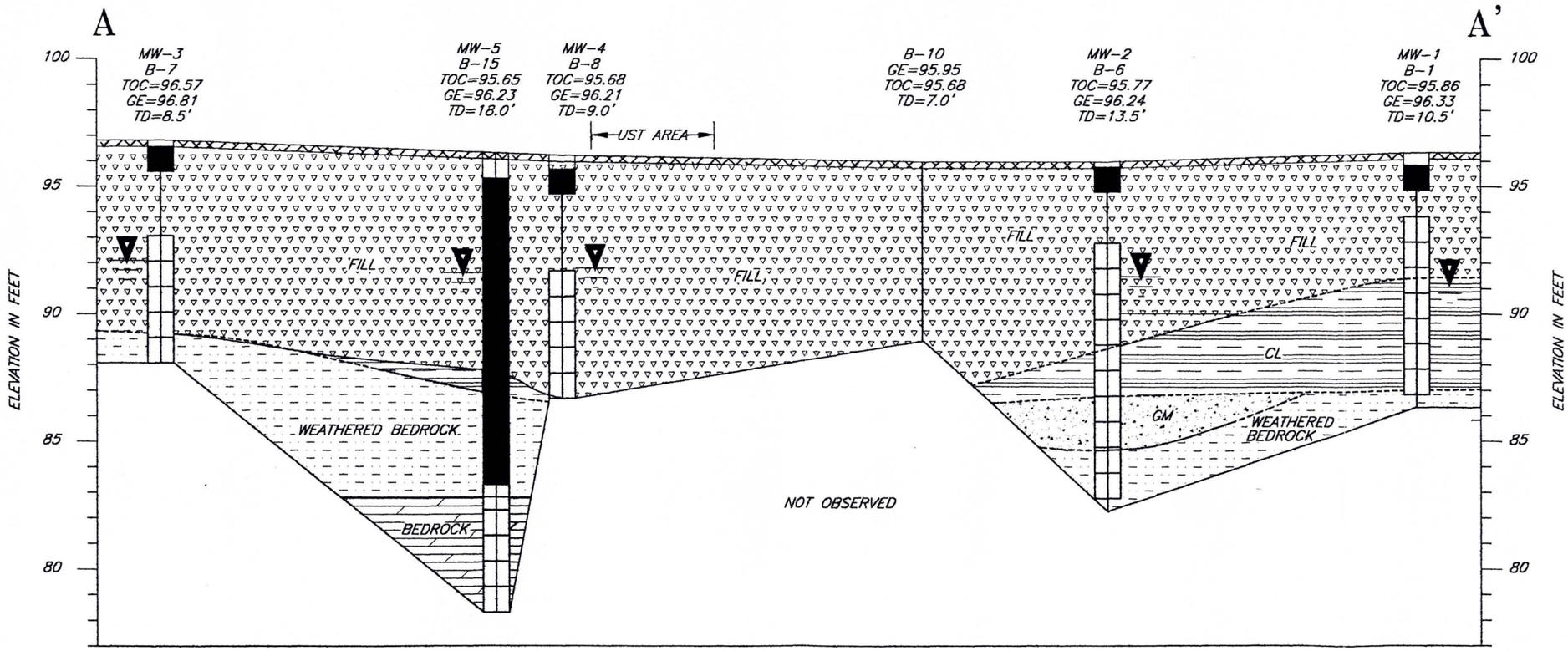


FIGURE 4: PRE-REMEDIAL GEOLOGIC CROSS -SECTION A-A'

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003			
DRAWN BY: KP	REVIEWED BY:		
DATE: 7/20/99	APPROVED BY:		
IDW: CLOSURES\CROSS			

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971

KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

NW-SIDE 2'
W-SIDE 2'
W-SIDE 5'
N-SIDE 2 2'
10000 GALLON UNLEADED GASOLINE UST
MW-5
MW-4
SW-SIDE 5'
UE
NW-BASE 4'
N-SIDE 3'
FORMER UST
FORMER UST
FORMER DISPENSER ISLAND
SIDEWALK
S-SIDE 2'
MW-2
NE-BASE 6'
S-SIDE 8'
E-BASE 6'
SE-SIDE 2 6'
NE-SIDE 3'
SE-SIDE 3'
E-SIDE 1'
ASPHALT
MH
MW-1
MW-3
OE
G
W
PP
WEST 3RD STREET
FH
MW-6
MH
MH
WO S-SIDE 3'
PP
GATE
W
SA'

N

10' 0 10' 20'

SCALE: 1" = 20'
ALL LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

EXCAVATED AREAS

- 4' DEEP EXCAVATION AREA
- 6' DEEP EXCAVATION AREA
- 12 -13' DEEP EXCAVATION AREA
- 8.5' DEEP EXCAVATION AREA

NOTE:

W-SIDE 2' — SAMPLE DEPTH

MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER

NOT ALL UTILITIES ARE LOCATED
UTILITY LOCATIONS ARE APPROXIMATE

✳ CONTAMINANTS DETECTED IN SOIL SAMPLES COLLECTED FROM VADOSE ZONE AT CONCENTRATIONS EXCEEDING NR720 RCLs.

FIGURE 5: POST-REMEDIAL SOIL SAMPLE LOCATION MAP

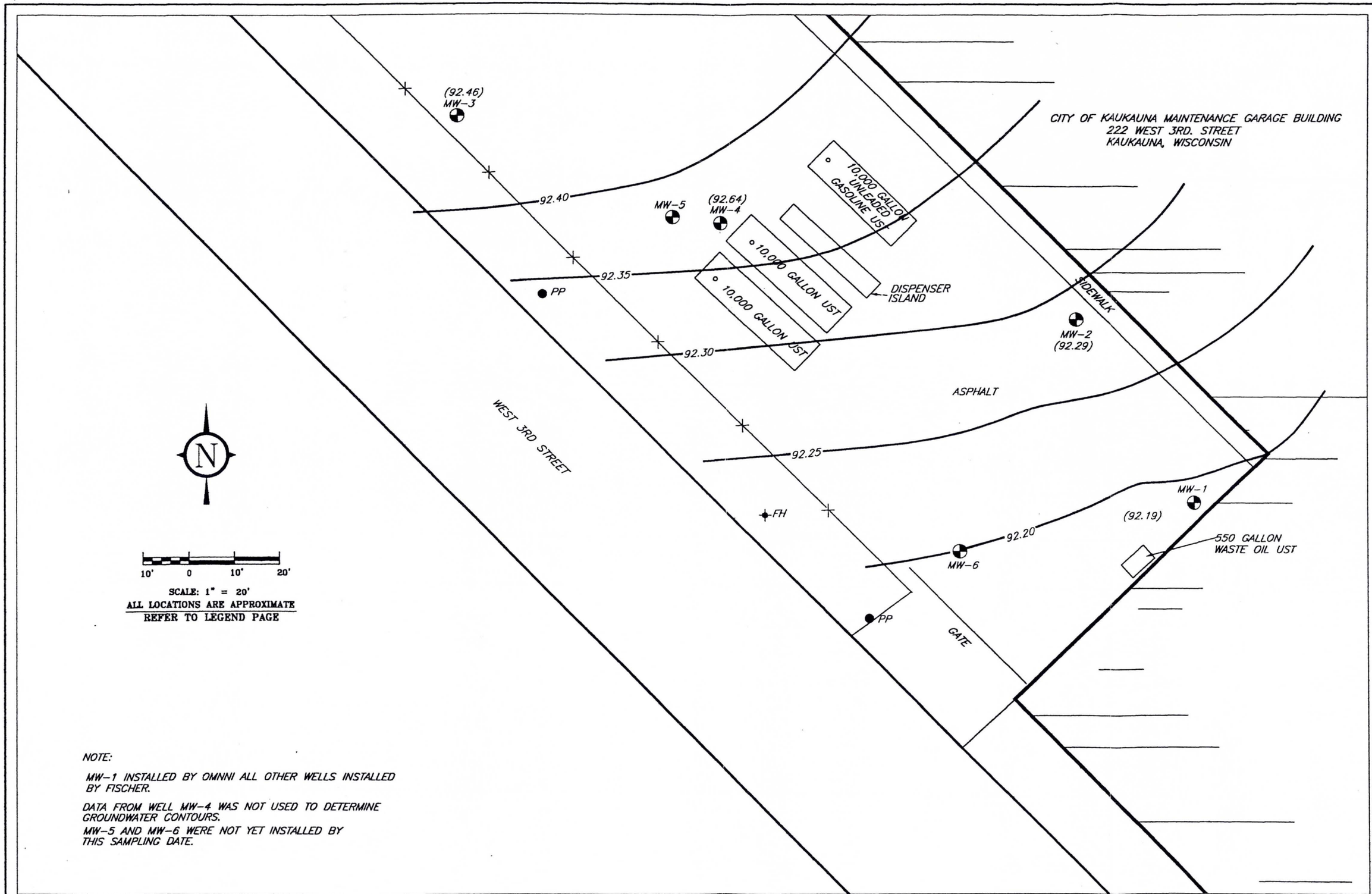
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003

DRAWN BY: KP | REVIEWED BY:
DATE: 7/31/98 | APPROVED BY:
IDN: CLOSURE\FIG5

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130



NOTE:

MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER.

DATA FROM WELL MW-4 WAS NOT USED TO DETERMINE GROUNDWATER CONTOURS.

MW-5 AND MW-6 WERE NOT YET INSTALLED BY THIS SAMPLING DATE.

FIGURE 6: GROUNDWATER CONTOUR MAP - APRIL 21, 1998

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
CLOSURE REQUEST

398132.003

DRAWN BY: KP | REVIEWED BY:
DATE: 7/31/98 | APPROVED BY:
ID#: CLOSURE\FIG6

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

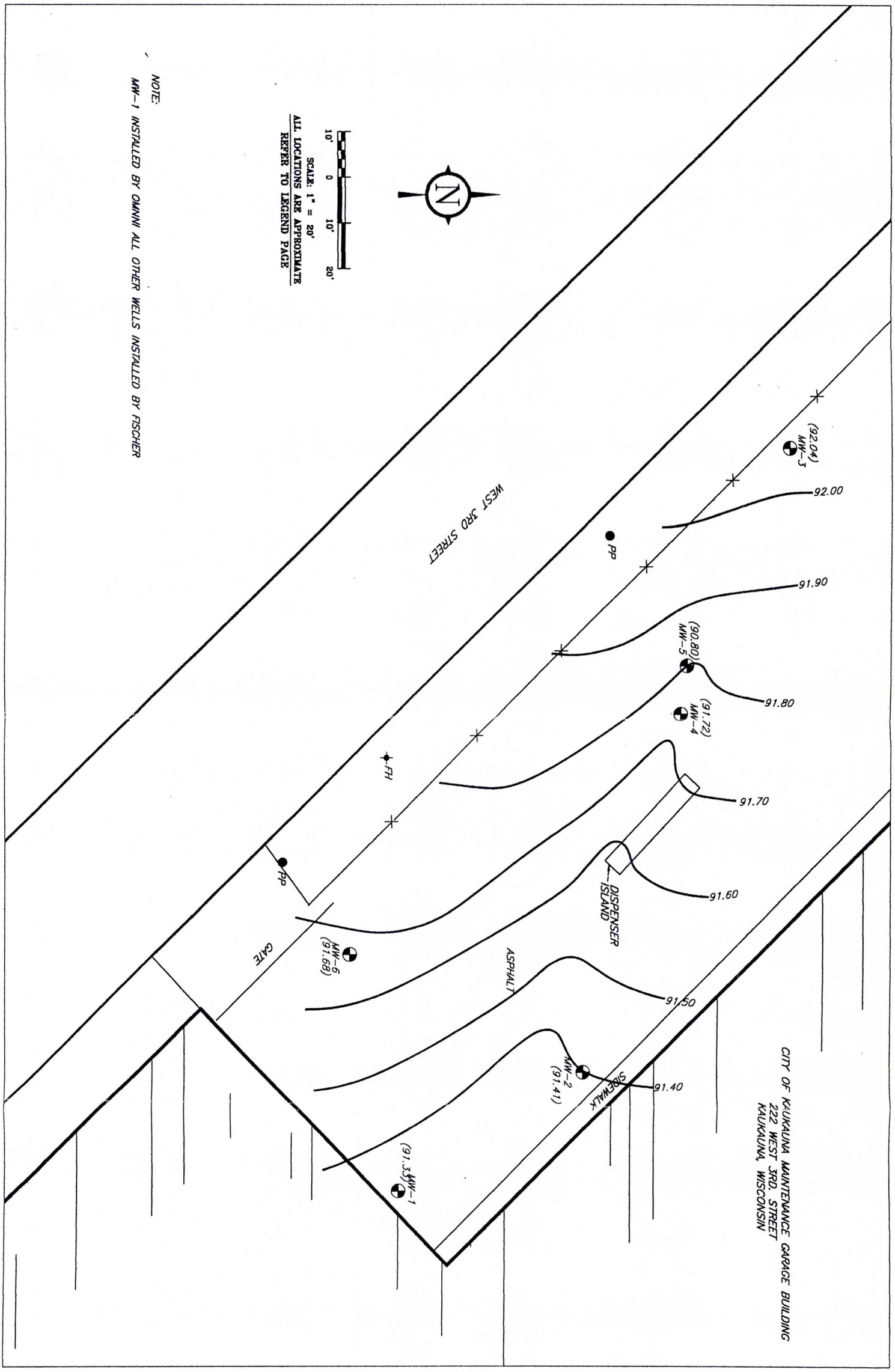


FIGURE 7: GROUNDWATER CONTOUR MAP - SEPTEMBER 16, 1998

FISCHER	RIPON OFFICE P.O. BOX 552 RIPON, WISCONSIN 54971 KAUKAUNA OFFICE P.O. BOX 127 KAUKAUNA, WISCONSIN 54130	398132.003 DRAWN BY: KP / REVIEWED BY: DATE: 7/21/99 / APPROVED BY: ID#: CLOSURE\FIG7	KAUKAUNA MAINTENANCE GARAGE KAUKAUNA, WISCONSIN CLOSURE REQUEST

TABLE 1
PRE-REMEDIAL SOIL ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sample No.	NR 720 RCL	B 1-2*	B 2-3*	B 3-2*	B 4-3*	B 5-2*
Sample Depth (feet)		4-6	6-8	4-6	6-8	2-4
Sampling Date		3/21/94	3/21/94	3/21/94	3/21/94	3/21/94
DIESEL RANGE ORGANICS (DRO) (mg/kg)						
DRO	250	<4.6	<5.2	<5.1	**280**	**12**
DETECTED PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) (ug/kg)						
Benzene	5.5	1.7	<1.2	<3.0	<1.1	<1.2
Ethylbenzene	2900	<1.1	<1.2	<3.0	2.4	<1.2
Methyl-Tert-Butyl-Ether	NE	3.1	<1.2	<3.0	<1.1	<1.2
m,p-Xylenes	4100	<1.1	<1.2	380	12	<1.2
o-Xylenes	4100	<1.1	<1.2	<3.0	1.1	<1.2
POLYNUCLEAR AROMATIC HYDROCARBONS (PAH) (ug/kg)						
No PAH detected	NE	NA	NA	NA	<LOD	NA
POLYCHLORINATED BIPHENYLS (PCB) (ug/kg)						
No PCB detected	NE	NA	NA	NA	<LOD	NA
LEAD and CADMIUM (mg/kg)						
Lead	50	NA	NA	NA	4.4	NA
Cadmium	4.9	NA	NA	NA	0.03	NA

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NE - RCL not established
RCL - NR 720 Residual Contaminant Levels (exceedances shaded)
* Samples collected by OMNNI Engineers

DRO - Diesel Range Organics
NA = Not Analyzed
LOD = Limit of Detection

TABLE 1 (Continued)
PRE-REMEDIAL SOIL ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sample No.	NR 720 RCL	B-6	B-7	B-8	B-9	B-9	B-10	B-10	B-11	B-11
Sample Depth (feet)		1-3	3-5	1-3	1-3	3-5	1-3	5-7	1-3	2-5
Sampling Date		4/15/98	4/15/98	4/15/98	4/15/98	4/15/98	4/15/98	4/15/98	4/15/98	4/15/98
GASOLINE RANGE ORGANICS (GRO), DIESEL RANGE ORGANICS (DRO) (mg/kg)										
GRO	250	<3.9	<2.8	22	85	16	<2.9	3.3	<2.9	<3.2
DRO	250	19	<4.0	47	27	<4.3	9.0	12	8.0	<4.4
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) (ug/kg)										
Benzene	5.5	<25	<25	**2300**	**1500**	**190**	<25	**71**	<25	<25
Ethylbenzene	2900	<25	<25	550	1900	460	30	<25	<25	<25
Methyl-Tert-Butyl-Ether	NE	<25	<25	<25	<25	<25	<25	<25	<25	<25
Toluene	1500	<25	<25	160	160	<25	92	<25	110	<25
1,2,4-Trimethylbenzene	NE	45	<25	590	2600	2200	65	300	<25	<25
1,3,5-Trimethylbenzene	NE	44	<25	230	1600	610	<25	73	<25	<25
Xylenes, Total	4100	110	<25	1600	**11190**	2200	136	130	<25	<25
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC) (ug/kg)										
Naphthalene	NE	NA	NA	NA	48	NA	NA	NA	NA	NA
s-Butylbenzene	NE	NA	NA	NA	47	NA	NA	NA	NA	NA
n-Butylbenzene	NE	NA	NA	NA	74	NA	NA	NA	NA	NA
Isopropylbenzene	NE	NA	NA	NA	340	NA	NA	NA	NA	NA
p-Isopropylbenzene	NE	NA	NA	NA	42	NA	NA	NA	NA	NA
n-Propylbenzene	NE	NA	NA	NA	330	NA	NA	NA	NA	NA
DETECTED POLYNUCLEAR AROMATIC HYDROCARBONS (PAH) (ug/kg)										
Benzo(a)anthracene	NE	NA	NA	16	NA	NA	NA	NA	NA	NA
Fluoranthene	NE	NA	NA	27	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	NE	NA	NA	430	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NE	NA	NA	790	NA	NA	NA	NA	NA	NA
Naphthalene	NE	NA	NA	630	NA	NA	NA	NA	NA	NA
Phenanthrene	NE	NA	NA	23	NA	NA	NA	NA	NA	NA
Pyrene	NE	NA	NA	17	NA	NA	NA	NA	NA	NA
LEAD (mg/kg)										
Lead	50	**150**	NA	40	**370**	NA	NA	NA	NA	NA

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR 720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

TABLE 1 (Continued)
PRE-REMEDIAL SOIL ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sample No.	NR 720 RCL	B-12	B-12	B-13	B-13	B-14	B-14	B-15	B-15	B-16
Sample Depth (feet)		1-3	5-7	1-3	5-7	1-3	3-5	2.5-4.5	4.5-6.5	4.5-6.5
Sampling Date		4/15/98	4/15/98	4/15/98	4/15/98	4/15/98	4/15/98	8/28/98	8/28/98	8/28/98
GASOLINE RANGE ORGANICS (GRO), DIESEL RANGE ORGANICS (DRO) mg/kg										
GRO	250	<3.0	100	<2.7	<2.9	3.9	<2.9	**2200**	**1100**	<2.9
DRO	250	33	48	56	<3.7	23	<4.1	**3500**	**920**	140
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) (ug/kg)										
Benzene	5.5	<25	**2100**	<25	<25	<25	<25	**13000**	**7100**	<25
Ethylbenzene	2900	<25	**15000**	36	<25	<25	<25	**54000**	**32000**	<25
Methyl-Tert-Butyl-Ether	NE	<25	<250	<25	<25	<25	<25	<1000	3200	<25
Toluene	1500	34	1500	30	<25	<25	<25	**3500**	850	<25
1,2,4-Trimethylbenzene	NE	47	45000	70	<25	55	<25	120000	69000	<25
1,3,5-Trimethylbenzene	NE	<25	14000	27	<25	38	<25	39000	23000	<25
Xylenes, Total	4100	69	**55000**	153	<25	86	<25	**166800**	**94800**	66
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC) ug/kg										
Naphthalene	NE	NA	6400	NA	NA	NA	NA	NA	NA	NA
p-Isopropyltoluene	NE	NA	1400	NA	NA	NA	NA	NA	NA	NA
s-Butylbenzene	NE	NA	1400	NA	NA	NA	NA	NA	NA	NA
n-Butylbenzene	NE	NA	4400	NA	NA	NA	NA	NA	NA	NA
Isopropylbenzene	NE	NA	2100	NA	NA	NA	NA	NA	NA	NA
p-Isopropyltoluene	NE	NA	750	NA	NA	NA	NA	NA	NA	NA
n-Propylbenzene	NE	NA	8400	NA	NA	NA	NA	NA	NA	NA
LEAD (mg/kg)										
Lead	50	NA	6.5	NA	NA	NA	NA	NA	NA	NA

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR 720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

TABLE 2

POST-REMEDIAL SOIL ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sample No.	NR 720 RCL	Confirmation #1	Confirmation #2	S-Side	S-Side	NE-Base	N-Side	NE-Side	E-Side	E-Base
Sample Depth (feet)				2	8	6	3	3	1	6
Sampling Date		2/23/99	2/23/99	2/23/99	2/23/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99
GASOLINE RANGE ORGANICS (GRO), DIESEL RANGE ORGANICS (DRO) (mg/kg)										
DRO	250	**1300**	<4.7	<4.6	<3.9	<3.8	110	57	<3.8	<3.7
GRO	250	120	<3.1	<3.1	<2.9	<2.8	<3.4	3.4	<2.6	<2.7
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg										
Benzene	5.5	<50	<25	<25	<25	<25	<25	<25	<25	<25
Ethylbenzene	2900	130Q	<25	<25	<25	<25	<25	44	<25	<25
Methyl-Tert-Butyl-Ether	NE	60Q	<25	<25	<25	<25	98	<25	<25	<25
Toluene	1500	<50	<25	<25	<25	<25	<25	<25	<25	<25
1,2,4-Trimethylbenzene	NE	1800	60Q	<25	<25	<25	66Q	150	<25	<25
1,3,5-Trimethylbenzene	NE	360	<25	<25	<25	<25	<25	59	<25	<25
m,p-Xylenes	4100	<50	70Q	<25	<25	<25	180	180	27Q	<25
o-Xylenes		110Q	<25	<25	<25	<25	45Q	50Q	<25	<25
LEAD (mg/kg)										
Lead	50	NA	NA	NA	NA	<3.9	**110**	NA	NA	4.6Q

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 2 (Continued)

POST-REMEDIAL SOIL ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sample No.	NR 720 RCL	SE-Side	N-Side 2	NW-Base	NW-Side	W-Side	SW-Side	SE-Side 2	WO S-Side	W-Side
Sample Depth (feet)		3	2	4	2	2	5	6	3	5
Sampling Date		2/24/99	2/25/99	2/25/99	3/1/99	3/1/99	3/1/99	3/1/99	2/23/99	3/1/99
GASOLINE RANGE ORGANICS (GRO), DIESEL RANGE ORGANICS (DRO) (mg/kg)										
DRO	250	210	<4.2	<4.4	<4.0	<4.3	<4.1	4.9	22	**1800**
GRO	250	12	<2.7	12	<2.7	<2.7	9.0	7.6	<2.8	**700**
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg										
Benzene	5.5	<25	<25	**200**	<25	<25	<25	<25	<25	**1700**
Ethylbenzene	2900	<25	<25	400	<25	<25	<25	31Q	<25	**11000**
Methyl-Tert-Butyl-Ether	NE	140	<25	<25	<25	<25	<25	<25	<25	890Q
Toluene	1500	<25	<25	52Q	<25	<25	<25	<25	<25	620Q
1,2,4-Trimethylbenzene	NE	<25	<25	930	<25	<25	100	370	<25	42000
1,3,5-Trimethylbenzene	NE	<25	<25	290	<25	<25	39Q	38Q	<25	15000
m,p-Xylenes	4100	65Q	<25	1200	<25	<25	55Q	73	<25	**37000**
o-Xylenes		<25	<25	46Q	<25	<25	<25	<25	<25	**2800**
LEAD (mg/kg)										
Lead	50	NA	NA	8.3Q	3.7Q	NA	<3.9	NA	NA	NA

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-1						MW-2		
Sampling Date	ES	PAL	4/12/94	1/23/95	9/26/95	4/21/98	6/5/98	4/8/99*	4/21/98	6/5/98	4/8/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)											
Benzene	5	0.5	1.2	<0.6	<0.6	<0.27	<0.27	<0.27	**150**	**170**	<0.26
Ethylbenzene	700	140	3.6	<1.0	<1.0	<0.32	<0.32	<0.32	11	38	<0.24
Methyl-tert-butyl-ether	60	12	17	5.2	9.6	6.4	6.7	2.8	19	17	11
Toluene	343	68.6	<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	5.5	1.9	0.33Q
1,2,4-Trimethylbenzene	484	96	<1.0	<1.0	<1.0	<0.22	<0.22	<0.22	3.7	15	<0.86
1,3,5-Trimethylbenzene			<1.0	<1.0	<1.0	<0.27	<0.27	<0.27	<0.27	0.32Q	<0.54
Xylenes, m + p	620	124	23	<1.0	<1.0	<0.43	<0.43	<0.43	8.6	26	<0.97
Xylene, o			<1.0	<1.0	<1.0	<0.24	<0.24	<0.24	0.78	0.37Q	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)											
1,2-Dichloroethane	5	0.5	4.9	4.7	**7.8**	NA	4.0	3.3	<0.37	38	<0.24
Isopropylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	1.4	NA	NA
n-Propylbenzene	NE	NE	<1.0	NA	NA	NA	NA	NA	1.2Q	NA	NA
LEAD and CADMIUM											
Lead	15	1.5	NA	NA	NA	NA	NA	NA	<1.6	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA	NA	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates analytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial sample. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 720		MW-3			MW-4		
Sampling Date	ES	PAL	4/21/98	6/5/98	4/8/99*	4/21/98	6/5/98	4/8/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)								
Benzene	5	0.5	<0.27	<0.27	<0.26	**2400**	**2300**	**1100**
Ethylbenzene	700	140	<0.32	<0.32	<0.24	560	470	230
Methyl-tert-butyl-ether	60	12	<0.32	<0.32	<0.22	15Q	20	6.7Q
Toluene	343	68.6	<0.27	<0.27	<0.21	67	58	27
1,2,4-Trimethylbenzene	484	96	<0.22	<0.22	<0.86	**660**	**480**	160
1,3,5-Trimethylbenzene			<0.27	<0.27	<0.54	**160**	**110**	26Q
Xylenes, m + p	620	124	<0.43	<0.43	<0.97	**1700**	**1300**	370
Xylene, o			<0.24	<0.24	<0.37	**41**	**40**	15Q
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)								
n-Butylbenzene	NE	NE	<0.29	NA	NA	23	NA	NA
Naphthalene	40	8	<0.35	NA	NA	**130**	**110**	37Q
s-Butylbenzene	NE	NE	<0.29	NA	NA	11Q	NA	NA
Isopropylbenzene	NE	NE	<0.26	NA	NA	43	NA	NA
p-Isopropyltoluene	NE	NE	<0.24	NA	NA	7.0Q	NA	NA
n-Propylbenzene	NE	NE	<0.76	NA	NA	110	NA	NA
LEAD and CADMIUM (ug/L)								
Lead	15	1.5	<1.6	NA	NA	<1.6	NA	NA
Cadmium	4.9	4.9	0.1	NA	NA	NA	NA	NA
DETECTED POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)								
Fluorene	400	880	NA	NA	NA	2.0Q	NA	NA
1-methylnaphthalene	NE	NE	NA	NA	NA	30	NA	NA
2-methylnaphthalene	NE	NE	NA	NA	NA	41	NA	NA
Naphthalene	40	8	NA	NA	NA	**60**	NA	NA
Phenanthrene	NE	NE	NA	NA	NA	15	NA	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates analytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial sample. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Monitoring Well	NR 140		MW-5		MW-6	
Sampling Date	ES	PAL	8/31/98	4/15/99*	8/31/98	4/8/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)						
Benzene	5	0.5	5.5	<0.26	<0.27	<0.26
Ethylbenzene	700	140	8.2	<0.24	<0.32	<0.24
Methyl-tert-butyl-ether	60	12	<0.32		<0.32	<0.22
Toluene	343	68.6	0.63	<0.21	<0.27	<0.21
1,2,4-Trimethylbenzene	484	96	14	<0.86	<0.22	<0.86
1,3,5-Trimethylbenzene			5.0	<0.54	<0.27	<0.54
Xylenes, m + p	620	124	23	<0.97	<0.43	<0.97
Xylene, o			1.3	<0.37	<0.24	<0.37
OTHER DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)						
s-Butylbenzene	NE	NE	0.53Q	NA	<0.29	NA
n-Butylbenzene	NE	NE	1.4	NA	<0.29	NA
Chloroform	6	0.6	0.68Q	NA	<0.35	NA
Naphthalene	40	8	3.2	<0.89	<0.35	NA
Isopropylbenzene	NE	NE	0.90	NA	<0.26	NA
n-Propylbenzene	NE	NE	2.8	NA	<0.76	NA
LEAD						
Lead	15	1.5	<1.6	NA	<1.6	NA

Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
Shading indicates anaytical result above NR 140 enforcement standards
All concentrations in micrograms per liter (ug/l).
* Post-remedial sample. All other samples are pre-remedial.
NA = Parameter not analyzed
NE = NR 140 enforcement standard (ES) not established
PAL = NR 140 Preventive Action Limit

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sump Well	NR 140		SW-1	SW-2
Sampling Date	ES	PAL	4/8/99*	4/15/99*
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC)				
Benzene	5	0.5	1.2	<0.26
Ethylbenzene	700	140	2.3	<0.24
Methyl-tert-butyl-ether	60	12	0.66Q	<0.22
Toluene	343	68.6	0.51Q	<0.21
1,2,4-Trimethylbenzene	484	96	5.9	<0.86
1,3,5-Trimethylbenzene			2.8	<0.54
Xylenes, m + p	620	124	12	<0.97
Xylene, o			1.8	<0.37

All concentrations in ug/l - micrograms per liter
ES = Enforcement Standard (exceedances shaded)
PAL = Preventive Action Limit
NA = not analyzed for parameter
Q = Analyte detected above limit of detection (LOD) but below limit of quantitation (LOQ)
NE = NR 140 enforcement standard (ES) not established
* Post-remedial sample.

TABLE 4

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-1			MW-2			MW-3		
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99
Nitrate/Nitrite	mg/l	NA	NA	0.061*	NA	NA	0.087*	NA	NA	0.57*
Sulfate	mg/l	NA	NA	64	NA	NA	160	NA	NA	170
Methane	ug/l	NA	NA	270	NA	NA	<0.9	NA	NA	7.4
FIELD TEST										
Temperature	°C	10.4	15.1	10.8	9.7	13.6	10.2	7.0	12.9	7.1
Conductivity	uS/cm	1200	2680	NA	1120	1460	NA	2090	3760	NA
pH	units	7.34	6.72	NA	7.44	6.49	NA	7.20	6.55	NA
Dissolved Oxygen	ppm	1.3	0.37	0.31	2.2	0.50	0.21	6.1	0.80	0.24
ORP	mV	NA	NA	15	NA	NA	-70	NA	NA	20
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	0.5	NA	NA	0.5

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

TABLE 4 (Continued)

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-4			MW-5			MW-6			SW-1	SW-2
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/15/9	4/21/98	6/5/98	4/8/99	4/8/99	4/15/99
Nitrate/Nitrite	mg/l	NA	NA	0.069*	NA	NA	NA	NA	NA	0.066*	NA	NA
Sulfate	mg/l	NA	NA	85	NA	NA	NA	NA	NA	81	NA	NA
Methane	ug/l	NA	NA	430	NA	NA	NA	NA	NA	530	NA	NA
FIELD TEST												
Temperature	°C	8.6	14.1	8.0	15.3	NA	NA	19.4	NA	7.9	7.9	NA
Conductivity	uS/cm	2210	2870	NA	780	NA	NA	5490	NA	NA	NA	NA
pH	units	7.37	6.58	NA	5.72	NA	NA	5.27	NA	NA	NA	NA
Dissolved Oxygen	ppm	4.3	0.53	0.17	0.22	NA	NA	0.24	NA	0.14	0.12	NA
ORP	mV	NA	NA	-65	130	NA	NA	-60	NA	OR	-75	NA
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	NA	NA	NA	0.5	0.5	NA

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

FISCHER

P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: feikauk@ athenet.net

RECEIVED
JUL 26 1999
LMD SOLID WASTE

July 21, 1999

Mr. Greg Tilkens
Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307

RE: REMEDIATION DOCUMENTATION REPORT for Kaukauna Maintenance Garage, 222 West 3rd Street, Kaukauna, WI
FISCHER #398132.003
WDNR # 03-45-1729
PECFA #54130-2406-22

Kaukauna Cty –

Dear Mr. Tilkens:

On behalf of the City of Kaukauna (the responsible party), FISCHER is submitting the attached report summarizing the remedial excavation and sampling activities performed at the Kaukauna Maintenance Garage during February 1999. This report also discusses the results of one groundwater monitoring event performed subsequent to the remedial excavation activities.

If you have any questions regarding this project please contact me at (920) 766-2069.

Sincerely,

FISCHER

Karen A. Burkman
Professional Soil Scientist

Robert H. Klauk, P.G.
Senior Hydrogeologist

KAB/rk/rle
c: Mr. John Sundelius
COMM

FISCHER

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E-mail: feikauk@ athenet.net

REMEDIATION DOCUMENTATION REPORT

Prepared For:

KAUKAUNA MAINTENANCE GARAGE

222 West 3rd Street
Kaukauna, Wisconsin
FISCHER #398132.003
WDNR ID # 03-45-1729
PECFA #54130-2406-22

Prepared By:

FISCHER
P. O. Box 127
Kaukauna, Wisconsin

July 21, 1999

TABLE OF CONTENTS
REMEDIATION DOCUMENTATION REPORT
KAUKAUNA MAINTENANCE GARAGE
July 21, 1999

EXECUTIVE SUMMARY i

SUBMITTAL CERTIFICATION ii

1.0 INTRODUCTION 1

1.1 PURPOSE 1
1.2 PROJECT BACKGROUND 1
1.3 SITE INFORMATION AND CONTACTS 2

2.0 REMEDIAL ACTION 3

2.1 REMEDIAL EXCAVATION 3
2.2 CONFIRMATION AND CLOSURE SAMPLING 4
2.2.1 Soil Analytical Results 4

3.0 POST REMEDIAL EXCAVATION GROUNDWATER MONITORING 6

3.1 GROUNDWATER FLOW DIRECTION 6
3.2 GROUNDWATER SAMPLING 6
3.2.1 Groundwater Analytical Results 6
3.3 GROUNDWATER FIELD MONITORING 7
3.3.1 Groundwater Field Monitoring Results 7

4.0 CONCLUSIONS 8

4.1 REMEDIAL ACTION 8
4.2 GROUNDWATER MONITORING 8
4.2.1 Natural Attenuation of Groundwater 8

5.0 RECOMMENDATIONS 9

TABLE OF CONTENTS (Continued)
REMEDIATION DOCUMENTATION REPORT
KAUKAUNA MAINTENANCE GARAGE
July 21, 1999

TABLES

Table 1	Summary of Soil Analytical Results – Remedial Excavation
Table 2	Groundwater Elevation Data
Table 3	Summary of Groundwater Analytical Results
Table 4	Summary of Groundwater Biodegradation Analytical Results

FIGURES

Figure 1	Site Location Map
Figure 2	Site Plan Prior to Remediation
Figure 3	Limits of Remedial Excavations and Closure Sample Locations
Figure 4	Post-Remediation Site Plan
Figure 5	Groundwater Elevation Contours – April 8, 1999

APPENDICES

Appendix A	Acronyms
Appendix B	Site Photographs
Appendix C	Soil Disposal Documentation
Appendix D	Soil Analytical Reports
Appendix E	Groundwater Analytical Reports

EXECUTIVE SUMMARY

The Kaukauna Maintenance Garage is located at 222 West 3rd Street in the City of Kaukauna, Outagamie County, Wisconsin (WI). Acronyms used throughout this report are referenced in Appendix A. The site presently operates as a maintenance garage and is owned by the City of Kaukauna. Five underground storage tanks (USTs) are registered with the Department of Commerce (COMM) for the site: two 10,000-gallon diesel fuel, one 10,000-gallon leaded gasoline, one 10,000-gallon unleaded gasoline, and one 550-gallon waste oil UST. The 10,000-gallon unleaded gasoline UST was upgraded and left in place and one new 10,000-gallon diesel fuel UST was installed. The remaining three USTs were removed from the site during the remedial excavation activities.

OMNNI Associates (OMNNI) previously conducted a site investigation with regards to the waste oil UST. Based on review of OMNNI's *Site Investigation Report*, the extent of contamination from the waste oil UST was not yet defined at that time. Reportedly, OMNNI collected a groundwater sample from a sump located near the remaining USTs and the analytical results indicated contamination.

The City of contracted FISCHER to perform a site investigation. Site investigation data was presented in FISCHER's *Site Investigation Report*, dated October 2, 1998. As part of FISCHER's site investigation activities, 11 soil borings were advanced at the site; four were completed as groundwater monitoring wells and one was completed as a bedrock piezometer. Contamination was detected within one meter of bedrock, and, therefore, an "environmental factor", as defined in COMM 47, appeared to be present.

FISCHER evaluated remedial alternatives and submitted a *Remedial Action Plan,* dated October 5, 1998. FISCHER proposed to address the "environmental factor" and contaminants by excavating a portion of the impacted soil and conducting additional groundwater monitoring.

From February 23 through 25, 1999, 1,389.75 tons of petroleum-impacted soil were excavated from two areas on the site and transported to the Ridgeview BioSite for bioremediation treatment. In order to excavate soil to bedrock to eliminate the "environmental factor", 203,985 gallons of groundwater were pumped from the largest excavation and transported to the Heart of the Valley municipal treatment plant located in Kaukauna. Two sump wells were installed during remedial excavation backfill operations.

Closure soil samples were collected from the base and sidewalls of the final excavations to verify any remaining contaminant concentrations. Analytical results indicate the majority of soil with contaminant concentrations exceeding Wisconsin Administrative Code (WAC) Chapter NR 720 generic residual contaminant levels has been excavated. One post-excavation groundwater monitoring event has been performed and the analytical results indicate soil remediation and natural attenuation have reduced contaminant concentrations in the groundwater.

SUBMITTAL CERTIFICATION

"I, Karen A. Burkman, hereby certify that I am a scientist as that term is defined in s. NR 712.03(3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Karen A Burkman — 7-21-99

Karen A. Burkman
Professional Soil Scientist, License #13-112

Date

"I, Robert H. Klauk hereby certify that I am a hydrogeologist as that term is defined in s.NR 712.03(1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Robert H. Klauk — 7/22/99

Robert H. Klauk, P.G.
Senior Hydrogeologist

Date

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to summarize the remedial action performed on-site during February 1999 and provide the Wisconsin Department of Natural Resources (WDNR) with an update of the groundwater monitoring results subsequent to remedial excavation activities. Acronyms used throughout this report are referenced in Appendix A.

1.2 PROJECT BACKGROUND

The Kaukauna Maintenance Garage is located at 222 West 3rd Street, Kaukauna, Wisconsin (WI). A site location map is presented in Figure 1. The subject site is owned and operated by the City of Kaukauna and is currently used as a municipal maintenance garage. Five underground storage tanks (USTs) are registered with the Department of Commerce (COMM) for the site: two 10,000-gallon diesel fuel, one 10,000-gallon leaded gasoline, one 10,000-gallon unleaded gasoline, and one 550-gallon waste oil UST. The 10,000-gallon unleaded gasoline UST was upgraded and left in place and one new 10,000-gallon diesel fuel UST was installed. The remaining three USTs were removed from the site during the remedial excavation activities. UST locations are identified on Figure 2.

OMNNI Associates (OMNNI) previously conducted a site investigation during which five soil borings were advanced at the site and one boring was converted into groundwater monitoring well MW-1. Based on a review of OMNNI's *Site Investigation Report*, dated June 1994, it was FISCHER's opinion that the extent of contamination from the other site USTs was not adequately defined.

The City of Kaukauna contracted FISCHER on February 18, 1998 to perform a site investigation to further define the extent of contamination. As part of the site investigation activities, 11 soil borings were advanced at the site; four were converted into groundwater monitoring wells and one was converted into a bedrock piezometer.

The vertical and horizontal extent of soil and groundwater contamination on-site was defined for the purposes of the site investigation. Contamination was detected within one meter of bedrock, and, therefore, an "environmental factor", as defined in COMM 47, was present.

FISCHER evaluated remedial alternatives and submitted a R*emedial Action Plan* (RAP), dated October 5, 1998. FISCHER proposed to address the "environmental factor" and contaminants by excavating a portion of the impacted soil and conducting additional groundwater monitoring.

1.3 SITE INFORMATION AND CONTACTS

Site Name and Location:	Kaukauna Maintenance Garage 222 West 3rd Street Kaukauna, WI 54130 Northeast ¼ of Government Lot 22, Township 22 North, Range 18 East of Outagamie County
Current Site Owner:	City of Kaukauna Department of Public Works P.O. Box 890 Kaukauna, WI 54130 Contact: Mr. John Sundelius – Street Superintendent Phone: (920) 766-6337
Consultant:	FISCHER P.O. Box 127 Kaukauna, WI 54130 Phone: (920) 766-2069
Project Manager:	Ms. Karen Burkman FISCHER P.O. Box 127 Kaukauna, WI 54130 Phone: (920) 766-2069
Project Hydrogeologist:	Mr. Robert H. Klauk, P.G. FISCHER P.O. Box 127 Kaukauna, WI 54130 Phone: (920) 766-2069
Site Operations:	The property is used as a municipal maintenance garage.

2.0 REMEDIAL ACTION

2.1 REMEDIAL EXCAVATION

Remedial excavation activities were performed by Gene Frederickson Trucking (GFT), Kaukauna, WI, under the direction of FISCHER personnel. During soil excavation activities, Fox Valley Petroleum Service (Little Chute, WI), Schroeder Environmental Cleaning Services, Inc. (DePere, WI) and GFT removed and cleaned three USTs, upgraded one 10,000 gallon UST, and installed a new 10,000 gallon UST in the remedial excavation, all under contracts separate from the contract for soil remediation. Holes were not observed in any of the removed USTs, however, some pitting was evident. The USTs were transported to GFT for scrap. Photographs of the soil excavation and tank removal activities are included in Appendix B.

Impacted soil was excavated from the site from February 23 through 25, 1999. Excavation activities were performed at two separate site locations, as proposed in the remedial action plan. The limits of the two excavation areas are identified on Figure 3. The eastern portion of the larger excavation extended to approximately six feet (ft) below ground surface (bgs). The northwest portion of the larger excavation extended only to approximately four ft bgs because the UST in this area was upgraded and left in place. The remainder of the larger excavation extended to bedrock, to approximately 12 to 13 ft bgs. The smaller excavation, near the former waste oil UST, extended to the apparent bedrock surface (approximately 8.5 ft bgs).

Groundwater rapidly flowed into the larger excavation and seeped into the waste oil UST excavation. In order to eliminate the "environmental factor" at this site, impacted soil within three ft of bedrock needed to be excavated. In order to achieve that goal, 203,985 gallons of contaminated groundwater was pumped from the larger excavation during soil removal. The impacted groundwater pumped from the excavation was transported by GFT to the Heart of the Valley municipal treatment plant located in Kaukauna, WI.

While excavating, FISCHER collected soil samples for olfactory and visual evaluation of hydrocarbon contamination, as well as field screening. FISCHER also used the site investigation results to direct excavation activities.

GFT excavated 1,389.75 tons of impacted soil and transported it to the Waste Management Ridgeview BioSite located in Whitelaw, WI for bioremediation treatment. A copy of Waste Management's invoice, documenting the quantity of soil received by the BioSite, is presented in Appendix C.

Groundwater monitoring well MW-2 was not destroyed during excavation activities; however, the soil immediately surrounding this well was removed and replaced with ¾-inch washed stone during excavation backfill operations. Two sump wells, SW-1 and SW-2, were installed in the larger excavation during backfill operations. Their locations are identified in Figure 4. The two sump wells were constructed of 4-inch diameter Schedule 40 polyvinyl chloride (PVC) riser material with 10-feet of Schedule 40 PVC, 0.02 (20 slot), factory cut, flush threaded screen. The sump wells were installed during excavation backfill activities by placing ¾-inch washed stone a minimum of two feet from the well screen and a minimum of two feet above the top of the screen.

The sump wells were finished with bentonite surface seal and a steel flushmount protective casing set in a concrete surface pad.

After the remedial excavation activities were complete, the 10,000 gallon UST was upgraded and the new UST was installed. Upon completion of the UST upgrade/installation, the largest excavation was backfilled. Due to the presence of subsurface water and sewer utility lines within the waste oil UST excavation, backfill operations were performed as quickly as possible to prevent damage to the utility lines. The excavations were backfilled with compacted ¾-inch washed stone. Three-quarter-inch washed stone was placed around the screen of monitoring well MW-2. Pump islands were subsequently installed over the larger excavation area for the upgraded and new USTs and the site was paved.

2.2 CONFIRMATION AND CLOSURE SAMPLING

One soil sample was randomly collected from each of two dump trucks as they left the site to document levels of soil contamination in the excavated soil. These samples are identified as "Confirmation #1, and #2". Both soil samples exhibited strong petroleum odors and PID field screening indicated the presence of volatile organic vapors.

Twelve soil closure samples were collected from the sidewalls of the larger excavation, and one from a sidewall of the waste oil UST excavation. Due to the accumulation of groundwater in the bottom of both excavations, only three soil samples were collected from the floor of the largest excavation. Only one sidewall sample could be collected before the waste oil UST excavation required backfilling in order to prevent damage to the adjacent subsurface utilities. The sidewall and floor closure samples were collected for laboratory analysis in order to identify remaining soil impacts. Sample locations are identified on Figure 3.

Closure samples were weighed in the field with a digital scale. Approximately 25 grams of soil were placed into clean laboratory prepared jars. Each GRO/PVOC soil sample was preserved utilizing premeasured laboratory grade methanol. A portion of the closure samples were also analyzed for lead. All samples were then transported, on ice, to EnChem, Inc. (WDNR #405132750) using standard chain-of-custody procedures. Closure soil samples were analyzed for gasoline range organics (GRO), diesel range organics (DRO), and petroleum volatile organic compounds (PVOC).

2.2.1 Soil Analytical Results

Laboratory analytical results, for the soil samples discussed in Section 2.2, are included in Appendix D and summarized in Table 1. Of the 16 closure samples analyzed, three had contaminant concentrations exceeding generic residual contaminant levels (RCLs). In the soil sample collected from the north sidewall in the eastern portion of the larger excavation, from a depth of approximately three ft bgs, lead was detected at a concentration of 110 milligrams per kilogram (mg/kg). This closure sample was collected from the apparent vadose zone. In the soil sample collected from the base of the larger excavation, above the upgraded UST, from a depth of approximately four ft bgs, benzene was detected at a concentration of 200 micrograms per kilogram (ug/kg). This closure

sample was collected from below the static groundwater table, as measured in nearby monitoring wells. In the soil sample collected from the west side of the larger excavation, from a depth of approximately five ft bgs, the following contaminants were detected at levels above the RCLs: DRO (1,800 mg/kg), GRO (700 mg/kg), benzene (1,700 ug/kg), ethylbenzene (11,000 ug/kg), and xylenes (39,800 ug/kg). This closure sample was also collected from below the static groundwater table, as measured in nearby monitoring wells.

3.0 POST REMEDIAL EXCAVATION GROUNDWATER MONITORING

3.1 GROUNDWATER FLOW DIRECTION

Depth to groundwater has been periodically measured in site monitoring and sump wells, and ranges from approximately 3.5 to 4.5 ft bgs. Groundwater level data recorded to date is presented in Table 2.

Groundwater elevation data has been used to estimate the groundwater flow direction. The preferential groundwater flow direction at the site has generally been toward the east/southeast since the inception of the monitoring program. The effect of the February 1999 remedial excavation on the site groundwater flow characteristics is illustrated on Figure 5.

3.2 GROUNDWATER SAMPLING

Post-excavation groundwater samples were collected from monitoring/sump wells MW-1, MW-2, MW-3, MW-4, MW-6, and SW-1 on April 8, 1999. Monitoring well MW-5 was temporarily paved over and sump well SW-2 was inaccessible on April 8, 1999. However, wells MW-5 and SW-2 were sampled on April 15, 1999.

Groundwater samples collected in April 1999 were submitted to a Wisconsin certified laboratory for PVOC analysis. A portion of the groundwater samples were also subsequently analyzed for 1,2-dichloroethane (DCA) and naphthalene. Groundwater samples were also collected for laboratory analysis of methane, nitrate/nitrite, and sulfate, in order to evaluate natural attenuation. Each well was purged prior to sample collection.

3.2.1 Groundwater Analytical Results

The laboratory analytical reports for the groundwater samples collected in April 1999 are included in Appendix E. A summary of groundwater analytical results, to date, is presented in Tables 3 and 4.

Groundwater samples collected in April 1999 from monitoring wells MW-1, MW-2, MW-3, MW-5 (bedrock well) and MW-6, and sump wells SW-1 and SW-2 did not have contaminant concentrations exceeding Wisconsin Administrative Code (WAC) Chapter NR 140 enforcement standards. Benzene was detected above the WAC Chapter NR 140 enforcement standard, at a concentration of 1,100 micrograms per liter (ug/l) in the groundwater sample collected from well MW-4 during April 1999.

3.3 GROUNDWATER FIELD MONITORING

Groundwater in the site wells/sump was monitored for temperature, dissolved oxygen (DO), oxygen-reduction potential (ORP), and ferrous iron during the April 1999 sampling events. Due to instrument malfunction, pH and conductivity were not recorded. The field monitoring was performed to evaluate natural attenuation.

3.3.1 Groundwater Field Monitoring Results

Field monitoring results, to date, are included in Table 4. Results of the April 1999 monitoring are as follows. Nitrate/nitrite results ranged from 0.061 to 0.57 mg/l. However, 0.036 mg/l nitrate/nitrite was also detected in the laboratory quality control blank. Sulfate results ranged from 64 to 170 mg/l and methane results ranged from <0.9 to 530 ug/l. DO results ranged from 0.12 to 0.31 parts per million, ORP results ranged from –75 to 20 millivolts, and ferrous iron results ranged from 0.5 to 10 mg/l.

4.0 CONCLUSIONS

4.1 REMEDIAL ACTION

In February 1999, 1,389.75 tons of petroleum-impacted soil was excavated from two locations on the site and transported to the Ridgeview BioSite for bioremediation treatment. Both excavations extended to bedrock; therefore, the "environmental factor" appears to have been eliminated at this site, with one exception. Impacted soil may be present beneath the UST that was upgraded and left in-place.

Closure soil samples were collected during remedial excavation activities. Only one of the 16 closure samples had a contaminant concentration (lead) exceeding generic RCLs and was collected from the vadose zone. Since only one sample collected from the vadose zone exceeded the generic RCL and only for lead, the site is currently paved, and the site will remain paved in the foreseeable future, it is FISCHER's opinion that a deed restriction is not warranted.

4.2 GROUNDWATER MONITORING

Laboratory analytical results of groundwater samples from monitoring wells MW-1, MW-2, MW-3, MW-5 and MW-6, and sump wells SW-1 and SW-2 during April 1999 did not have contaminant concentrations exceeding NR 140 enforcement standards. Prior to soil remediation, benzene was detected in wells MW-2 and MW-5 at concentrations above the NR 140 enforcement standard. Therefore, remedial activities and natural attenuation appear to have reduced contaminant concentrations in groundwater at the locations of wells MW-2 and MW-5. Since bedrock well MW-5 does not appear to be impacted, additional bedrock wells are not proposed.

Benzene was detected at a concentration above the NR 140 enforcement standard in the groundwater sample collected from well MW-4 during April 1999. The benzene concentrations detected in groundwater samples collected from well MW-4 have decreased by approximately 50% subsequent to the remedial excavation activities. Prior to soil remediation, naphthalene, trimethylbenzenes, and xylenes had also been detected in groundwater samples collected from well MW-4 at levels above the NR 140 enforcement standards. Therefore, remedial activities and natural attenuation appear to have reduced contaminant concentrations in groundwater at the location of well MW-4.

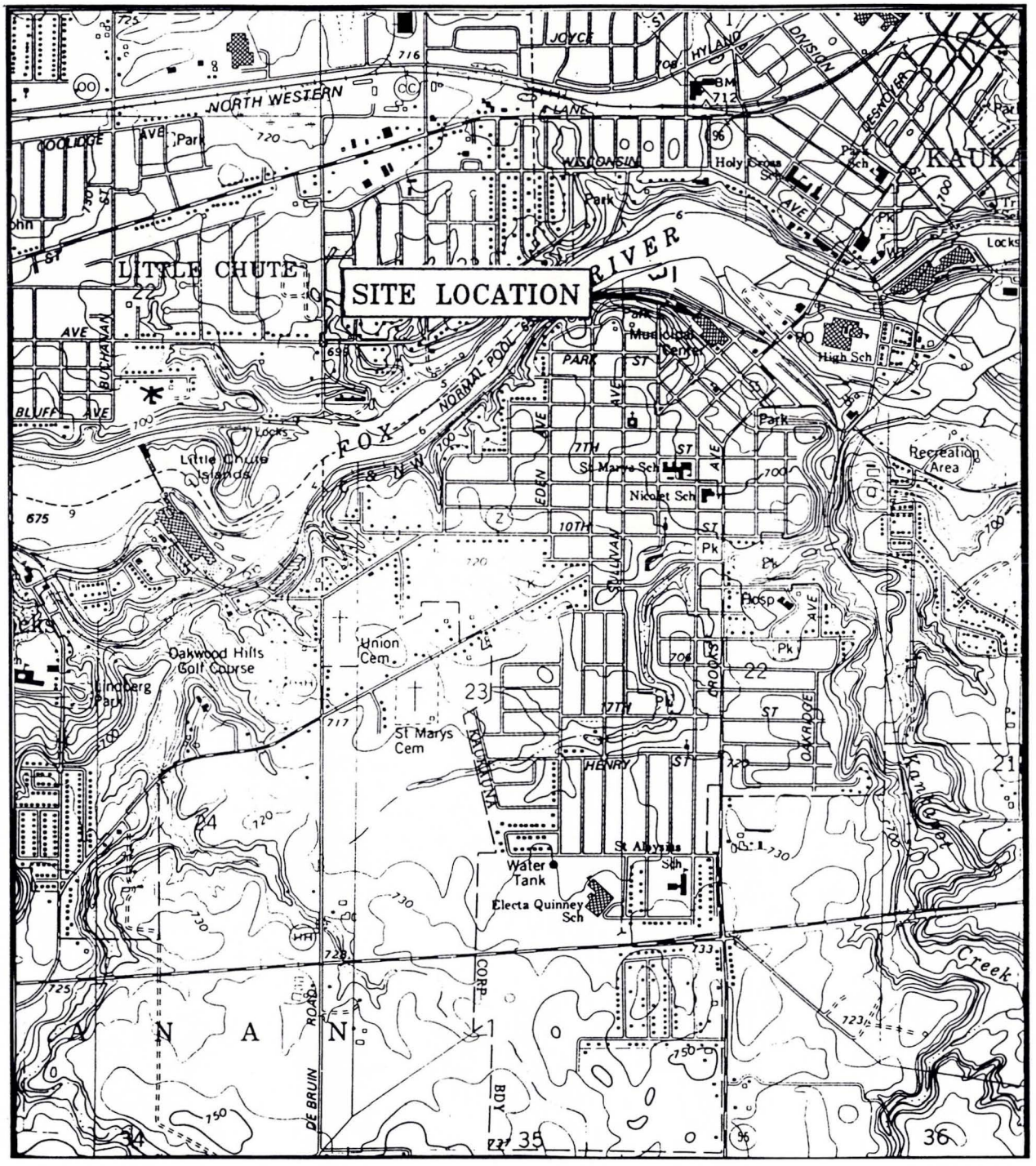
4.2.1 Natural Attenuation of Groundwater

Metabolic byproduct concentrations (methane and ferrous iron) are higher within the contaminant plume compared to outside the contaminant plume. This indicates remediation by natural attenuation is occurring. The DO, nitrate/nitrite, and sulfate concentrations detected during the April 1999 sampling event could not be used to show conclusive natural attenuation trends in the site groundwater.

5.0 RECOMMENDATIONS

Since the "environmental factor" has been eliminated, with the exception of impacted soil possibly located beneath the UST that was upgraded, and groundwater contaminant concentrations have been reduced since remedial excavation operations, FISCHER recommends case closure. FISCHER will submit a separate case closure request (with a groundwater use restriction) to the WDNR.

FIGURES



KAUKAUNA QUADRANGLE
U.S.G.S. 7.5 MINUTE SERIES
(TOPOGRAPHIC) OUTAGAMIE COUNTY
WISCONSIN

N

SCALE: 1:24,000

FIGURE 1: SITE LOCATION MAP

FISCHER RIPON OFFICE P.O. BOX 552, RIPON, WI 54971 KAUKAUNA OFFICE P.O. BOX 127, KAUKAUNA, WI 54130	JOB #:398132.003 DATE: 5/12/99 IDB: RAP\FIG1	KAUKAUNA MAINTENANCE GARAGE KAUKAUNA, WISCONSIN REMEDIATION DOCUMENTATION REPORT

LEGEND

- Property Line
- Centerline of Roadway
- Sanitary Sewer Line
- Storm Sewer Line
- Water Line
- Gas Line
- Overhead Electric Lines
- Underground Electric Lines
- Overhead Communication Lines
- Underground Communication Lines
- Groundwater Contour Line and Elevation
- Surface Contour Line and Elevation
- GW Extraction Piping
- SVE Extraction Piping
- Air Sparging Piping
- Manhole
- Utility Power Pole
- Fire Hydrant
- Light Pole
- Traffic Signal
- PID Reading
- Estimated Limits of Groundwater Contamination
- Estimated Limits of Soil Contamination
- Soil Sample
- Existing UST or AST
- Removed UST or AST
- Limits of Excavation
- Proposed Monitoring Well
- Monitoring Well
- Proposed Soil Boring
- Soil Boring
- Proposed Soil Probe
- Soil Probe
- Temporary Monitoring Well
- Extraction/Recovery Sump/Well
- Private Well
- Abandoned Well
- Backhoe Test Pit

REVISED 3/31/99

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FISCHER

KAUKAUNA OFFICE
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KAUKAUNA, WI 54130
TEL. (920) 766-2069
FAX (920) 759-2669

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

WEST 3RD STREET

ASPHALT

SIDEWALK

B-7 MW-3
B-13
B-12
B-15 MW-5
B-8 MW-4
B-14
B-9
B-10
MW-2
B-6
B-11
B-3 MW-1
B-1
B-4
MW-6 B-16
B-2
B-5

FILL PIPE
10,000 GALLON UST
FILL PIPES
10,000 GALLON UST
10,000 GALLON UST
DISPENSER ISLAND
550 GALLON WASTE OIL TANK
GATE

PP
OE
W
G
FH
MH
UE
SA

N

10' 0 10' 20'

SCALE: 1" = 20'
ALL LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

NOT ALL UTILITIES ARE LOCATED
UTILITY LOCATIONS ARE APPROXIMATE

NOTE:
B-1 THROUGH B-5 AND MW-1 INSTALLED BY OMNNI
ALL OTHER BORING S AND WELLS INSTALLED BY FISCHER

FIGURE 2: SITE PLAN PRIOR TO REMEDIATION

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

398132.003
DRAWN BY: JP
DATE: 7/21/98
ID#: RAP\FIG2
REVIEWED BY:
APPROVED BY:

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

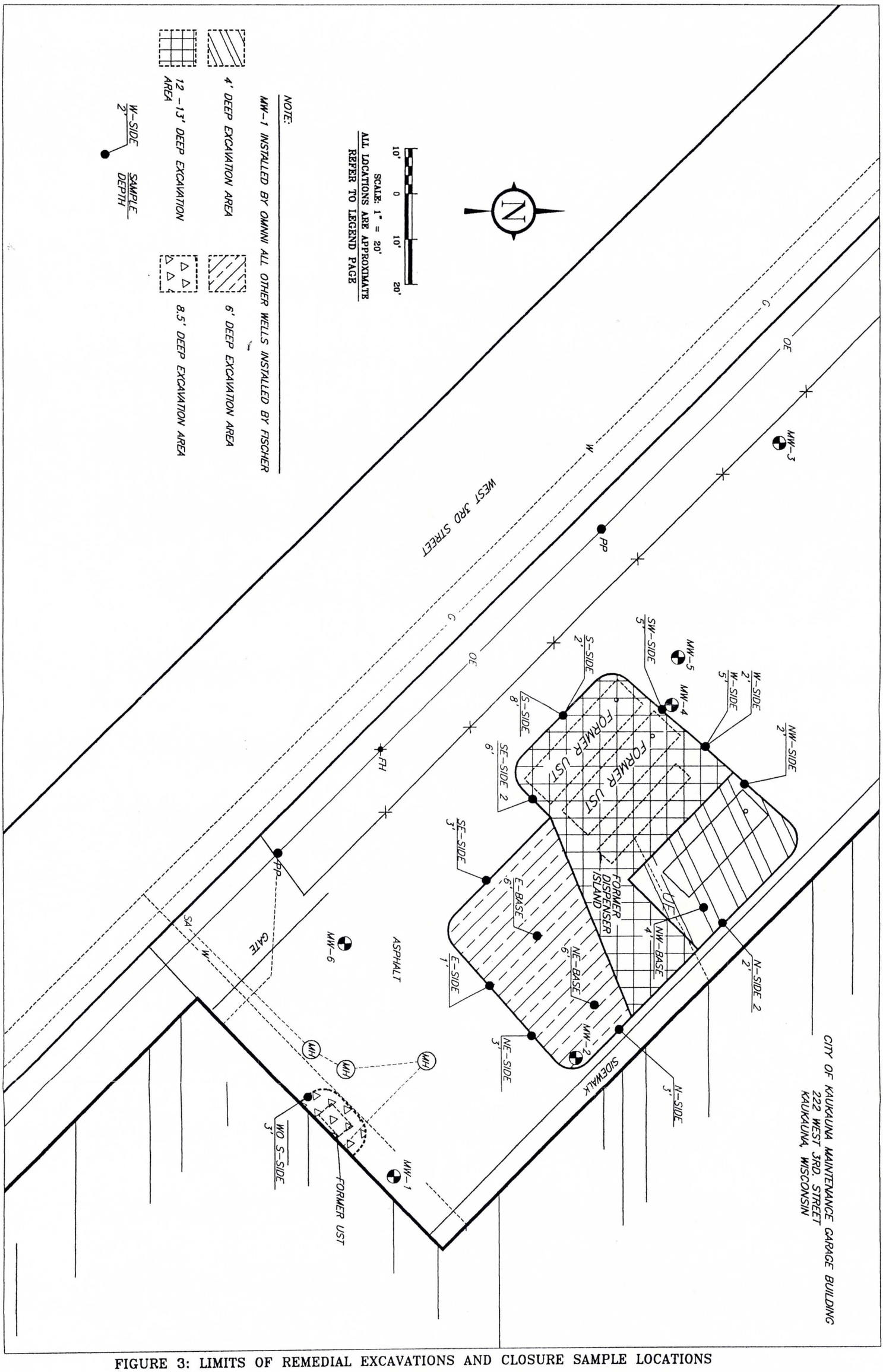


FIGURE 3: LIMITS OF REMEDIAL EXCAVATIONS AND CLOSURE SAMPLE LOCATIONS

FISCHER	RIPON OFFICE P.O. BOX 552 RIPON, WISCONSIN 54971 KAUKAUNA OFFICE P.O. BOX 127 KAUKAUNA, WISCONSIN 54130	398182.003 DRAWN BY: KP DATE: 7/21/99 ID#: RAP\FIG3 REVIEWED BY: APPROVED BY:	KAUKAUNA MAINTENANCE GARAGE KAUKAUNA, WISCONSIN REMEDIATION DOCUMENTATION REPORT

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

MW-3
MW-5
MW-4
MW-2
MW-1
MW-6
SW-1
SW-2
FH
PP
PP
10,000 GALLON UNLEADED GASOLINE UST
10,000 GALLON DIESEL FUEL UST
PUMP ISLAND
CONCRETE PAD
ASPHALT
SIDEWALK
GATE
WEST 3RD STREET

N

10' 0 10' 20'

SCALE: 1" = 20'
ALL LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

NOTE:

MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER

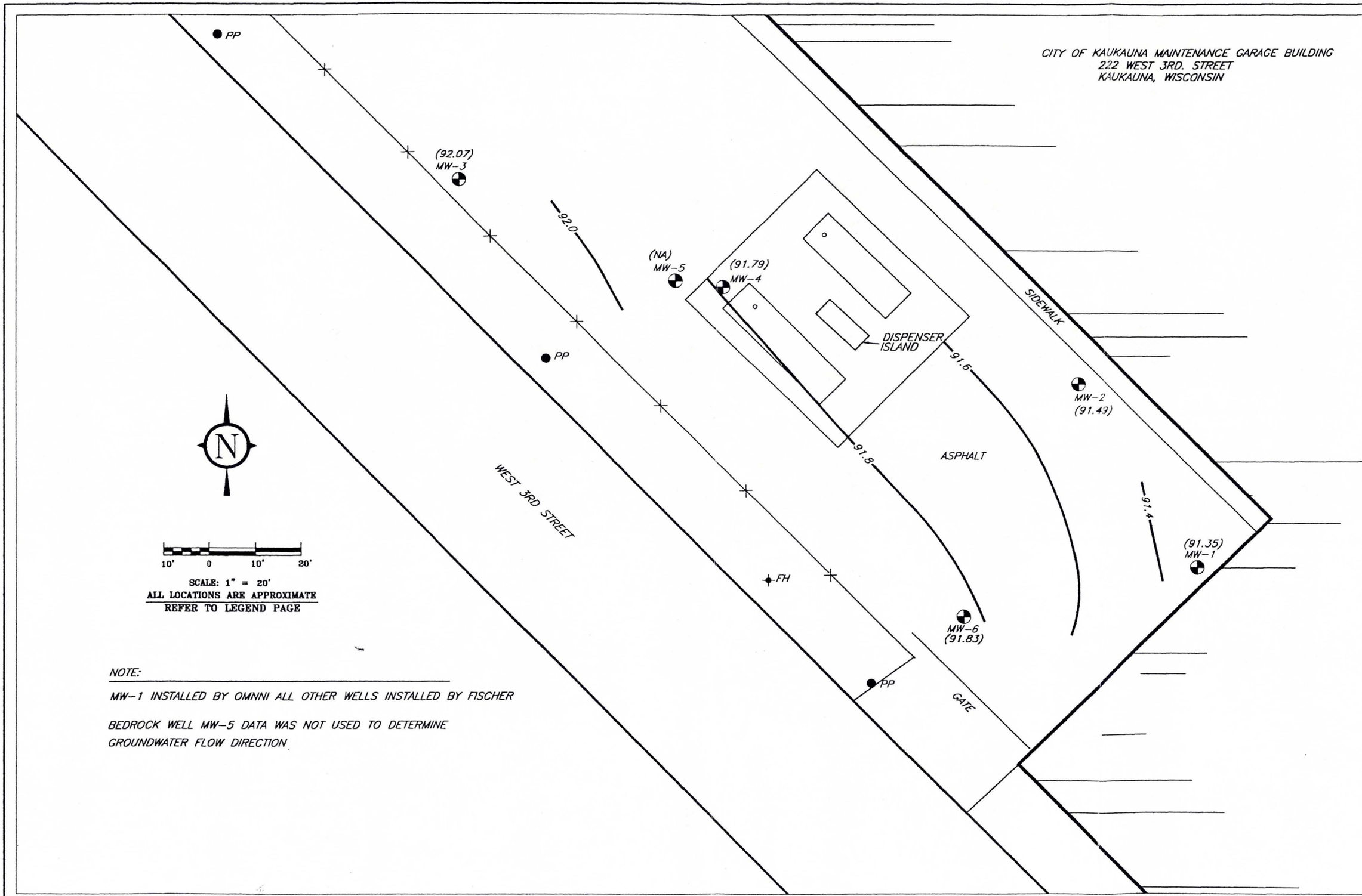
FIGURE 4: POST-REMEDIAL SITE PLAN

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA. WISCONSIN
REMEDIATION DOCUMENTATION REPORT

398132.003
DRAWN BY: KP REVIEWED BY:
DATE: 7/21/99 APPROVED BY:
ID#: R&PA\FIG4

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130



NOTE:

MW-1 INSTALLED BY OMNNI ALL OTHER WELLS INSTALLED BY FISCHER

BEDROCK WELL MW-5 DATA WAS NOT USED TO DETERMINE GROUNDWATER FLOW DIRECTION

FIGURE 5: GROUNDWATER ELEVATION CONTOURS ON APRIL 8, 1999

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIATION DOCUMENTATION REPORT

398132.003

DRAWN BY: KP
DATE: 7/21/99
ID#: RAP\FIG7
REVIEWED BY:
APPROVED BY:

FISCHER

RIPON OFFICE P.O. BOX 552
RIPON, WISCONSIN 54971
KAUKAUNA OFFICE P.O. BOX 127
KAUKAUNA, WISCONSIN 54130

TABLES

TABLE 1

SUMMARY OF SOIL ANALYTICAL RESULTS - REMEDIAL EXCAVATION
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sampling Date	2/23/99	2/23/99	2/23/99	2/23/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99	2/24/99	RCL
Parameter	Confirmation #1	Confirmation #2	S-Side 2 ft	S-Side 8 ft	NE-Base 6 ft	N-Side 3 ft	NE-Side 3 ft	E-Side 1 ft	E-Base 6 ft	SE-Side 3 ft	
DRO (mg/kg)	1300	<4.7	<4.6	<3.9	<3.8	110	57	<3.8	<3.7	210	250
GRO (mg/kg)	120	<3.1	<3.1	<2.9	<2.8	<3.4	3.4	<2.6	<2.7	12	250
Lead (mg/kg)	NA	NA	NA	NA	<3.9	110	NA	NA	4.6Q	NA	50
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg											
Benzene	<50	<25	<25	<25	<25	<25	<25	<25	<25	<25	5.5
Ethylbenzene	130Q	<25	<25	<25	<25	<25	44	<25	<25	<25	2900
Methyl-Tert-Butyl-Ether	60Q	<25	<25	<25	<25	98	<25	<25	<25	140	NE
Toluene	<50	<25	<25	<25	<25	<25	<25	<25	<25	<25	1500
1,2,4-Trimethylbenzene	1800	60Q	<25	<25	<25	66Q	150	<25	<25	<25	NE
1,3,5-Trimethylbenzene	360	<25	<25	<25	<25	<25	59	<25	<25	<25	NE
m,p-Xylenes	<50	70Q	<25	<25	<25	180	180	27Q	<25	65Q	4100
o-Xylenes	110Q	<25	<25	<25	<25	45Q	50Q	<25	<25	<25	

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 1 (Continued)

SUMMARY OF SOIL ANALYTICAL RESULTS - REMEDIAL EXCAVATION

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Sampling Date	2/25/99	2/25/99	3/1/99	3/1/99	3/1/99	3/1/99	2/23/99	3/1/99	RCL
Parameter	**N-Side 2 2 ft**	**NW-Base 4 ft**	**NW-Side 2 ft**	**W-Side 2 ft**	**SW-Side 5 ft**	**SE-Side 2 6 ft**	**WO S-Side 3 ft**	**W-Side 5 ft**	
DRO (mg/kg)	<4.2	<4.4	<4.0	<4.3	<4.1	4.9	22	**1800**	250
GRO (mg/kg)	<2.7	12	<2.7	<2.7	9.0	7.6	<2.8	**700**	250
Lead (mg/kg)	NA	8.3Q	3.7Q	NA	<3.9	NA	NA	NA	50
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOC) ug/kg									
Benzene	<25	**200**	<25	<25	<25	<25	<25	**1700**	5.5
Ethylbenzene	<25	400	<25	<25	<25	31Q	<25	**11000**	2900
Methyl-Tert-Butyl-Ether	<25	<25	<25	<25	<25	<25	<25	890Q	NE
Toluene	<25	52Q	<25	<25	<25	<25	<25	620Q	1500
1,2,4-Trimethylbenzene	<25	930	<25	<25	100	370	<25	42000	NE
1,3,5-Trimethylbenzene	<25	290	<25	<25	39Q	38Q	<25	15000	NE
m,p-Xylenes	<25	1200	<25	<25	55Q	73	<25	**37000**	4100
o-Xylenes	<25	46Q	<25	<25	<25	<25	<25	**2800**	

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
NA - not analyzed for parameter
LOD - Limits of Detection
LOQ - Limits of Quantitation

GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - NR720 Residual Contaminant Levels (exceedances shaded)
NE - RCL not established

Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

APPENDIX A

Acronyms

ACRONYMS

1,2 -DCA	1,2-dichloroethane
AST	aboveground storage tank
ASTM	American Society for Testing Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylenes
cm/sec	centimeter per second
Co.	Company
COMM	Department of Commerce
CTH	County Trunk Highway
DILHR	Department of Industry, Labor and Human Relations
DO	dissolved oxygen
DOT	Department of Transportation
DRO	diesel range organics
ES	Enforcement Standard
EPA	Environmental Protection Agency
ERP	Environmental Repair Program
ES	enforcement standard
ft	feet
GNHS	Geological and Natural History Survey
GRO	gasoline range organics
lbs	pounds
LOD	limit of detection
LOQ	limit of quantitation
LSA	limited site assessment
LUST	leaking underground storage tank
MDL	method detection limit
mg/kg	milligram per kilogram (ppm)
mg/l	milligram per liter (ppm)
MTBE	methyl tert butyl ether
NA	natural attenuation
ND	no analyte detected above the limit of detection
NE	no established compound standard
NS	not sampled for the particular parameter(s)
ORP	oxygen-reduction potential
PAH	polynuclear aromatic hydrocarbons / polycyclic aromatic hydrocarbons
PAL	preventive action limit
PECFA	Petroleum Environmental Clean-up Fund Act
PID	photoionization detector
PVC	polyvinyl chloride
PVOC	petroleum volatile organic compounds
ppb	parts per billion
ppm	parts per million
RAP	remedial action plan
RCL	residual contaminant level
RNA	remediation by natural attenuation
RP	responsible party
SPT	standard penetration test
TOC	total organic carbon
TKN	total kjeldahl nitrogen
µg/kg	microgram per kilogram (ppb)
µg/l	microgram per liter (ppb)
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compounds
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
WI	Wisconsin
yds^3	cubic yards

APPENDIX B

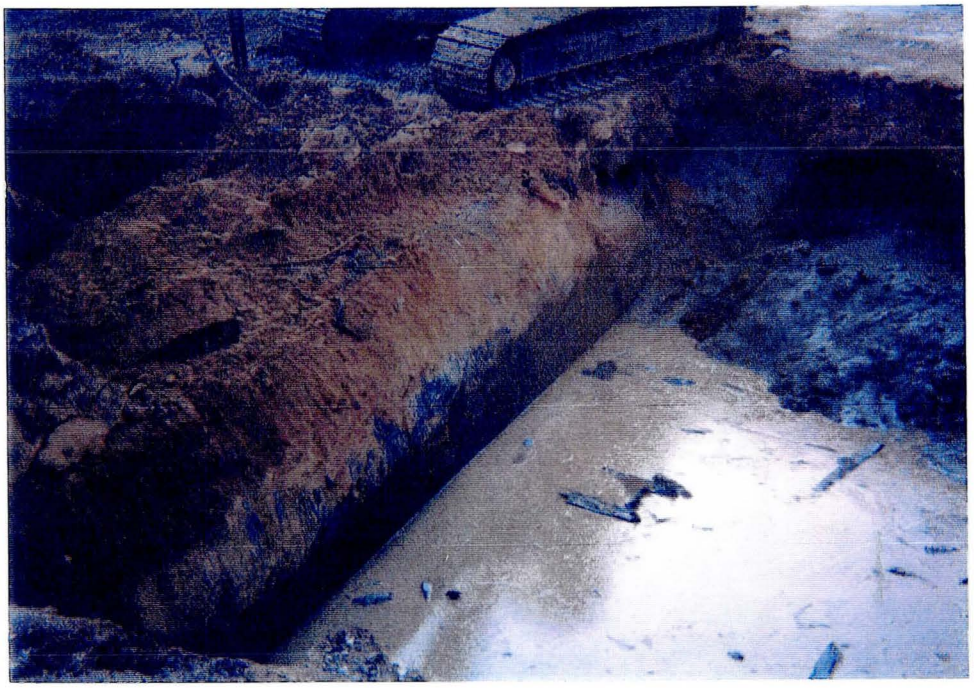
Site Photographs



Asphalt and pump island removed. UST uncovered.



UST removed.



UST uncovered. Groundwater accumulation in excavation.



USTs removed.



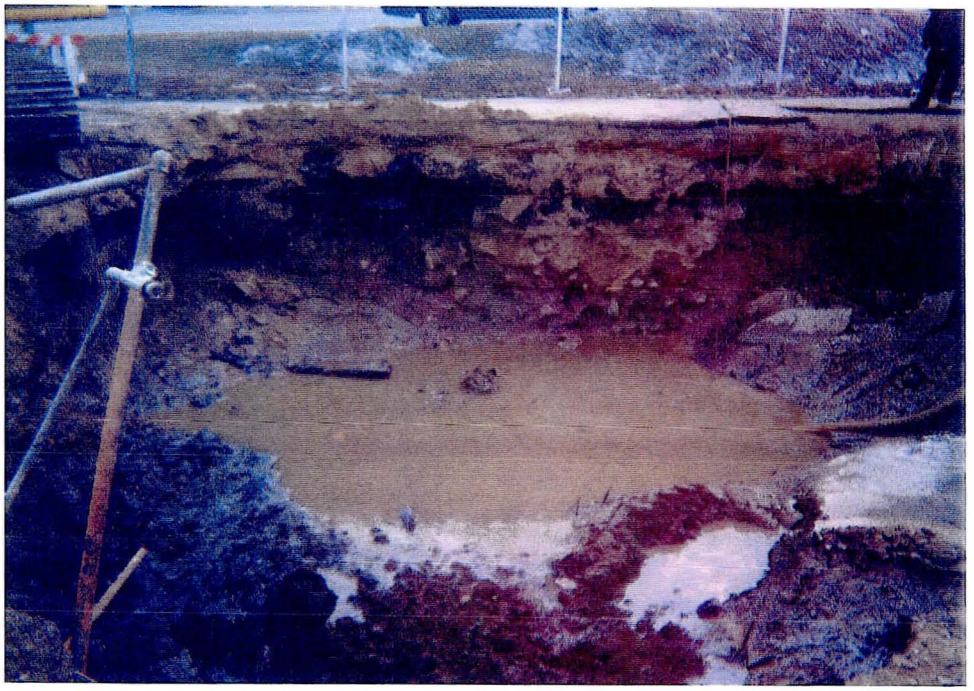
USTs removed. UST to be upgraded in place at photo right.



Eastern portion of final excavation.



Final excavation.



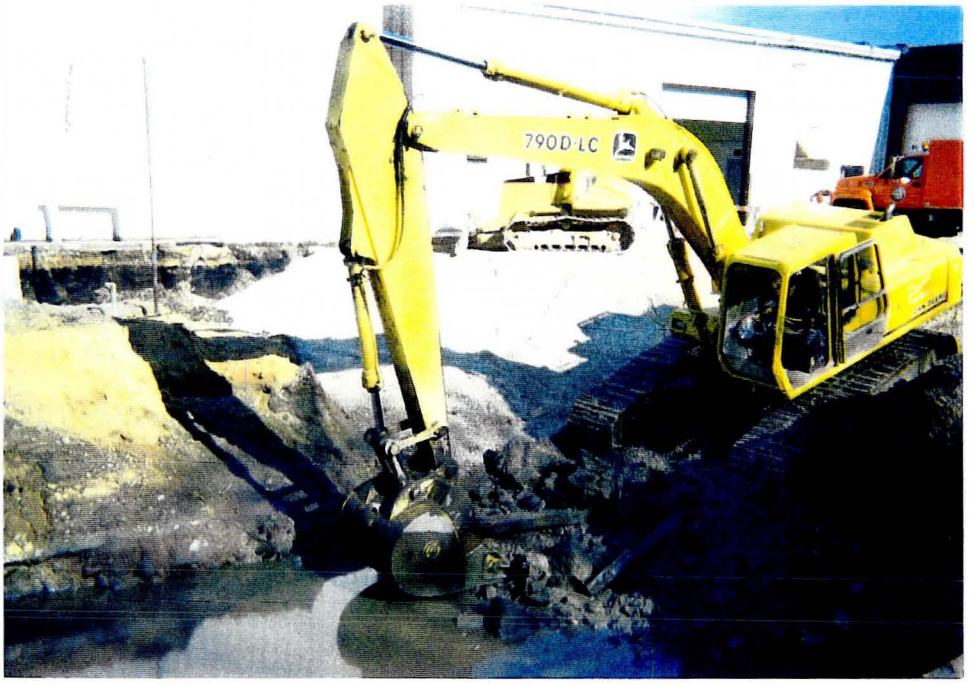
Southern portion of excavation.



Southern part of excavation.



UST to be upgraded under concrete block.



Excavation and backfilling.



Dewatering excavation.



New pump island and new UST to left of pump island. Upgraded UST to right of pump island.



Newly installed sump in foreground.



Backfilled excavation.



Waste oil UST removed.



Waste oil UST final excavation.
Sanitary sewer line suspended.



Cleaning of waste oil UST.



Backfilling of waste oil UST excavation. Sanitary sewer line suspended.

TABLE 2
GROUNDWATER ELEVATION DATA
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Well No.	Date	Depth to GW (ft)	TOC Reference Elevation (ft)	GW Elevation (ft)	Well Depth (ft)	Height of Water Column (ft)	Comments
MW-1	4/21/98	3.67	95.86	92.19	9.57	5.90	
MW-2	4/21/98	3.48	95.77	92.29	13.28	9.80	
MW-3	4/21/98	4.11	96.57	92.46	8.76	4.65	
MW-4	4/21/98	3.04	95.68	92.64	8.13	5.09	
MW-1	5/1/98	4.05	95.86	91.81	9.57	5.52	
MW-2	5/1/98	3.82	95.77	91.95	13.28	9.46	
MW-3	5/1/98	4.46	96.57	92.11	8.76	4.30	
MW-4	5/1/98	3.32	95.68	92.36	8.13	4.81	
MW-1	6/5/98	4.41	95.86	91.45	9.38	4.97	
MW-2	6/5/98	4.21	95.77	91.56	13.12	8.91	
MW-3	6/5/98	4.73	96.57	91.84	8.55	3.82	
MW-4	6/5/98	3.79	95.68	91.89	8.18	4.39	
MW-5*	8/28/98	4.13	95.65	91.52	17.38	13.25	Prior to development
MW-6	8/28/98	3.57	95.32	91.75	6.98	3.41	Prior to development
MW-1	9/16/98	4.53	95.86	91.33	9.38	4.85	Well depth previously measured
MW-2	9/16/98	4.36	95.77	91.41	13.12	8.76	Well depth previously measured
MW-3	9/16/98	4.53	96.57	92.04	8.55	4.02	Well depth previously measured
MW-4	9/16/98	3.96	95.68	91.72	8.18	4.22	Well depth previously measured
MW-5*	9/16/98	4.14	95.65	91.52	17.38	13.25	Well depth previously measured
MW-6	9/16/98	3.64	95.32	91.68	6.98	3.34	Well depth previously measured
MW-1	4/8/99	4.51	95.86	91.35	9.34	4.83	
MW-2	4/8/99	4.30	95.79	91.49	13.07	8.77	
MW-3	4/8/99	4.50	96.57	92.07	8.52	4.02	
MW-4	4/8/99	3.91	95.70	91.79	8.15	4.24	
MW-5*	4/8/99	-	95.65	-	-	-	Temporarily paved over
MW-6	4/8/99	3.49	95.32	91.83	6.94	3.45	
SW-1	4/8/99	3.54	-	-	12.02	-	
SW-2	4/8/99	-	-	-	-	-	Inaccessible

Notes: All depths measured from Top of Casing (TOC). * = bedrock well
GW = groundwater ft = feet
Elevations in feet in reference to benchmark with an assumed elevation of 100 feet.

TABLE 3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MW-1
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date						ES	PAL
	4/12/94	1/23/95	9/26/95	4/21/98	6/5/98	4/8/99		
Cadmium	0.1	NA	NA	NA	NA	NA	5	0.5
DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)								
Benzene	1.2	<0.6	<0.6	<0.27	<0.27	<0.27	5	0.5
1,2-Dichloroethane	4.9	4.7	**7.8**	NA	4.0	3.3	5	0.5
Ethylbenzene	3.6	<1.0	<1.0	<0.32	<0.32	<0.32	700	140
Methyl-Tert-Butyl-Ether	17	5.2	9.6	6.4	6.7	2.8	60	12
Xylenes, Total	23	<1.0	<1.0	<0.43	<0.43	<0.67	620	124

All concentrations in ug/l - micrograms per liter

ES - Enforcement Standard (exceedances shaded)

PAL - Preventive Action Limit

NA - not analyzed for parameter

Note: April 12, 1994, Jan 23, 1995, Sept 26, 1995, sampling events by OMNNI Associates

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MW-2
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date			ES	PAL
	4/21/98	6/5/98	4/8/99		
Lead	<1.6	NA	NA	15	1.5
DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)					
Benzene	**150**	**170**	<0.26	5	0.5
Ethylbenzene	11	38	<0.24	700	140
Isopropylbenzene	1.4	NA	NA	NE	NE
Methyl-Tert-Butyl-Ether	19	17	11	60	12
n-Propylbenzene	1.2	NA	NA	NE	NE
Toluene	5.5	1.9	0.33Q	343	68.6
Trimethylbenzenes	3.7	15.32	<1.40	480	96
Xylenes, Total	9.38	26.37	<1.34	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MW-3
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date			ES	PAL
	4/21/98	6/5/98	4/8/99		
Lead	<1.6	NA	NA	15	1.5
VOLATILE ORGANIC COMPOUNDS (VOC)					
None detected	<LOD	<LOD	<LOD	Varies	Varies

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MW-4
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date			ES	PAL
	4/21/98	6/5/98	4/8/99		
Lead	<1.6	NA	NA	15	1.5
DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)					
Benzene	**2400**	**2300**	**1100**	5	0.5
s-Butylbenzene	11	NA	NA	NE	NE
n-Butylbenzene	23	NA	NA	NE	NE
Ethylbenzene	560	470	230	700	140
Isopropylbenzene	43	NA	NA	NE	NE
p-Isopropyltoluene	7.0	NA	NA	NE	NE
Methyl-Tert-Butyl-Ether	15	20	6.7Q	60	12
Naphthalene	**130**	**110**	37Q	40	8
n-Propylbenzene	110	NA	NA	NE	NE
Toluene	67	58	27	343	68.6
Trimethylbenzenes	**820**	**590**	186Q	480	96
Xylenes, Total	**1741**	**1340**	385Q	620	124
DETECTED POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)					
Fluorene	2.0	NA	NA	400	80
1-methylnaphthalene	30	NA	NA	NE	NE
2-methylnaphthalene	41	NA	NA	NE	NE
Naphthalene	**60**	NA	NA	40	8
Phenanthrene	15	NA	NA	NE	NE

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MW-5
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date		ES	PAL
	8/31/98	4/15/99		
Lead	<1.6	NA	15	1.5
DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)				
Benzene	**5.5**	<0.26	5	0.5
s-Butylbenzene	0.53	NA	NE	NE
n-Butylbenzene	1.4	NA	NE	NE
Chloroform	0.68	NA	6	0.6
Ethylbenzene	8.2	<0.24	700	140
Isopropylbenzene	0.90	NA	NE	NE
Naphthalene	3.2	<0.89	40	8
n-Propylbenzene	2.8	NA	NE	NE
Toluene	0.63	<0.21	343	68.6
Trimethylbenzenes	19.0	<1.40	480	96
Xylenes, Total	24.3	<1.34	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - MW-6
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date		ES	PAL
	8/31/98	4/8/99		
Lead	<1.6	NA	15	1.5
VOLATILE ORGANIC COMPOUNDS (VOC)				
None detected	<LOD	<LOD	Varies	Varies

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - SW-1
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date 4/8/99	ES	PAL
DETECTED VOLATILE ORGANIC COMPOUNDS (VOC)			
Benzene	1.2	5	0.5
Ethylbenzene	2.3	700	140
Methyl-Tert-Butyl-Ether	0.66Q	60	12
Toluene	0.51Q	343	68.6
Trimethylbenzenes	8.7	480	96
Xylenes, Total	14	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - SW-2
KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

Parameter	Sampling Date 4/15/99	ES	PAL
VOLATILE ORGANIC COMPOUNDS (VOC)			
None detected	<LOD	Varies	Varies

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded)
PAL - Preventive Action Limit
NA - not analyzed for parameter
Trimethylbenzenes - Sum of 1,2,4 and 1,3,5 Trimethylbenzenes
NE - not established
LOQ - Limits of Quantitation
LOD - Limits of Detection
Q = The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

TABLE 4

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-1			MW-2			MW-3		
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/8/99
Nitrate/Nitrite	mg/l	NA	NA	0.061*	NA	NA	0.087*	NA	NA	0.57*
Sulfate	mg/l	NA	NA	64	NA	NA	160	NA	NA	170
Methane	ug/l	NA	NA	270	NA	NA	<0.9	NA	NA	7.4
FIELD TEST										
Temperature	°C	10.4	15.1	10.8	9.7	13.6	10.2	7.0	12.9	7.1
Conductivity	uS/cm	1200	2680	NA	1120	1460	NA	2090	3760	NA
pH	units	7.34	6.72	NA	7.44	6.49	NA	7.20	6.55	NA
Dissolved Oxygen	ppm	1.3	0.37	0.31	2.2	0.50	0.21	6.1	0.80	0.24
ORP	mV	NA	NA	15	NA	NA	-70	NA	NA	20
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	0.5	NA	NA	0.5

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

TABLE 4 (Continued)

SUMMARY OF GROUNDWATER BIODEGRADATION ANALYTICAL RESULTS

KAUKAUNA MAINTENANCE GARAGE - FISCHER #398132.003

PARAMETERS	Units	MW-4			MW-5			MW-6			SW-1	SW-2
		4/21/98	6/5/98	4/8/99	4/21/98	6/5/98	4/15/99	4/21/98	6/5/98	4/8/99	4/8/99	4/15/99
Nitrate/Nitrite	mg/l	NA	NA	0.069*	NA	NA	NA	NA	NA	0.066*	NA	NA
Sulfate	mg/l	NA	NA	85	NA	NA	NA	NA	NA	81	NA	NA
Methane	ug/l	NA	NA	430	NA	NA	NA	NA	NA	530	NA	NA
FIELD TEST												
Temperature	°C	8.6	14.1	8.0	15.3	NA	NA	19.4	NA	7.9	7.9	NA
Conductivity	uS/cm	2210	2870	NA	780	NA	NA	5490	NA	NA	NA	NA
pH	units	7.37	6.58	NA	5.72	NA	NA	5.27	NA	NA	NA	NA
Dissolved Oxygen	ppm	4.3	0.53	0.17	0.22	NA	NA	0.24	NA	0.14	0.12	NA
ORP	mV	NA	NA	-65	130	NA	NA	-60	NA	OR	-75	NA
Iron, Ferrous	mg/l	NA	NA	10	NA	NA	NA	NA	NA	0.5	0.5	NA

mg/l - milligrams per liter
ug/l - micrograms per liter
uS/cm - microsiemens per centimeter
NA - not analyzed for parameter
* - Also present in blank at 0.036 mg/l.

ppm - parts per million
mV - millivolts
ORP - oxygen / reduction potential
°C - degrees Celsius

APPENDIX C
Soil Disposal Documentation

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/23/99	261411	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	28.680	$544.92
					890	0.00	$544.92	T			
2/23/99	261413	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	29.170	$554.23
					890	0.00	$554.23	T			
2/23/99	261414	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	27.660	$525.54
					890	0.00	$525.54	T			
2/23/99	261416	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	28.970	$550.43
					890	0.00	$550.43	T			
2/23/99	261420	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	30.430	$578.17
					890	0.00	$578.17	T			
2/23/99	261440	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	27.620	$524.78
					890	0.00	$524.78	T			
2/23/99	261443	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	29.210	$554.99
					890	0.00	$554.99	T			
2/23/99	261474	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	24.290	$461.51
					890	0.00	$461.51	T			
2/23/99	261477	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	28.820	$547.58
					890	0.00	$547.58	T			
2/23/99	261481	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	28.860	$548.34
					890	0.00	$548.34	T			
2/23/99	261484	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	30.750	$584.25
					890	0.00	$584.25	T			
2/23/99	261485	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	21.900	$416.10
					890	0.00	$416.10	T			
2/23/99	261508	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	25.120	$477.28
					890	0.00	$477.28	T			
2/23/99	261511	FRED645	BR474171								
		CITY OF KAUKAUNA							0.00	24.640	$468.16
					890	0.00	$468.16	T			

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/23/99	261513	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	27.810	$528.39
					890	0.00	$528.39	T			
2/23/99	261523	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	34.330	$652.27
					890	0.00	$652.27	T			
2/23/99	261524	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	26.000	$494.00
					890	0.00	$494.00	T			
2/23/99	261525	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	27.160	$516.04
					890	0.00	$516.04	T			
2/23/99	261533	FRED645	BR474171								
		CITY OF KAUKAUNA							0.00	26.270	$499.13
					890	0.00	$499.13	T			
2/23/99	261537	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	30.660	$582.54
					890	0.00	$582.54	T			
2/23/99	261539	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	28.190	$535.61
					890	0.00	$535.61	T			
2/23/99	261541	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	29.080	$552.52
					890	0.00	$552.52	T			
2/24/99	77499	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	25.730	$488.87
					890	0.00	$488.87	T			
2/24/99	77500	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	28.900	$549.10
					890	0.00	$549.10	T			
2/24/99	261558	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	25.910	$492.29
					890	0.00	$492.29	T			
2/24/99	261559	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	28.330	$538.27
					890	0.00	$538.27	T			
2/24/99	261561	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	24.070	$457.33
					890	0.00	$457.33	T			
2/24/99	261562	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	22.490	$427.31
					890	0.00	$427.31	T			

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/24/99	261570	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	21.890	$415.91
					890	0.00	$415.91	T			
2/24/99	261584	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	23.810	$452.39
					890	0.00	$452.39	T			
2/24/99	261589	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	25.060	$476.14
					890	0.00	$476.14	T			
2/24/99	261590	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	28.280	$537.32
					890	0.00	$537.32	T			
2/24/99	261592	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	26.620	$505.78
					890	0.00	$505.78	T			
2/24/99	261598	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	26.510	$503.69
					890	0.00	$503.69	T			
2/24/99	261609	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	31.390	$596.41
					890	0.00	$596.41	T			
2/24/99	261619	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	33.520	$636.88
					890	0.00	$636.88	T			
2/24/99	261621	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	31.670	$601.73
					890	0.00	$601.73	T			
2/24/99	261627	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	27.730	$526.87
					890	0.00	$526.87	T			
2/24/99	261629	FRED645	BR474171								
		CITY OF KAUKAUNA							0.00	26.430	$502.17
					890	0.00	$502.17	T			
2/24/99	261630	FRED658	BR474171								
		CITY OF KAUKAUNA							0.00	27.190	$516.61
					890	0.00	$516.61	T			
2/24/99	261648	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	28.940	$549.86
					890	0.00	$549.86	T			
2/25/99	261710	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	26.040	$494.76
					890	0.00	$494.76	T			

All Trucks, Customer:0011053

Cust #: 0011053 Cust Name: CITY OF KAUKAUNA

Date	Ticket	Truck # / Generator	Profile	Manifest	Commodity Code	Commodity Tkt Yds	Commodity Fee		Landfill Yards	Tons	Fees
2/25/99	261718	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	26.560	$504.64
					890	0.00	$504.64	T			
2/25/99	261725	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	30.570	$580.83
					890	0.00	$580.83	T			
2/25/99	261741	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	29.160	$554.04
					890	0.00	$554.04	T			
2/25/99	261747	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	28.990	$550.81
					890	0.00	$550.81	T			
2/25/99	261777	FRED647	BR474171								
		CITY OF KAUKAUNA							0.00	32.300	$613.70
					890	0.00	$613.70	T			
2/25/99	261781	FRED661	BR474171								
		CITY OF KAUKAUNA							0.00	22.980	$436.62
					890	0.00	$436.62	T			
2/25/99	261782	FRED656	BR474171								
		CITY OF KAUKAUNA							0.00	30.010	$570.19
					890	0.00	$570.19	T			
2/25/99	261803	FRED641	BR474171								
		CITY OF KAUKAUNA							0.00	33.050	$627.95
					890	0.00	$627.95	T			
	50				Totals:				0.00	1,389.750	$26,405.25

APPENDIX D
Soil Analytical Reports

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
414-469-2436 • 1-800-736-2436
FAX 414-469-8827

802 Deming Way
Madison, WI 53717
608-827-5501 • 1-888-536-2436
Fax: 608-827-5503

1423 N. 8th Street., Suite 122
Superior, WI 54880
715-392-5844 • 1-800-837-8238
FAX 715-392-5843

CHAIN OF CUSTODY

0371

Page 1 of 2

P.O. # _____ Quote # _____

Company Name: Fischer Environmental
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.003
Project Name: Kaukauna Garage
Project Location: 3rd St. Kaukauna
Sampled By (Print): Karen Burkman

Regulatory Program (circle): (UST) RCRA CLP SDWA NPDES/WPDES CAA NR____
Other PECFA

NR720 Confirmation Analysis Required? (circle): Y (N)
(En Chem will not confirm unless otherwise instructed.)

Mail Report To: Karen Burkman
Company: Fischer Env.
Address: PO Box 127 Kaukauna, WI 54130

Invoice To: City of Kaukauna
Company: C/o Fischer
Address: PO Box 127 Kaukauna
Mail Invoice To: Karen Q Fischer

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	GRO/PVOC	DRO	Lead	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
	Confirm #1	2/23	am	X	X		+	S	✓	1-2oz-M 1-5oz		001
	Confirm #2		pm	X	X		+	S				002
S-	Side 2 ft		am	X	X		—	S				003
S-	Side 8 ft		am	X	X		—	S				004
WO-	S. Side 3 ft		pm	X	X		—	S				005
	TB		am	X			+	F		1-2oz-M		006
N &	Base 6 ft	2/24		X	X	X	—	S		1-2oz-M 1-5oz		007
N-	Side 3 ft			X	X	X	—	S				008
NE-	Side 3 ft			X	X		—	S				009
E-	Side 1 ft			X	X		—	S				010
E-	Base 6 ft			X	X	X	—	S				011
	TB			X			+	F		1-2oz-M		012
SE-	Side 3 ft			X	X		—	S	✓	1-2oz-M 1-5oz		013

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
Karen Burkman	2/25/99 905	Andrea Kerr	2/25/99 905
Relinquished By:	Date/Time:	Received By:	Date/Time:
Andrea Kerr 2/25/99	1330		
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By (En Chem):	Date/Time:

En Chem Project No. 890817
Sample Receipt Temp. ROI
Sample Receipt pH (Wet/Metals)

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 3/5/99

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
890817-001	CONFIRM #1	2/23/99			
890817-002	CONFIRM #2	2/23/99			
890817-003	S-SIDE 2 FT	2/23/99			
890817-004	S-SIDE 8 FT	2/23/99			
890817-005	WO-S SIDE 3FT	2/23/99			
890817-006	TB	2/23/99			
890817-007	NE-BASE 6FT	2/24/99			
890817-008	N-SIDE 3 FT	2/24/99			
890817-009	NE-SIDE 3 FT	2/24/99			
890817-010	E-SIDE 1 FT	2/24/99			
890817-011	E-BASE 6FT	2/24/99			
890817-012	TB	2/24/99			
890817-013	SE-SIDE 3 FT	2/24/99			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

Approval Signature

3/6/99

Date

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

Lab#:	TestGroupID:	Comment:
890817-001 CONFIRM #1	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling diesel fuel or extremely weathered gasoline.
890817-003 S-SIDE 2 FT	GRO-S-ME	Reported concentration due to early peaks in window.
890817-005 WO-S SIDE 3FT	DRO-S	Hump was present late in chromatogram.
890817-008 N-SIDE 3 FT	GRO-S-ME	Low level peaks present in chromatogram.
	DRO-S	Front peaks,late eluting hump and diesel range peaks present in the chromatogram.
890817-009 NE-SIDE 3 FT	GRO-S-ME	Low level peaks present in chromatogram.
	DRO-S	Front peaks,late eluting hump and diesel range peaks present in the chromatogram.
890817-013 SE-SIDE 3 FT	DRO-S	Hump was present late in chromatogram.

EN CHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : CONFIRM #1
Lab Sample Number : 890817-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/23/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	87.2				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 2/26/99 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	1300			42	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD GRO **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	120			5.7	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030B **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	97				%Recov		2/26/99	MOD 8021B
Benzene	< 50	50	120		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	130	57	140		ug/kg	Q	2/26/99	MOD 8021B
Methyl-tert-butyl-ether	60	57	140		ug/kg	Q	2/26/99	MOD 8021B
Toluene	< 50	50	120		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	360	57	140		ug/kg		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	1800	57	140		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : CONFIRM #1

Report Date : 3/1/99

Lab Sample Number : 890817-001

Collection Date : 2/23/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	<	50	50	120	ug/kg		2/26/99	MOD 8021B
Xylene, -o		110	57	140	ug/kg	Q	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : CONFIRM #2 **Report Date :** 3/1/99

Lab Sample Number : 890817-002 **Collection Date :** 2/23/99

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	79.8				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL Prep Method: Wi MOD DRO Prep Date: 2/26/99 Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.7			4.7	mg/kg		2/26/99	Wi MOD DRO
Blank spike	85			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL Prep Method: Wi MOD GRO Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 3.1			3.1	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL Prep Method: SW846 5030B Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	92				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	60	31	74		ug/kg	Q	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : CONFIRM #2

Report Date : 3/1/99

Lab Sample Number : 890817-002

Collection Date : 2/23/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p		70	31	74	ug/kg	Q	2/26/99	MOD 8021B
Xylene, -o	<	25	25	60	ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : S-SIDE 2 FT
Lab Sample Number : 890817-003
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/23/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	80.5				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 2/26/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.6			4.6	mg/kg		2/26/99	Wi MOD DRO
Blank spike	85			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 3.1			3.1	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : S-SIDE 2 FT

Report Date : 3/1/99

Lab Sample Number : 890817-003

Collection Date : 2/23/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : S-SIDE 8 FT
Lab Sample Number : 890817-004
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/23/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	86.5				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 2/26/99 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 3.9			3.9	mg/kg		2/26/99	Wi MOD DRO
Blank spike	85			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD GRO **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.9			2.9	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030B **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : S-SIDE 8 FT

Report Date : 3/1/99

Lab Sample Number : 890817-004

Collection Date : 2/23/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : WO-S SIDE 3FT
Lab Sample Number : 890817-005
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/23/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	88.3				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 2/26/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	22			4.5	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.8			2.8	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	92				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : WO-S SIDE 3FT

Report Date : 3/1/99

Lab Sample Number : 890817-005

Collection Date : 2/23/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TB

Report Date : 3/1/99

Lab Sample Number : 890817-006

Collection Date : 2/23/99

WI DNR LAB ID : 405132750

Matrix Type : METHANOL

Organic Results

GASOLINE RANGE ORGANICS - METHANOL **Prep Method:** Wi MOD GRO **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2500			2500	ug/L		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 50			50	ug/L		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL **Prep Method:** SW846 5030B **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/l		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/l		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60		ug/l		2/26/99	MOD 8021B
Xylene, -o	< 25	25	60		ug/l		2/26/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : NE-BASE 6FT

Report Date : 3/3/99

Lab Sample Number : 890817-007

Collection Date : 2/24/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Lead	< 3.9	3.9	12		mg/kg		3/2/99	SW846 3051	SW846 7421	MSB
Solids, percent	88.1				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL Prep Method: Wi MOD DRO Prep Date: 2/26/99 Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 3.8			3.8	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL Prep Method: Wi MOD GRO Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.8			2.8	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL Prep Method: SW846 5030B Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TB

Report Date : 3/2/99

Lab Sample Number : 890855-003

Collection Date : 2/25/99

WI DNR LAB ID : 405132750

Matrix Type : METHANOL

Organic Results

GASOLINE RANGE ORGANICS - METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/1/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2500			2500	ug/L		3/1/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		3/1/99	Wi MOD GRO
Blank Spike Duplicate	103			1.00	%Recov		3/1/99	Wi MOD GRO
Blank	< 50			50	ug/L		3/1/99	Wi MOD GRO

Organic Results

PVOC - METHANOL — Prep Method: SW846 5030B — Prep Date: 3/1/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	96				%Recov		3/1/99	MOD 8021B
Benzene	< 25	25	60		ug/l		3/1/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/l		3/1/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/l		3/1/99	MOD 8021B
Toluene	< 25	25	60		ug/l		3/1/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/l		3/1/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/l		3/1/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60		ug/l		3/1/99	MOD 8021B
Xylene, -o	< 25	25	60		ug/l		3/1/99	MOD 8021B

Company Name: Fischer Environmental
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.003
Project Name: Kauk. Garage
Project Location: 3rd St. Kauk.
Sampled By (Print): Karen Burkman

Regulatory Program (circle): UST RCRA CLP SDWA NPDES/WPDES CAA NR____
Other PECFA

NR720 Confirmation Analysis Required? (circle): Y N
(En Chem will not confirm unless otherwise instructed.)

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Page 1 of 1
P.O. # ____ Quote # ____
Mail Report To: Karen Burkman
Company: Fischer Env.
Address: PO Box 127
Kaukauna, WI
Invoice To: City of Kaukauna
Company: c/o Fischer
Address: PO Box 127
Kaukauna
Mail Invoice To: Karen Burkman

FILTERED? (YES/NO) N
PRESERVATION (CODE)* F A A

ANALYSES REQUESTED: GRO/PVOC, DRO, Lead

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE (1999)	COLLECTION TIME	GRO/PVOC	DRO	Lead					FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
NW-Side-2 ft		3/1	pm	Y	Y	X	[illegible] 3/4/99				–	S	X	1-5oz, 2-2oz M, 1-2oz		001
W-Side-2 ft		↓	↓	Y	Y						–	↓	↓	↓		002
W-Side-5 ft		↓	↓	Y	Y						+	↓	↓	↓		003
SW-Side-5 ft		↓	↓	Y	Y	X	[illegible] 3/4/99				–	↓	↓	↓		004
SE-Side-2-6 ft		↓	↓	Y	Y						+	↓	↓	↓		005
TB		↓	↓	X	~~X~~ KJB						+	F	↓	1-2oz M		006

SHADED AREA FOR LABORATORY USE ONLY

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:	En Chem Project No.
Karen Burkman	3/2/99	Tom Washinke	3/2/99 2:30 ROI	890890
Tom Washinke	3/2/99 KJB 1516			Sample Receipt Temp. ROI
				Sample Receipt pH (Wet/Metals)
		Received By (En Chem): [illegible]	3/2/99 1516	

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- Analytical Report -

Project Name : KAUK. GARAGE

Project Number : 398132.003

WI DNR LAB ID : 405132750

Client: FISCHER ENVIRONMENTAL CONSU

Report Date : 3/12/99

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
890890-001	NW-SIDE-2 FT	3/1/99			
890890-002	W-SIDE-2 FT	3/1/99			
890890-003	W-SIDE-5 FT	3/1/99			
890890-004	SW-SIDE-5FT	3/1/99			
890890-005	SE-SIDE-2-6 FT	3/1/99			
890890-006	TB	3/1/99			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

J. Duraceau

Approval Signature

3/12/99

Date

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Lab#:	TestGroupID:	Comment:
890890-003 W-SIDE-5 FT	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling diesel fuel or extremely weathered gasoline.
890890-004 SW-SIDE-5FT	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling diesel fuel or extremely weathered gasoline.
890890-005 SE-SIDE-2-6 FT	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling diesel fuel or extremely weathered gasoline.

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- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : NW-SIDE-2 FT
Lab Sample Number : 890890-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/4/99
Collection Date : 3/1/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Lead	3.7	3.7	12		mg/kg	Q	3/3/99	SW846 3051	SW846 7421	MSB
Solids, percent	93.2				%		3/3/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/3/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 3/3/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.0			4.0	mg/kg		3/3/99	Wi MOD DRO
Blank spike	84			50	%Recov		3/3/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		3/3/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/3/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.7			2.7	mg/kg		3/3/99	Wi MOD GRO
Blank Spike	106			1.00	%Recov		3/3/99	Wi MOD GRO
Blank Spike Duplicate	107			1.00	%Recov		3/3/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/3/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103				%Recov		3/3/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : NW-SIDE-2 FT
Lab Sample Number : 890890-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/4/99
Collection Date : 3/1/99
Matrix Type : SOIL

1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	3/3/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	3/3/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : W-SIDE-2 FT
Lab Sample Number : 890890-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/4/99
Collection Date : 3/1/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	92.2				%		3/3/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/3/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 3/3/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.3			4.3	mg/kg		3/3/99	Wi MOD DRO
Blank spike	84			50	%Recov		3/3/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		3/3/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/3/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.7			2.7	mg/kg		3/3/99	Wi MOD GRO
Blank Spike	106			1.00	%Recov		3/3/99	Wi MOD GRO
Blank Spike Duplicate	107			1.00	%Recov		3/3/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/3/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103				%Recov		3/3/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : W-SIDE-2 FT

Report Date : 3/4/99

Lab Sample Number : 890890-002

Collection Date : 3/1/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	< 25	25	60	ug/kg	3/3/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

EN CHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : W-SIDE-5 FT
Lab Sample Number : 890890-003
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/4/99
Collection Date : 3/1/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	78.6				%		3/3/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/3/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 3/3/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	1800			90	mg/kg		3/3/99	Wi MOD DRO
Blank spike	84			50	%Recov		3/3/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		3/3/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/3/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	700			40	mg/kg		3/3/99	Wi MOD GRO
Blank Spike	106			1.00	%Recov		3/3/99	Wi MOD GRO
Blank Spike Duplicate	107			1.00	%Recov		3/3/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/3/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		3/3/99	MOD 8021B
Benzene	1700	400	960		ug/kg		3/3/99	MOD 8021B
Ethylbenzene	11000	400	960		ug/kg		3/3/99	MOD 8021B
Methyl-tert-butyl-ether	890	400	960		ug/kg	Q	3/3/99	MOD 8021B
Toluene	620	400	960		ug/kg	Q	3/3/99	MOD 8021B
1,3,5-Trimethylbenzene	15000	400	960		ug/kg		3/3/99	MOD 8021B
1,2,4-Trimethylbenzene	42000	400	960		ug/kg		3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : W-SIDE-5 FT

Report Date : 3/4/99

Lab Sample Number : 890890-003

Collection Date : 3/1/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	37000	400	960	ug/kg	3/3/99	MOD 8021B
Xylene, -o	2800	400	960	ug/kg	3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : SW-SIDE-5FT
Lab Sample Number : 890890-004
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/11/99
Collection Date : 3/1/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Lead	< 3.9	3.9	12		mg/kg		3/10/99	SW846 3051	SW846 7421	MSB
Solids, percent	83.2				%		3/3/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/3/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 3/3/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.1			4.1	mg/kg		3/3/99	Wi MOD DRO
Blank spike	84			50	%Recov		3/3/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		3/3/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/3/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	9.0			3.0	mg/kg		3/3/99	Wi MOD GRO
Blank Spike	106			1.00	%Recov		3/3/99	Wi MOD GRO
Blank Spike Duplicate	107			1.00	%Recov		3/3/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/3/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	110				%Recov		3/3/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
1,3,5-Trimethylbenzene	39	30	72		ug/kg	Q	3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : SW-SIDE-5FT
Lab Sample Number : 890890-004
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/11/99
Collection Date : 3/1/99
Matrix Type : SOIL

1,2,4-Trimethylbenzene		100	30	72	ug/kg		3/3/99	MOD 8021B
Xylenes, -m, -p		55	30	72	ug/kg	Q	3/3/99	MOD 8021B
Xylene, -o	<	25	25	60	ug/kg		3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

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Green Bay, WI 54302
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800-7-ENCHEM
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- Analytical Report -

Project Name : KAUK. GARAGE

Project Number : 398132.003

Field ID : SE-SIDE-2-6 FT

Lab Sample Number : 890890-005

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 3/4/99

Collection Date : 3/1/99

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	88.3				%		3/3/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/3/99

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 3/3/99 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	4.9			4.4	mg/kg		3/3/99	Wi MOD DRO
Blank spike	84			50	%Recov		3/3/99	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		3/3/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/3/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD GRO **Prep Date:** 3/3/99 **Analyst:** PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	7.6			2.8	mg/kg		3/3/99	Wi MOD GRO
Blank Spike	106			1.00	%Recov		3/3/99	Wi MOD GRO
Blank Spike Duplicate	107			1.00	%Recov		3/3/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/3/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030B **Prep Date:** 3/3/99 **Analyst:** PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	106				%Recov		3/3/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Ethylbenzene	31	28	67		ug/kg	Q	3/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		3/3/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		3/3/99	MOD 8021B
1,3,5-Trimethylbenzene	38	28	67		ug/kg	Q	3/3/99	MOD 8021B
1,2,4-Trimethylbenzene	370	28	67		ug/kg		3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE
Project Number : 398132.003
Field ID : SE-SIDE-2-6 FT
Lab Sample Number : 890890-005
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/4/99
Collection Date : 3/1/99
Matrix Type : SOIL

Xylenes, -m, -p	73	28	67	ug/kg	3/3/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	3/3/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUK. GARAGE

Project Number : 398132.003

Field ID : TB

Lab Sample Number : 890890-006

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 3/4/99

Collection Date : 3/1/99

Matrix Type : METHANOL

Organic Results

GASOLINE RANGE ORGANICS - METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2500			2500	ug/L		3/3/99	Wi MOD GRO
Blank Spike	106			1.00	%Recov		3/3/99	Wi MOD GRO
Blank Spike Duplicate	107			1.00	%Recov		3/3/99	Wi MOD GRO
Blank	< 50			50	ug/L		3/3/99	Wi MOD GRO

Organic Results

PVOC - METHANOL — Prep Method: SW846 5030B — Prep Date: 3/3/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103				%Recov		3/3/99	MOD 8021B
Benzene	< 25	25	60		ug/l		3/3/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/l		3/3/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/l		3/3/99	MOD 8021B
Toluene	< 25	25	60		ug/l		3/3/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/l		3/3/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/l		3/3/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60		ug/l		3/3/99	MOD 8021B
Xylene, -o	< 25	25	60		ug/l		3/3/99	MOD 8021B

APPENDIX E

Groundwater Analytical Reports

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436 • 1-800-736-2436
FAX 920-469-8827

525 Science Drive
Madison, WI 53711
608-232-3300 • 1-888-536-2436
FAX: 608-233-0502

1423 N. 8th Street, Suite 122
Superior, WI 54880
715-392-5844 • 1-800-837-8238
FAX 715-392-5843

CHAIN OF CUSTODY

33454

Page 1 of 1

P.O. # _____ Quote # _____

Company Name: FISCHER
Branch or Location: Kaukauna, WI.
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.003
Project Name: Kaukauna Maint. Garage
Project State: Kaukauna, WI.
Sampled By (Print): Shad W. / Mark R.

Regulatory Program (circle): UST RCRA CLP SDWA NPDES/WPDES CAA NR_____
Other _____

NR720 Confirmation Analysis Required? (circle): Y N
(En Chem will not confirm unless otherwise instructed.)

Mail Report To: Karen Burkman
Company: FISCHER
Address: P.O. Box 127
Kaukauna, WI. 54130-2404
Invoice To: Kaukauna Maint. Garage c/o FISCHER
Company: Kaukauna Maint. Garage
Address: Same
Mail Invoice To: Karen Burkman

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	FILTERED? (YES/NO)	PRESERVATION (CODE)*	ANALYSES REQUESTED: PVOC	1,2 DCA	Naphthalene	Methane	Sulfate	Nitrate/Nitrite	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
MW-1	Monitoring Well #1	4/6/99	am	N	B	X	X		X	X	X			N/A	GW	X	X	6-40ml 2-250ml	001
-2	#2			N	B	X												↓	002
-3	#3			N	B	X												12-40ml 2-250ml	003
-4	#4			N	B	X		X										6-40ml 2-250ml	004
-6	#6			N	B	X			↓	↓	↓							↓	005
RS-1	Recovery Sump #1			N	A	X												3-40ml	006
Trip Bl.	Trip Blank			N	A													1-40ml	007
DUP	Duplicate	↓	↓	N	A	X								↓	↓	↓	↓	3-40ml	008
SW-1																			

SHADED AREA FOR LABORATORY USE ONLY

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
[signature]	4/13/99 10:15am	[signature]	4/13/99 10:15
[signature]	4/13/99 1540		
		[signature]	4/13/99 1720

En Chem Project No. 89 1724
Sample Receipt Temp. 10.2
Sample Receipt pH (Wet/Metals)
Custody Seal

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE

Project Number : 398132.003

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 4/26/99

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
891724-001	MW-1	4/8/99			
891724-002	MW-2	4/8/99			
891724-003	MW-3	4/8/99			
891724-004	MW-4	4/8/99			
891724-005	MW-6	4/8/99			
891724-006	RS-1	4/8/99			
891724-007	TRIP BLANK	4/8/99			
891724-008	DUPLICATE	4/8/99			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

Approval Signature

4/26/99
Date

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

Lab#:	TestGroupID:	Comment:
891724-	W-N-W	Analyte was present in the blank at 0.036 mg/L.

EN CHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-1

Report Date : 4/26/99

Lab Sample Number : 891724-001

Collection Date : 4/8/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Nitrogen, NO3 + NO2	0.061	0.017	0.054		mg/L	B	4/21/99	EPA 353.2	EPA 353.2	*MD
Sulfate	64	8.8	28		mg/L		4/21/99	EPA 375.2	EPA 375.2	*MD

Organic Results

METHANE Prep Method: MOD. 8015 Prep Date: 4/16/99 Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Methane	270	8.8	28		ug/l		4/16/99	MOD. 8015

Organic Results

PVOC + 1,2-DICHLOROETHANE - WATER Prep Method: SW846 5030B Prep Date: 4/14/99 Analyst: DJF

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		4/14/99	SW846 8260B
1,2-Dichloroethane	3.3	0.37	1.2		ug/L		4/14/99	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		4/14/99	SW846 8260B
Methyl-tert-butyl-ether	2.8	0.32	1.0		ug/L		4/14/99	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		4/14/99	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		4/14/99	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		4/14/99	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		4/14/99	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		4/14/99	SW846 8260B
Dibromofluoromethane	96				%Recov		4/14/99	SW846 8260B
Toluene-d8	97				%Recov		4/14/99	SW846 8260B
4-Bromofluorobenzene	86				%Recov		4/14/99	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE
Project Number : 398132.003
Field ID : MW-2
Lab Sample Number : 891724-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/26/99
Collection Date : 4/8/99
Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Nitrogen, NO3 + NO2	0.087	0.017	0.054		mg/L	B	4/21/99	EPA 353.2	EPA 353.2	*MD
Sulfate	160	8.8	28		mg/L		4/21/99	EPA 375.2	EPA 375.2	*MD

Organic Results

METHANE Prep Method: MOD. 8015 Prep Date: 4/16/99 Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Methane	< 0.9	0.9	2.9		ug/l		4/16/99	MOD. 8015

Organic Results

PVOC - WATER Prep Method: SW846 5030B Prep Date: 4/14/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	96				%Recov		4/16/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		4/16/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		4/16/99	MOD 8021B
Methyl-tert-butyl-ether	11	0.22	0.70		ug/l		4/16/99	MOD 8021B
Toluene	0.33	0.21	0.67		ug/l	Q	4/16/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		4/16/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		4/16/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		4/16/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		4/16/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE
Project Number : 398132.003
Field ID : MW-3
Lab Sample Number : 891724-003
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/26/99
Collection Date : 4/8/99
Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Nitrogen, NO3 + NO2	0.57	0.017	0.054		mg/L	B	4/21/99	EPA 353.2	EPA 353.2	*MD
Sulfate	170	8.8	28		mg/L		4/21/99	EPA 375.2	EPA 375.2	*MD

Organic Results

METHANE — Prep Method: MOD. 8015 — Prep Date: 4/16/99 — Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Methane	7.4	0.9	2.9		ug/l		4/16/99	MOD. 8015

Organic Results

PVOC - WATER — Prep Method: SW846 5030B — Prep Date: 4/14/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	96				%Recov		4/16/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		4/16/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		4/16/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		4/16/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		4/16/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		4/16/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		4/16/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		4/16/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		4/16/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE
Project Number : 398132.003
Field ID : MW-4
Lab Sample Number : 891724-004
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/26/99
Collection Date : 4/8/99
Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Nitrogen, NO3 + NO2	0.069	0.017	0.054		mg/L	B	4/21/99	EPA 353.2	EPA 353.2	*MD
Sulfate	85	8.8	28		mg/L		4/21/99	EPA 375.2	EPA 375.2	*MD

Organic Results

METHANE — Prep Method: MOD. 8015 — Prep Date: 4/16/99 — Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Methane	430	22	70		ug/l		4/16/99	MOD. 8015

Organic Results

PVOC + NAPHT - WATER — Prep Method: SW846 5030B — Prep Date: 4/14/99 — Analyst: MSB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		4/17/99	MOD 8021B
Benzene	1100	5.2	17		ug/l		4/17/99	MOD 8021B
Ethylbenzene	230	4.8	15		ug/l		4/17/99	MOD 8021B
Methyl-tert-butyl-ether	6.7	4.4	14		ug/l	Q	4/17/99	MOD 8021B
Naphthalene	37	18	57		ug/l	Q	4/17/99	MOD 8021B
Toluene	27	4.2	13		ug/l		4/17/99	MOD 8021B
1,3,5-Trimethylbenzene	26	11	35		ug/l	Q	4/17/99	MOD 8021B
1,2,4-Trimethylbenzene	160	17	54		ug/l		4/17/99	MOD 8021B
Xylenes, -m, -p	370	19	61		ug/l		4/17/99	MOD 8021B
Xylene, -o	15	7.4	24		ug/l	Q	4/17/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-6

Report Date : 4/26/99

Lab Sample Number : 891724-005

Collection Date : 4/8/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Nitrogen, NO3 + NO2	0.066	0.017	0.054		mg/L	B	4/21/99	EPA 353.2	EPA 353.2	*MD
Sulfate	81	8.8	28		mg/L		4/21/99	EPA 375.2	EPA 375.2	*MD

Organic Results

METHANE — Prep Method: MOD. 8015 — Prep Date: 4/16/99 — Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Methane	530	44	140		ug/l		4/16/99	MOD. 8015

Organic Results

PVOC - WATER — Prep Method: SW846 5030B — Prep Date: 4/14/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	97				%Recov		4/16/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		4/16/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		4/16/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		4/16/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		4/16/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		4/16/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		4/16/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		4/16/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		4/16/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : ~~RS-1~~ SW-1

Report Date : 4/16/99

Lab Sample Number : 891724-006

Collection Date : 4/8/99

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC - WATER — Prep Method: SW846 5030B — Prep Date: 4/14/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	96				%Recov		4/16/99	MOD 8021B
Benzene	1.2	0.26	0.83		ug/l		4/16/99	MOD 8021B
Ethylbenzene	2.3	0.24	0.76		ug/l		4/16/99	MOD 8021B
Methyl-tert-butyl-ether	0.66	0.22	0.70		ug/l	Q	4/16/99	MOD 8021B
Toluene	0.51	0.21	0.67		ug/l	Q	4/16/99	MOD 8021B
1,3,5-Trimethylbenzene	2.8	0.54	1.7		ug/l		4/16/99	MOD 8021B
1,2,4-Trimethylbenzene	5.9	0.86	2.7		ug/l		4/16/99	MOD 8021B
Xylenes, -m, -p	12	0.97	3.1		ug/l		4/16/99	MOD 8021B
Xylene, -o	1.8	0.37	1.2		ug/l		4/16/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE

Project Number : 398132.003

Field ID : TRIP BLANK

Lab Sample Number : 891724-007

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 4/15/99

Collection Date : 4/8/99

Matrix Type : WATER

Organic Results

PVOC + NAPHTHALENE - WATER — Prep Method: SW846 5030B — Prep Date: 4/14/99 — Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	81				%Recov		4/14/99	SW846 8260B
Dibromofluoromethane	83				%Recov		4/14/99	SW846 8260B
4-Bromofluorobenzene	80				%Recov		4/14/99	SW846 8260B
Benzene	< 0.27	0.27	0.86		ug/L		4/14/99	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		4/14/99	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0		ug/L		4/14/99	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		4/14/99	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		4/14/99	SW846 8260B
Naphthalene	< 0.35	0.35	1.1		ug/L		4/14/99	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		4/14/99	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		4/14/99	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		4/14/99	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		4/14/99	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.GARAGE
Project Number : 398132.003
Field ID : DUPLICATE
Lab Sample Number : 891724-008
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/16/99
Collection Date : 4/8/99
Matrix Type : WATER

Organic Results

PVOC - WATER — Prep Method: SW846 5030B — Prep Date: 4/14/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		4/16/99	MOD 8021B
Benzene	1100	2.6	8.3		ug/l		4/16/99	MOD 8021B
Ethylbenzene	240	2.4	7.6		ug/l		4/16/99	MOD 8021B
Methyl-tert-butyl-ether	9.4	2.2	7.0		ug/l		4/16/99	MOD 8021B
Toluene	24	2.1	6.7		ug/l		4/16/99	MOD 8021B
1,3,5-Trimethylbenzene	27	5.4	17		ug/l		4/16/99	MOD 8021B
1,2,4-Trimethylbenzene	170	8.6	27		ug/l		4/16/99	MOD 8021B
Xylenes, -m, -p	380	9.7	31		ug/l		4/16/99	MOD 8021B
Xylene, -o	17	3.7	12		ug/l		4/16/99	MOD 8021B

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Page 1 of 1

Company Name: FISCHER
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.003
Project Name:
Project Location: Kaukauna
Sampled By (Print): Karen Burkman

Regulatory Program *(circle)*: UST RCRA CLP SDWA NPDES/WPDES CAA NR_____
Other

NR720 Confirmation Analysis Required? *(circle)*: Y (N)
(En Chem will not confirm unless otherwise instructed.)

P.O. # Quote #
Mail Report To: Karen Burkman
Company: FISCHER
Address: PO Box 127 Kaukauna
Invoice To: City of Kaukauna
Company: C/o FISCHER
Address:
Mail Invoice To: Karen Burkman

ANALYSES REQUESTED: PVOC + Naphthalene

FILTERED? (YES/NO): N
PRESERVATION (CODE)*: B

| FIELD ID | SAMPLE DESCRIPTION | COLLECTION DATE | COLLECTION TIME | | |

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- Analytical Report -

Project Name :

Project Number : 398132.003

WI DNR LAB ID : 405132750

Client: FISCHER ENVIRONMENTAL

Report Date : 4/20/99

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
891831-001	MW-5	4/15/99			
891831-002	SW-2	4/15/99			
891831-003	TB	4/15/99			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

G Duranceau
Approval Signature

4/20/99
Date

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- Analytical Report -

Project Name :

Project Number : 398132.003

Field ID : MW-5

Lab Sample Number : 891831-001

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL

Report Date : 4/20/99

Collection Date : 4/15/99

Matrix Type : WATER

Organic Results

PVOC + NAPHT - WATER **Prep Method:** SW846 5030B **Prep Date:** 4/19/99 **Analyst:** PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	107				%Recov		4/19/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		4/19/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		4/19/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		4/19/99	MOD 8021B
Naphthalene	< 0.89	0.89	2.8		ug/l		4/19/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		4/19/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		4/19/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		4/19/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		4/19/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		4/19/99	MOD 8021B

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- Analytical Report -

Project Name :

Project Number : 398132.003

Field ID : SW-2

Lab Sample Number : 891831-002

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL

Report Date : 4/20/99

Collection Date : 4/15/99

Matrix Type : WATER

Organic Results

PVOC + NAPHT - WATER — Prep Method: SW846 5030B — Prep Date: 4/19/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	107				%Recov		4/19/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		4/19/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		4/19/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		4/19/99	MOD 8021B
Naphthalene	< 0.89	0.89	2.8		ug/l		4/19/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		4/19/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		4/19/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		4/19/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		4/19/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		4/19/99	MOD 8021B

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- Analytical Report -

Project Name :

Project Number : 398132.003

Field ID : TB

Lab Sample Number : 891831-003

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL

Report Date : 4/20/99

Collection Date : 4/15/99

Matrix Type : WATER

Organic Results

PVOC + NAPHT - WATER **Prep Method:** SW846 5030B **Prep Date:** 4/19/99 **Analyst:** PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	108				%Recov		4/19/99	MOD 8021B
Benzene	< 0.26	0.26	0.83		ug/l		4/19/99	MOD 8021B
Ethylbenzene	< 0.24	0.24	0.76		ug/l		4/19/99	MOD 8021B
Methyl-tert-butyl-ether	< 0.22	0.22	0.70		ug/l		4/19/99	MOD 8021B
Naphthalene	< 0.89	0.89	2.8		ug/l		4/19/99	MOD 8021B
Toluene	< 0.21	0.21	0.67		ug/l		4/19/99	MOD 8021B
1,3,5-Trimethylbenzene	< 0.54	0.54	1.7		ug/l		4/19/99	MOD 8021B
1,2,4-Trimethylbenzene	< 0.86	0.86	2.7		ug/l		4/19/99	MOD 8021B
Xylenes, -m, -p	< 0.97	0.97	3.1		ug/l		4/19/99	MOD 8021B
Xylene, -o	< 0.37	0.37	1.2		ug/l		4/19/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : NE-BASE 6FT

Report Date : 3/3/99

Lab Sample Number : 890817-007

Collection Date : 2/24/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Field ID : N-SIDE 3 FT

Lab Sample Number : 890817-008

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 3/3/99

Collection Date : 2/24/99

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Lead	110	4.5	14		mg/kg		3/2/99	SW846 3051	SW846 7421	MSB
Solids, percent	72.7				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL Prep Method: Wi MOD DRO Prep Date: 2/26/99 Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	110			5.3	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL Prep Method: Wi MOD GRO Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 3.4			3.4	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL Prep Method: SW846 5030B Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	92				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	98	34	82		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : N-SIDE 3 FT

Report Date : 3/3/99

Lab Sample Number : 890817-008

Collection Date : 2/24/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,2,4-Trimethylbenzene	66	34	82	ug/kg	Q	2/26/99	MOD 8021B
Xylenes, -m, -p	180	34	82	ug/kg		2/26/99	MOD 8021B
Xylene, -o	45	34	82	ug/kg	Q	2/26/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : NE-SIDE 3 FT
Lab Sample Number : 890817-009
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/24/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	75.8				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 2/26/99 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	57			5.2	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD GRO **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	3.4			3.3	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030B **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	92				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	44	33	79		ug/kg	Q	2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	59	33	79		ug/kg	Q	2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	150	33	79		ug/kg		2/26/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : NE-SIDE 3 FT **Report Date :** 3/1/99

Lab Sample Number : 890817-009 **Collection Date :** 2/24/99

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Xylenes, -m, -p	180	33	79	ug/kg		2/26/99	MOD 8021B
Xylene, -o	50	33	79	ug/kg	Q	2/26/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : E-SIDE 1 FT
Lab Sample Number : 890817-010
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/24/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	94.6				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 2/26/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 3.8			3.8	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.6			2.6	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : E-SIDE 1 FT

Report Date : 3/1/99

Lab Sample Number : 890817-010

Collection Date : 2/24/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	27	26	62	ug/kg	Q	2/26/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : E-BASE 6FT
Lab Sample Number : 890817-011
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/3/99
Collection Date : 2/24/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Lead	4.6	3.6	11		mg/kg	Q	3/2/99	SW846 3051	SW846 7421	MSB
Solids, percent	91.9				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL Prep Method: Wi MOD DRO Prep Date: 2/26/99 Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 3.7			3.7	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL Prep Method: Wi MOD GRO Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.7			2.7	mg/kg		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL Prep Method: SW846 5030B Prep Date: 2/26/99 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : E-BASE 6FT

Report Date : 3/3/99

Lab Sample Number : 890817-011

Collection Date : 2/24/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	2/26/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	2/26/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : TB
Lab Sample Number : 890817-012
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/1/99
Collection Date : 2/24/99
Matrix Type : METHANOL

Organic Results

GASOLINE RANGE ORGANICS - METHANOL — Prep Method: Wi MOD GRO — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2500			2500	ug/L		2/26/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		2/26/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		2/26/99	Wi MOD GRO
Blank	< 50			50	ug/L		2/26/99	Wi MOD GRO

Organic Results

PVOC - METHANOL — Prep Method: SW846 5030B — Prep Date: 2/26/99 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	91				%Recov		2/26/99	MOD 8021B
Benzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/l		2/26/99	MOD 8021B
Toluene	< 25	25	60		ug/l		2/26/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/l		2/26/99	MOD 8021B
Xylenes, -m, -p	< 25	25	60		ug/l		2/26/99	MOD 8021B
Xylene, -o	< 25	25	60		ug/l		2/26/99	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : SE-SIDE 3 FT
Lab Sample Number : 890817-013
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/3/99
Collection Date : 2/24/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	61.1				%		2/26/99	SM2540G	SM2540G	NJS

Organic Results

Preservation Date : 2/25/99

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 2/26/99 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	210			6.3	mg/kg		2/26/99	Wi MOD DRO
Blank spike	73			50	%Recov		2/26/99	Wi MOD DRO
Blank spike duplicate	75			50	%Recov		2/26/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		2/26/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD GRO **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	12			4.1	mg/kg		3/2/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		3/2/99	Wi MOD GRO
Blank Spike Duplicate	104			1.00	%Recov		3/2/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/2/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030B **Prep Date:** 2/26/99 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103				%Recov		3/2/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		3/2/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		3/2/99	MOD 8021B
Methyl-tert-butyl-ether	140	41	98		ug/kg		3/2/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		3/2/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		3/2/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		3/2/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : SE-SIDE 3 FT
Lab Sample Number : 890817-013
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/3/99
Collection Date : 2/24/99
Matrix Type : SOIL

Xylenes, -m, -p		65	41	98	ug/kg	Q	3/2/99	MOD 8021B
Xylene, -o	<	25	25	60	ug/kg		3/2/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

Company Name: Fischer Env.
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.003
Project Name: Kaukauna Garage
Project Location: Third St. Kaukauna
Sampled By (Print): Karen Burkman

Regulatory Program (circle): UST RCRA CLP SDWA
NPDES/WPDES CAA NR____
Other PECFA

NR720 Confirmation Analysis Required? (circle): Y N
(En Chem will not confirm unless otherwise instructed.)

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FAX 715-392-5843

CHAIN OF CUSTODY

0370

Page 1 of 1
P.O. # ____ Quote # ____
Mail Report To: Karen Burkman
Company: Fischer Environmental
Address: PO Box 127
Kaukauna, WI 54130
Invoice To: City of Kaukauna
Company: C/o Fischer
Address: PO Box 127
Kaukauna, WI
Mail Invoice To: Karen Burkman

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE (1999)	COLLECTION TIME	FILTERED? (YES/NO)	PRESERVATION (CODE)*	ANALYSES REQUESTED: GRO/PVOC	DRO	Lead	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
N-Side 2 - 2ft		2/5	9am	N	F	X	X		-	S	X	1-5oz 1-2oz 2-2oz		001
NW - Base - 4ft		↓	↓	N	A	X	X	X	+	S	↓	↓		002
TB		↓	↓	N	A	X			+	F	↓	1-2oz		003

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
Karen Burkman	2/26/99 1440	[signature]	2-26-99 1440
[signature]	2-26-99 1640		
		Received By (En Chem): [signature]	2/26/99

En Chem Project No. 890455
Sample Receipt Temp. R05
Sample Receipt pH (Wet/Metals)

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- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 3/5/99

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
890855-001	N-SIDE 2-2FT	2/25/99			
890855-002	NW-BASE-4 FT	2/25/99			
890855-003	TB	2/25/99			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

Approval Signature

3/6/99

Date

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Lab#:	TestGroupID:	Comment:
890855-002	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling gasoline. Early and late peaks were present outside of window.
NW-BASE-4 FT		

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- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : N-SIDE 2-2FT
Lab Sample Number : 890855-001
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/3/99
Collection Date : 2/25/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Solids, percent	92.1				%		3/1/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/1/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 3/1/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.2			4.2	mg/kg		3/2/99	Wi MOD DRO
Blank spike	79			50	%Recov		3/2/99	Wi MOD DRO
Blank spike duplicate	86			50	%Recov		3/2/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/2/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/1/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.7			2.7	mg/kg		3/1/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		3/1/99	Wi MOD GRO
Blank Spike Duplicate	103			1.00	%Recov		3/1/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/1/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 3/1/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	97				%Recov		3/1/99	MOD 8021B
Benzene	< 25	25	60		ug/kg		3/1/99	MOD 8021B
Ethylbenzene	< 25	25	60		ug/kg		3/1/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		3/1/99	MOD 8021B
Toluene	< 25	25	60		ug/kg		3/1/99	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/kg		3/1/99	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/kg		3/1/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : N-SIDE 2-2FT

Report Date : 3/3/99

Lab Sample Number : 890855-001

Collection Date : 2/25/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Xylenes, -m, -p	< 25	25	60	ug/kg	3/1/99	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	3/1/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE
Project Number : 398132.003
Field ID : NW-BASE-4 FT
Lab Sample Number : 890855-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 3/4/99
Collection Date : 2/25/99
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analys
Lead	8.3	4.0	13		mg/kg	Q	3/3/99	SW846 3051	SW846 7421	MSB
Solids, percent	81.1				%		3/1/99	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 3/1/99

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 3/1/99 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.4			4.4	mg/kg		3/1/99	Wi MOD DRO
Blank spike	79			50	%Recov		3/1/99	Wi MOD DRO
Blank spike duplicate	86			50	%Recov		3/1/99	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		3/1/99	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: Wi MOD GRO — Prep Date: 3/1/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	12			3.1	mg/kg		3/1/99	Wi MOD GRO
Blank Spike	103			1.00	%Recov		3/1/99	Wi MOD GRO
Blank Spike Duplicate	103			1.00	%Recov		3/1/99	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		3/1/99	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030B — Prep Date: 3/1/99 — Analyst: PMS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	97				%Recov		3/1/99	MOD 8021B
Benzene	200	31	74		ug/kg		3/1/99	MOD 8021B
Ethylbenzene	400	31	74		ug/kg		3/1/99	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		3/1/99	MOD 8021B
Toluene	52	31	74		ug/kg	Q	3/1/99	MOD 8021B
1,3,5-Trimethylbenzene	290	31	74		ug/kg		3/1/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA GARAGE

Project Number : 398132.003

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : NW-BASE-4 FT

Report Date : 3/4/99

Lab Sample Number : 890855-002

Collection Date : 2/25/99

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,2,4-Trimethylbenzene	930	31	74	ug/kg		3/1/99	MOD 8021B
Xylenes, -m, -p	1200	31	74	ug/kg		3/1/99	MOD 8021B
Xylene, -o	46	31	74	ug/kg	Q	3/1/99	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

Vac. - Dino

Wisconsin
Department of Commerce

Environmental & Regulatory Services
2129 Jackson Street
Oshkosh, Wisconsin 54901

Tommy G. Thompson, Governor
Philip Edw. Albert, Acting Secretary

COMM 47 REMEDIAL ALTERNATIVE RESPONSE

CLAIMANT:
City of Kaukauna Dept. of Public Works
Attn: John Sundelius
PO Box 890
Kaukauna WI 54130

CLAIM # 54130-2406-22
BRRT # 03-45-001729
SITE:
Kaukauna Maintenance Garage
222 West 3rd Street
Kaukauna WI

RECOMMENDED ALTERNATIVE: **SUBMITTAL DATE:** October 2, 1998
Excavate, Biosite approximately 1020 cubic yards and groundwater monitor

__XXX__	**Approved with cost caps**
$ 140,558.00	**Cap on total cost to closed remedial action status-**
_____	**Site will be bundled with other remediation(s)**
_____	**Site will be directed to the public bid process**

COMMENTS: The department approves the remedial approach however some costs for the groundwater monitoring program appear high. Have your consultant review the time and personnel needed to complete these tasks.

Important Claim Note: This document serves as the Department's written approval to submit your first claim for eligible site investigation and remedial action planning costs, per COMM 47.355(2)(b). Please include a copy of this document in your site investigation claim package.

- **COMM 47.33(2)(b) The cost detail for the selected remediation alternative shall establish the total estimated cost for the remediation up to the point of receiving approval as a closed remedial action.**

- **COMM 47.337(5) CLAIMANT OPTIONS. (a) After receiving an approval of a remedial action plan from the department, a claimant may elect to either implement the alternative or to select another alternative. If the claimant elects to implement a higher cost remedial strategy, the claimant must notify the department in writing of the intent to use a higher cost alternative. The notification must include the statement that the claimant agrees that the department approved alternative establishes the maximum reimbursable amount for consulting and commodity services under the fund and that additional costs for the occurrence, excluding interest, will not be submitted to the fund.**

- **COMM 47.01(3) INTENT OF PECFA. (a) The PECFA fund does not relieve a responsible party from liability. The individual or organization responsible for a contaminated property shall carry out the remediation of that property. PECFA's role is to provide monetary awards to responsible parties who have completed and paid for PECFA approved remediation activities and services. The availability or unavailability of PECFA funding shall not be the determining factor as to whether a remediation shall be completed.**

- **The approval does not guarantee the reimbursement of costs. Final determination regarding the eligibility of costs will be determined at the time of claim review. The department's approval is based on the limited information submitted in the remedial alternative cost approval document and does not imply that the department concurs that the recommended remedial alternative will achieve the remedial results anticipated by the consultant or required by law.**

SIGNATURE Dee Zoellner **DATE**: November 12, 1998
Dee Zoellner (tel. 920-424-0046) Hydrogeologist, PECFA Site Review Section

cc: Karen Burkman – Fischer Env.
PECFA electronic file
Regional Supervisor, WDNR Remediation and Redevelopment Program

FISCHER
ENVIRONMENTAL, INC.
P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: madkauk@athenet.com

RECEIVED
OCT 22 1998
WDNR OSH
LUST PROGRAM

October 21, 1998

Mr. Kevin McKnight
Wisconsin Department of Natural Resources
P.O. Box 2565
Oshkosh, Wisconsin 54903

RE: **SITE INVESTIGATION REPORT ADDENDUM for the Kaukauna Maintenance Garage**
222 West 3rd Street, Kaukauna, WI (Outagamie County)
FISCHER Project #398132.002
WDNR LUST ID # 03-45-1729
PECFA # 54130-2406-22

Dear Mr. McKnight:

Fischer Environmental, Inc. (FISCHER) previously submitted the "Site Investigation Report", dated October 2, 1998 for the Kaukauna Maintenance Garage. The attached forms were inadvertently excluded from that report. Please included these forms with the previously submitted report.

If you have any questions, feel free to contact Ms. Karen Burkman at (920) 766-2069.

Respectfully Submitted,

FISCHER ENVIRONMENTAL, INC.

Karen A. Burkman
Senior Project Manager

KAB/kb

cc: City of Kaukauna
Department of Commerce

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.002	*N/A*	*B-15/MW-5*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
MES *Gary*	*8/28/98*	*8/28/98*	*HSA*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	*N/A*	*MW-5*	*Feet MSL*	*Feet MSL*	*8 inches*

Boring Location	Lat / Long	Local Grid Location (if applicable)
State Plane *N, E* *NI/4 of Gov. Lot 22, T 21N, R 18E*	**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	*Feet* ***S*** *Feet* ***W***

County	DNR County Code	Civil Town/City/ or Village
Outagamie	*45*	*Kaukauna*

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
				Asphalt	Asphalt									
SS1	15	9,7,5,6	2	**GRAVEL**, (3/4" w/fines).	GP SW			137	12					
				SAND, medium to fine grained, trace Gravel, brown, moist, w/ silt	SM									
SS2	12	2,3,3,6	4	Silty **SAND**, medium to fine grained, with Gravel, black and tan, moist				679	6					Poor Recovery
SS3	12	2,4,4,10	6	Silty **SAND**, medium to fine grained, with Gravel, black and tan, moist	CL			614	8					
				Silty **SAND**, trace Gravel and Clay, brown, moist	SM									
SS4	22	7,8 19,23	8	Silty **CLAY**, brownish black, trace Sand and Gravel, wet, with bedrock frags	CL			112	27					
SS5		34,51 47,47	10	Weathered **BEDROCK**				38	98					
SS6		19,37 33,31	12					5	70					
SS7		29,101	14	**BEDROCK**	Bedrock			12	101					
			16											
			18	*E.O.B at 18 feet*										
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen A Burkhard	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 182, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 182.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
☐ Underground Tanks
☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.002	*N/A*	*B-16/MW-6*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
STS *Brian*	*8/28/98*	*8/28/98*	*HSA*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	*N/A*	*MW-6*	*Feet MSL*	*Feet MSL*	*8 inches*

Boring Location	Lat / Long	Local Grid Location (if applicable)
State Plane *N, E* *NI/4 of Gov. Lot 22, T 21N, R 18E*	Lat *N44° 0' 38"* Long *W88° 32'33"*	*Feet* **S** *Feet* **W**

County	DNR County Code	Civil Town/City/ or Village
Outagamie	*45*	*Kaukauna*

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
				Asphalt	Asphalt									
SS1	13	3,1,1,2	2	**GRAVEL**, (3/4" fines)	GP			1.2	2					
				Silty **SAND**, trace Gravel, brown to black, moist	SP-SW									
SS2	14	3,2,3,5	4	Silty **CLAY**, dark brown to black	CL			ND	5					
				Silty **SAND**, fine to medium grained, black, moist	SP-SW									
SS3	6	11,5,4,9	6	Silty **CLAY**, brown to light brown, moist	CL			3.8	9					
SS4	24	11,9 50,50	8	Weathered **BEDROCK** fragments, with Silt, tanish brown, moist ▼ Wet at 6.5 feet	SM			ND	59					
			10	*E.O.B at 8.5 feet*										
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen Buehler	FISCHER ENVIRONMENTAL INC.

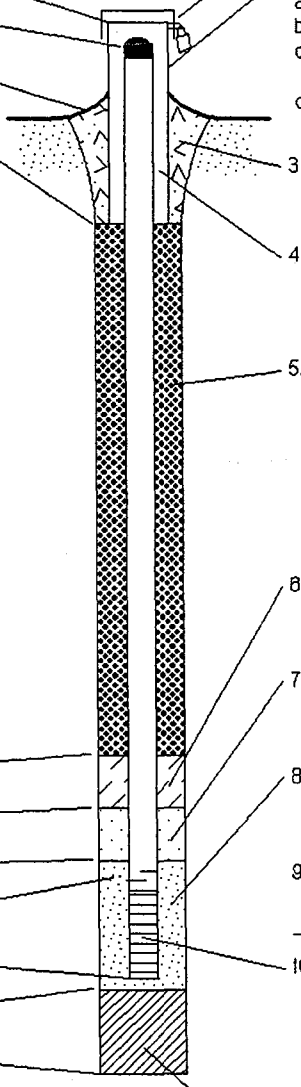
This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4.90

Facility/Project Name	Local Grid Location of Well	Well Name
Kaukauna Maintenance Garage/#398132.002	*Feet S, Feet W*	*MW-5*
Facility License, Permit or Monitoring Number	**Grid Origin Location**	**Wis. Unique Well Number** / **DNR Well Number**
N/A		*N/A* / *N/A*
Type of Well Water Table Observation Well ☒ 11; Piezometer ☐ 12	**Section Location of Waste/Source**	**Date Well Installed**
	NI/4 of Gov. Lot 22, T 21N, R 18E	*8/28/98*
Distance Well Is From Waste/Source Boundary	**Location of Well Relative to Waste/Source**	**Well Installed By: (Person's Name and Firm)**
Is Well A Point of Enforcement Std. Application? ☒ Yes ☐ No	*u* ☐ *Upgradient* *s* ☐ *Sidegradient* *d* ☐ *Downgradient* *n* ☒ *Not Known*	*Brian STS*



A. Protective pipe, top elevation _____ ft. MSL
B. Well casing, top elevation _____ ft. MSL
C. Land surface elevation _____ ft. MSL
D. Surface seal, bottom _____ ft. MSL or 13 ft.

12. USCS Classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☒ 41
x _____ Other ☒ Rotary Wash

15. Drilling fluid used: Water ☒ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

17. Source of water *(attach analysis)*:
City of Green Bay water

E. Bentonite seal, top _____ ft. MSL or 13 ft.
F. Fine sand, top _____ ft. MSL or _____ ft.
G. Filter pack, top _____ ft. MSL or 13 ft.
H. Screen joint, top _____ ft. MSL or 13 ft.
I. Well bottom _____ ft. MSL or 18 ft.
J. Filter pack, bottom _____ ft. MSL or 18 ft.
K. Borehole, bottom _____ ft. MSL or 18 ft.
L. Borehole, diameter 8 in.
M. O.D. well casing 2.25 in.
N. I.D. well casing 2.049 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Flushmount — Steel ☒ 04; Other ☒
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Locking Expandable Cap
3. Surface seal: Bentonite ☐ 30; Concrete ☒ 01; Other ☐
4. Material between well casing and protective pipe: Bentonite ☒ 30; Annular space seal ☐; Other ☐
5. Annular space seal: a. Granular Bentonite ☐ 33
b. _____ Lbs/gal mud weight ..... Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
d. _____ % Bentonite ..... Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☒ 08
6. Bentonite seal: a. Bentonite Granules ☐ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. 3/8" Chipped Bentonite Other ☒ x
7. Fine sand material: Manufacturer, product name and mesh size
a. _____
b. Volume added _____ ft^3
8. Filter pack material: Manufacturer, product name and mesh size
a. American Materials 20-40 Sand
b. Volume added _____ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☒ 24; Other ☐
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11; Continuous slot ☒ 01; Other ☐
b. Manufacturer Buffalo
c. Slot size: 0.010 in.
d. Slotted length: 5 ft.
11. Backfill material (below filter pack): None ☒ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Karen Burbank — Firm FISCHER ENVIRONMENTAL INC.

Please complete both sides of this form and return to the appropriate DNR office listted at the top of this form as required by chs. 144, 147 and 160 Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch. 144 Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147 Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4.90

Facility/Project Name	County Name	Well Name
Kaukauna Maintenance Garage/#398132.002	Outagamie	MW-5

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well Number
N/A	45	N/A	N/A

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☐ 61
surged with block and bailed	☒ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 45 min.

4. Depth of well (from top of well casing) 17.38 ft.

5. Inside diameter of well 2.049 in.

6. Volume of water in filter pack and well casing 8.7 gal.

7. Volume of water removed from well 30.0 gal.

8. Volume of water added (if any) 0 gal.

9. Source of water added City of Green Bay water

10. Analysis performed on water added? ☐ Yes ☒ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 4.13 ft.	4.16 ft.
Date mm/dd/yy	b. 8/28/98	8/28/98
Time	c. 9:47 ☐ p.m. ☒ a.m.	10:32 ☐ p.m. ☒ a.m.
12. Sediment in well bottom	0 inches	0 inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) Cloudy	Clear ☒ 10 Turbid ☐ 15 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	n/a mg/l	n/a mg/l
15. COD	n/a mg/l	n/a mg/l

16. Additional comments on development:
Purged dry three times

Well developed by: Person's Name and Firm

Name: Brian Youngwirth

Firm: FISCHER ENVIRONMENTAL INC.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Kara Barbara

Print Initials: K A B

Firm: FISCHER ENVIRONMENTAL INC.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 4.90

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*	**Local Grid Location of Well** *Feet S, Feet W*	**Well Name** *MW-6*
Facility License, Permit or Monitoring Number *N/A*	**Grid Origin Location**	**Wis. Unique Well Number** *N/A* **DNR Well Number** *N/A*
Type of Well Water Table Observation Well ☒ 11 Piezometer ☐ 12	**Section Location of Waste/Source** *N1/4 of Gov. Lot 22, T 21N, R 18E*	**Date Well Installed** *8/28/98*
Distance Well Is From Waste/Source Boundary	**Location of Well Relative to Waste/Source** *u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☒ Not Known*	**Well Installed By: (Person's Name and Firm)** *Brian STS*
Is Well A Point of Enforcement Std. Application? ☒ Yes ☐ No		

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or 2.5 ft.

12. USCS Classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☒ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☒ 41
_____ Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

17. Source of water *(attach analysis)*:
_____

E. Bentonite seal, top _____ ft. MSL or 2.5 ft.

F. Fine sand, top _____ ft. MSL or _____ ft.

G. Filter pack, top _____ ft. MSL or _____ ft.

H. Screen joint, top _____ ft. MSL or 2.5 ft.

I. Well bottom _____ ft. MSL or 7.5 ft.

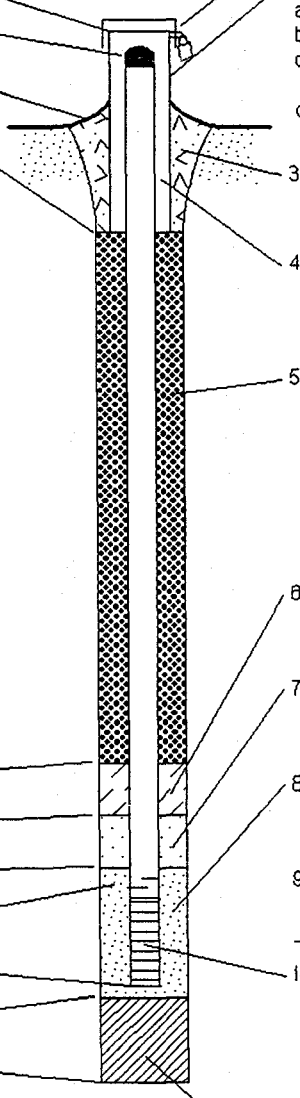
J. Filter pack, bottom _____ ft. MSL or 8.5 ft.

K. Borehole, bottom _____ ft. MSL or 8.5 ft.

L. Borehole, diameter 8 in.

M. O.D. well casing 2.25 in.

N. I.D. well casing 2.049 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Flushmount Steel ☒ 04 Other ☒
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Locking Expandable Cap

3. Surface seal: Bentonite ☐ 30 Concrete ☒ 01 _____ Other ☐

4. Material between well casing and protective pipe: Bentonite ☒ 30 Annular space seal ☐ _____ Other ☐

5. Annular space seal: a. Granular Bentonite ☐ 33
b. ____ Lbs/gal mud weight .....Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
d. ____ % Bentonite .....Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08

6. Bentonite seal: a. Bentonite Granules ☐ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. 3/8" Chipped Bentonite Other ☒ x

7. Fine sand material: Manufacturer, product name and mesh size
a. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name and mesh size
a. _____
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
_____ Other ☐

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☒ 01 _____ Other ☐
b. Manufacturer Buffalo
c. Slot size: 0.010 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☒ 14 _____ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen A Burke	FISCHER ENVIRONMENTAL INC.

Please complete both sides of this form and return to the appropriate DNR office listted at the top of this form as required by chs. 144, 147 and 160 Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch. 144 Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147 Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4.90

Facility/Project Name	County Name	Well Name	
Kaukauna Maintenance Garage/#398132.002	*Outagamie*	*MW-6*	
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well Number**
N/A	*45*	*N/A*	*N/A*

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☐ 61
surged with block and bailed	☐ 42
surged with block and pumped	☒ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well *58 min.*

4. Depth of well (from top of well casing) *6.98 ft.*

5. Inside diameter of well *2.049 in.*

6. Volume of water in filter pack and well casing *2.25 gal.*

7. Volume of water removed from well *6 gal.*

8. Volume of water added (if any) *0 gal.*

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☒ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. *3.57 ft.*	*3.96 ft.*
Date *mm/dd/yy*	b. *8/28/98*	*8/28/98*
Time	c. *9:43* ☐ p.m. ☒ a.m.	*10:45* ☐ p.m. ☒ a.m.
12. Sediment in well bottom	*0.9 inches*	*0 inches*
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe)	Clear ☒ 10 Turbid ☐ 15 (Describe)
	very cloudy	

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	*n/a mg/l*	*n/a mg/l*
15. COD	*n/a mg/l*	*n/a mg/l*

16. Additional comments on development:

Purged dry three times

Well developed by: Person's Name and Firm

Name: Brian Youngwirth

Firm: FISCHER ENVIRONMENTAL INC.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Karen Berg

Print Initials: KMB

Firm: FISCHER ENVIRONMENTAL INC.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
William R. Selbig, Regional Director

Oshkosh Service Center
905 Bay Shore Drive., P.O. Box 2565
Oshkosh, Wisconsin 54903
TELEPHONE 920-424-3050
FAX 920-424-4404

October 12, 1998

City of Kaukauna
ATTN: Mr. John Sundelius
201 West 2nd Street
Kaukauna, WI 54130

SUBJECT: Acknowledgment of Receipt / Notice to Proceed
Kaukauna Waste Oil Collection Site
WDNR BRRTS Unique ID # 03-45-1729

Dear Mr. Sundelius:

We have received the above-referenced submittal from Fischer Environmental, Inc.. Staffing and workload levels do not allow us to provide you with review and oversight at this time and thus this letter is not an approval of your work plans and reports. This letter serves as your "Notice to Proceed" with investigation and remediation of the site. Your submittals will be filed until the Department is able to review them, or until site remediation is completed. The entire case file will remain as part of the Department's public records.

All site work must comply with all applicable statutes, program guidance, standards and Administrative Rules. The major goals of any environmental cleanup action are to define the extent of contamination, choose appropriate remedial options and remediate soils/groundwater to state standards. It is very important that your consultant understands and meets the minimum standards established by the Department; however, you, as the responsible party, are ultimately responsible for the investigation and remediation that is required at your site, according to Wisconsin Statutes s. 292.01-292.81 Stats. Failure to follow guidance may result in timely and/or costly delays when the project is reviewed for closure or reimbursement from PECFA.

Effective this date, on a quarterly basis, you or your consultant should provide the Department with a status report, providing an update on site activities, including monitoring results, evaluations and future work, and your proposed schedule. If any emergency actions are necessary, you must notify the WDNR manager immediately. As workload and staff levels are adjusted, the status of this case may be changed and we may be able to review your consultant's work for completeness and acceptability. You will be informed, in writing, if the site management is changed.

Please send only one copy of all submittals and remember to identify all submittals with the WDNR BRR CASE ID number. All correspondence and reports should be sent to the Department at the following address:

Wisconsin Department of Natural Resources
ATTN: Remediation and Redevelopment
905 Bayshore Drive
P.O. Box 2565
Oshkosh, WI 54903

The Department will review your case when the full extent of contamination has been determined and appropriate cleanup has occurred.

If you have any questions about this letter please contact me at (920) 424-7890.

Sincerely,

Kevin D. McKnight
WDNR, Hydrogeologist
mcknik@dnr.state.wi.us

cc: file
Karen Burkman, FEI, P.O. Box 127, Kaukauna WI 54130

FISCHER
ENVIRONMENTAL, INC.
P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: madkauk@athenet.com

RECEIVED
OCT 07 1998
WDNR OSH
LUST PROGRAM

REMEDIAL ACTION PLAN

Prepared For:

Kaukauna Maintenance Garage
222 West 3rd Street
Kaukauna, WI

Project # 398132.002
WDNR LUST ID # 03-45-1729
PECFA # 54130-2406-22

October 5, 1998

FISCHER
ENVIRONMENTAL, INC.
P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 ▯ FAX: 920-759-2669
E-mail: madkauk@athenet.com

October 5, 1998

Mr. Dino Tsoris
Wisconsin Department of Natural Resources
P.O. Box 2565
Oshkosh, Wisconsin 54903

RE: **REMEDIAL ACTION PLAN for the Kaukauna Maintenance Garage**
222 West 3rd Street, Kaukauna, WI (Outagamie County)
FISCHER Project #398132.002
WDNR LUST ID # 03-45-1729
PECFA # 54130-2406-22

Dear Mr. Tsoris:

On behalf of the City of Kaukauna, the party responsible for the release at the above referenced property, Fischer Environmental, Inc. (FISCHER) is pleased to submit this Remedial Action Plan for the above referenced site. Contamination has been detected within one meter of bedrock, therefore, an "environmental factor" exists, based on COMM 47.

If you have any questions regarding this report, feel free to contact Ms. Karen Burkman at (920) 766-2069.

Respectfully Submitted,

FISCHER ENVIRONMENTAL, INC.

Karen A. Burkman
Senior Project Manager

Herbert E. Berger, Jr.
Senior Hydrogeologist

KAB/heb/kab

cc: City of Kaukauna – Mr. John Sundelius
Department of Commerce

TABLE OF CONTENTS
REMEDIAL ACTION PLAN
Kaukauna Maintenance Garage
10/5/98

SECTION **PAGE**

EXECUTIVE SUMMARY ..... **i**

SUBMITTAL CERTIFICATION ..... **iii**

1.0 INTRODUCTION **1**

1.1 BACKGROUND 1

2.0 CONTAMINANT MASS CALCULATIONS **3**

3.0 EVALUATION OF REMEDIAL ALTERNATIVES **4**

3.1 GENERAL INFORMATION 4
3.2 REMEDIATION BY NATURAL ATTENUATION 4
3.2.1 Source Control 5
3.2.2 Plume Stability 5
3.2.3 Duration Until Enforcement Standard Compliance 5
3.2.4 Institutional Controls 5
3.2.5 Potential Receptors and Migration Pathways 5
3.3 OTHER REMEDIAL ALTERNATIVES 6
3.4 RECOMMENDED ALTERNATIVE 6

4.0 LIMITATIONS OF DATA **8**

5.0 REFERENCES **9**

TABLES

Table 1 Costs for Recommended Remedial Alternative

FIGURES

Figure 1 Proposed Soil Excavation Areas

APPENDICES

Appendix A Acronyms

EXECUTIVE SUMMARY

The Kaukauna Maintenance Garage is located at 222 West 3rd Street in the City of Kaukauna, Outagamie County, Wisconsin (WI). (Acronyms used throughout this report are referenced in Appendix A.) The site presently operates as a maintenance garage and is owned by the City of Kaukauna. Four registered underground storage tanks (USTs) are located on-site: one 10,000 gallon diesel fuel, one 10,000 gallon leaded gasoline, one 10,000 gallon unleaded gasoline and one 550 gallon waste oil UST. The USTs are in use, with the exception of the UST formerly containing leaded gasoline.

OMNNI Associates (OMNNI) has been conducting a Site Investigation with regards to the waste oil UST since contamination was discovered in December of 1993. OMNNI drilled five soil borings at the site and one boring was converted into a ground-water monitoring well. Based on review of OMNNI's Site Investigation report, dated June 1994, the extent of contamination from the waste oil UST was not yet defined at that time. Reportedly, OMNNI collected a ground-water sample from a sump located near the remaining USTs and the analytical results indicated contamination from the other USTs.

Since the City of Kaukauna is in the process of upgrading or removing the UST systems, and since OMNNI detected contamination in the diesel fuel and gasoline UST area, the City contracted Fischer Environmental, Inc. (FISCHER) to perform a Site Investigation. Associated investigation data was presented in FISCHER's Site Investigation Report, dated October 2, 1998. As part of the Site Investigation activities, 11 soil borings were advanced at the site; four were converted into ground-water monitoring wells and one was converted into a bedrock piezometer.

Of the soil samples exhibiting contaminant concentrations exceeding Wisconsin Department of Natural Resources' (WDNR's) generic Residual Contaminant Levels (RCLs), only samples collected from borings B-6, 1-3 feet (ft), B-8, 1-3 ft and B-9, 1-3 ft, appear to have been collected from above the subsequent water table, as measured in the ground-water monitoring wells. Petroleum compounds detected in soil samples collected beneath or at the static water table are generally considered to be dissolved in ground water. The soil zone where ground water fluctuates can be identified as the smear zone. At this site, the vadose zone appears to be the most impacted, relative to the smear zone. The extent of soil contamination, in the vadose and smear zones, appears to have been defined and consists of approximately 1300 cubic yards, assuming an average thickness of seven feet.

Depth to ground water on the site, based on water levels in the monitoring wells, is approximately 3.5 to 4.5 ft below the ground surface (bgs). The ground-water flow is interpreted to be in a southeasterly direction.

The most recent analytical results indicated WDNR's Enforcement Standards (ES) were exceeded in ground-water monitoring wells MW-2 and MW-4 and in piezometer MW-5. The horizontal extent of ground-water contamination, based on ES exceedances, appears to have been defined. The detection of 1,2-Dichloroethane, which is generally associated with gasoline, in well MW-1 appears to indicate one ground-water contaminant plume.

Piezometer MW-5 was installed in the most impacted portion of the ground-water contaminant plume. Since Benzene was the only compound detected in piezometer MW-5 above the ES, and since it was detected at a concentration only slightly exceeding the ES, the vertical extent of ground-water contamination was considered defined for the purposes of the Site Investigation.

A subsurface utility trench appears to be present from the 10,000 gallon USTs to the building. Soil borings were drilled on each side of this utility trench. Since contamination was detected, there is a possibility the trench is a preferential migration pathway. Subsurface utility trenches appear to be present near the waste oil UST. However, based on analytical results for samples collected from nearby borings, these trenches do not appear to be preferential migration pathways.

"Environmentally sensitive areas", such as wetlands and surface waters, do not appear to be located adjacent to, or immediately down gradient of, the site. A potable well is not reportedly located on the subject site and was not evident during several site inspections. It is FISCHER's opinion that contamination has been detected within one meter of bedrock. Bedrock appeared to be present on-site as shallow as 8.5 ft bgs. Therefore, an "environmental factor" appears to be present and active remedial treatment can be justified, based on review of Department of Commerce (COMM) 47.

This Remedial Action Plan (RAP) includes an evaluation of remedial alternatives for this site.

FISCHER proposes to address the "environmental factor" and contaminants by excavating approximately 1020 cubic yards of soil and conducting additional ground-water monitoring. Assuming additional data supports Remediation by Natural Attenuation (RNA) as a final remedy after soil excavation is implemented, it is FISCHER's opinion that "flexible" closure or closure can be requested within eight sampling events. Therefore, the total remedial costs to achieve a closed remedial action are estimated to be $140,558. If RNA as the final remedy after source control does not appear to be feasible, based on the additional data, another remedial alternative may need to be implemented. Additional funds, if required, would be requested at that time.

SUBMITTAL CERTIFICATION

"I, Karen A. Burkman, hereby certify that I am a scientist as that term is defined in s. NR 712.03(3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Karen A. Burkman — 10-5-98

Karen A. Burkman
Senior Project Manager

Date

"I, Herbert E. Berger, Jr., hereby certify that I am a hydrogeologist as that term is defined in s.NR 712.03(1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Karen A. Burkman — 10-5-98

for Herbert E. Berger, Jr.
Senior Hydrogeologist

Date

1.0 INTRODUCTION

1.1 BACKGROUND

The Kaukauna Maintenance Garage site is owned and operated by the City of Kaukauna and currently operates as a municipal maintenance garage. Four registered USTs are located on-site: one 10,000 gallon diesel fuel, one 10,000 gallon leaded gasoline, one 10,000 gallon unleaded gasoline and one 550 gallon waste oil UST. The USTs are in use, with the exception of the UST formerly containing leaded gasoline.

OMNNI has been conducting a Site Investigation with regards to the waste oil UST since contamination was discovered in December of 1993. OMNNI drilled five soil borings at the site and one boring was converted into a ground-water monitoring well (MW-1). Based on review of OMNNI's Site Investigation report, dated June 1994, the extent of contamination from the waste oil UST was not yet defined at that time. Reportedly, OMNNI collected a ground-water sample from a sump located near the remaining USTs and the analytical result indicated contamination from the other USTs.

Since the City of Kaukauna is in the process of upgrading or removing the UST systems, and since OMNNI detected contamination in the diesel fuel and gasoline UST area, the City contracted FISCHER on February 18, 1998 to perform a Site Investigation. As part of the Site Investigation activities, 11 soil borings were advanced at the site; four were converted into ground-water monitoring wells and one was converted into a bedrock piezometer.

Of the soil samples exhibiting contaminant concentrations exceeding WDNR's generic RCLs, only samples collected from borings B-6, 1-3 ft, B-8, 1-3 ft and B-9, 1-3 ft, appear to have been collected from above the subsequent water table, as measured in the ground-water monitoring wells. Petroleum compounds detected in soil samples collected beneath or at the static water table are generally considered to be dissolved in ground water. The soil zone where ground water fluctuates can be identified as the smear zone. At this site, the vadose zone appears to be the most impacted, relative to the smear zone. The extent of soil contamination, in the vadose and smear zones, appears to have been defined and consists of approximately 1300 cubic yards, assuming an average thickness of seven ft.

Depth to ground water on the site, based on water levels in the monitoring wells, is approximately 3.4 to 4.5 ft bgs. The ground-water flow is interpreted to be in a southeasterly direction.

The most recent analytical results indicated WDNR's Enforcement Standards (ES) were exceeded in ground-water monitoring wells MW-2 and MW-4 and in piezometer MW-5. The horizontal extent of ground-water contamination, based on ES exceedances, appears to have been defined. The detection of 1,2-Dichloroethane in well MW-1 appears to indicate one ground-water contaminant plume.

Piezometer MW-5 was installed in the most impacted portion of the ground-water contaminant plume. Since Benzene was the only compound detected in piezometer MW-5 above the ES, and since it was detected at a concentration only slightly exceeding the ES, the vertical extent of ground-water contamination was considered defined for the purposes of the Site Investigation.

"Environmentally sensitive areas", such as wetlands and surface waters, do not appear to be located adjacent to, or immediately down gradient of, the site. A potable well is not reportedly located on the subject site and was not evident during several site inspections. FISCHER is not aware of potable wells located down gradient of, or adjacent to, the subject site. Therefore, there do not appear to be any known potential receptors, with the possible exception of the Fox River, located approximately 600 feet northeast of the Kaukauna Maintenance Garage.

In a previous report, OMNNI indicated bedrock was encountered at the site at ten ft bgs. During FISCHER's Site Investigation, auger refusal, probably bedrock, was encountered at 8.5 to nine ft bgs. Soil contamination has been detected in samples collected from seven ft bgs and ground-water contamination has been detected in monitoring wells screened just above what appears to be bedrock. One of the COMM 47 "environmental factors" is the presence of contamination within one meter (three feet) of bedrock. It is FISCHER's opinion that contamination has been detected within one meter of bedrock. Therefore, an "environmental factor" appears to be present and active remedial treatment can be justified, based on review of COMM 47.

Site characteristics such as soil conditions and hydrogeology, and the nature and extent of the contamination, were described in more detail in FISCHER's Site Investigation Report.

As a result of the Site Investigation, FISCHER has prepared this Remedial Action Plan. The remediation goal for this site is to stabilize and reduce the size of the contaminated ground-water plume within a reasonable period and also to address the "environmental factor".

2.0 CONTAMINANT MASS CALCULATIONS

Based on the results of the Site Investigation, FISCHER estimated the volume and location of the mass of contaminants. FISCHER calculated there are approximately seven pounds (lbs) of total Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) in the vadose zone (soil above the water table); two lbs total BTEX in the smear zone (estimated to be two ft thick); and two lbs in the ground water (contaminated zone estimated to be 5 ft thick).

3.0 EVALUATION OF REMEDIAL ALTERNATIVES

3.1 GENERAL INFORMATION

Various technological alternatives are available for the remediation of petroleum-affected soil and ground water. These alternatives are classified as either in situ (in place) or ex situ treatment. RNA may also be considered a viable alternative. Technologies are selected based on the extent of contamination, nature of contaminants, subsurface soil classifications, estimated effectiveness of the selected technology and overall cost of remediation.

In accordance with rule COMM 47, FISCHER has evaluated the following environmental factors.

1) "Documented expansion of plume margin."
2) "Verified contaminant concentrations in a private or public potable well that exceed the PAL established under Chapter, Stats. 160."
3) "Contamination within bedrock or within 1 meter of bedrock."
4) "Petroleum product that is not in the dissolved phase (floating product) is present with a thickness of 0.01 ft or more, and verified by more than one sampling event."
5) "Documented contamination discharges to a surface water or wetland."

As indicated previously, it is FISCHER's opinion that contamination has been detected within one meter of bedrock. Therefore, an "environmental factor" appears to be present and active remedial treatment can be justified, based on review of COMM 47.

3.2 REMEDIATION BY NATURAL ATTENUATION

Natural Attenuation is defined in NR 700, Wisconsin Administrative Code as "the reduction in the concentration and mass of a substance and its breakdown products in groundwater, due to naturally occurring physical, chemical, and biological processes without human intervention or enhancement. These processes include, but are not limited to, dispersion, diffusion, sorption and retardation, and degradation processes such as biodegradation, abiotic degradation and radioactive decay."

In order for case closure to be granted by the WDNR utilizing RNA as the remedial alternative, the following criteria should be met.

- Adequate source control measures have been taken.
- The ground-water contaminant plume is either stable or receding. Ground-water contamination exceeding PALs will not migrate beyond boundaries for which Ground-Water Use Restrictions are recorded.
- Natural Attenuation will bring the ground water into compliance within a reasonable period of time.
- If an Enforcement Standard(s) is exceeded, a Ground-Water Use Restriction shall be filed with the county registrar of deeds office.
- There is no existing or anticipated threat to public health, safety or welfare or the environment.

3.2.1 Source Control

The four existing USTs and associated piping and dispensers will either be upgraded to current standards or removed and possibly replaced. Impacted soil exceeding WDNR's generic RCLs is present on-site within the vadose and smear zones. Based on calculations, the total mass of BTEX appears to be greater within the vadose zone compared to the mass within the smear zone and ground water. Removal of the majority of the impacted soil and smear zone (Figure 1) would provide source control and enhance RNA. Not all of the soil exceeding RCLs will be removed from the site due to inaccessibility. The excavation will not extend to the building walls or near any USTs that will remain in place. Although pumping and disposal of contaminated ground water during excavation is anticipated, the excavation will not extend to depths that will create an excessive amount of ground water pumping and disposal, in order to control costs.

3.2.2 Plume Stability

Based on review of analytical results, the ground-water contaminant plume appears to be relatively stable. Source control would enhance the plume's stability.

3.2.3 Duration Until Enforcement Standard Compliance

The length of time until the WDNR's ES are met will be estimated, during the next phase of this project, by utilizing historical ground-water monitoring results. Dissolved organic contaminant data will be used in conjunction with aquifer testing data to evaluate the behavior of the contaminant plume. A solute transport model will be used to predict contaminant movement and concentrations.

3.2.4 Institutional Controls

A representative of the City of Kaukauna indicated they are willing to accept a Ground-Water Use Restriction.

3.2.5 Potential Receptors and Migration Pathways

Surficial soils appear to be significantly impacted. The site is currently paved and will remain paved after the proposed tank upgrading/removal. However, exposure by direct contact is possible if surficial and/or subsurface soils are exposed in the future.

Based on ground-water levels in the monitoring wells, depth to ground water on the site is approximately 3.5 to 4.5 ft bgs. The ground-water flow is interpreted to be in a southeasterly direction.

"Environmentally sensitive areas", such as wetlands and surface waters, do not appear to be located adjacent to, or immediately down gradient of, the site. A potable well is not reportedly located on the subject site and was not evident during several site inspections. FISCHER is not aware of potable wells located down gradient of, or adjacent to, the

subject site. Therefore, there do not appear to be any known potential receptors, with the possible exception of the Fox River, located approximately 600 feet northeast of the Kaukauna Maintenance Garage. However, based on ground-water levels measured to date, ground water does not appear to be flowing toward the Fox River.

A subsurface utility trench appears to be present from the 10,000 gallon USTs to the building. Soil borings were conducted on each side of this utility trench. Since contamination was detected, there is a possibility the trench is a preferential migration pathway. Subsurface utility trenches appear to be present near the waste oil UST. However, based on analytical results for samples collected from nearby borings, these trenches do not appear to be preferential migration pathways.

3.3 OTHER REMEDIAL ALTERNATIVES

As stated previously, "active treatment" can be justified as a remedial alternative at this site due to the presence of an "environmental factor", based on COMM 47. However, based on soil conditions (non-homogeneous fill overlying clay overlying bedrock), the proposed tank removal/upgrading, and an evaluation of costs, soil excavation, which is considered a "non-active source control", appears to be the most feasible.

3.4 RECOMMENDED ALTERNATIVE

Based on the information presented in the preceding sections, RNA could be a feasible alternative if source control is implemented. Based on cost estimates, FISCHER recommends soil excavation and treatment at the Ridgeview BioSite located in Whitelaw, WI and ground-water monitoring. The approximate area proposed for excavation is identified on Figure 1 and consists of approximately 1020 cubic yards of soil. Soil excavation is proposed to be conducted at the time the USTs are removed/upgraded.

The presence of USTs that may be upgraded instead of removed, the building, and subsurface utilities will limit the lateral extent of the soil excavation (not all of the soil exceeding the RCLs will be excavated). The excavation may need to be pumped if an excessive amount of ground water flows into the excavation. The depth of the excavation may be limited to no greater than seven feet in the area of the former USTs. However, in order to control ground water pumping and disposal costs, the excavation may be shallower.

Representative soil samples will be obtained from the excavation limits to document removal of affected soil. These closure samples will be analyzed for Gasoline Range Organics (GRO), Petroleum Volatile Organic Compounds (PVOC), and Diesel Range Organics (DRO). Upon completion of the closure sampling, the excavation will be backfilled to grade with imported fill. New USTs may be placed in a portion of the excavation.

If MW-1, MW-2 and/or MW-4 are removed during the excavation, one to three recovery sumps will be installed in order to monitor the ground-water at these locations after the excavation. The existing ground-water monitoring wells, existing piezometer and the newly installed sumps will be sampled for the presence of PVOC. A portion of the ground-water samples may also be analyzed for 1,2-Dichloroethane and/or Naphthalene, depending upon previous analytical results. At least

one event will include sampling for continued evaluation of RNA to see if RNA is a viable remedial method or if additional measures will need to be considered.

After one post-excavation monitoring event has been completed, FISCHER will consult with the WDNR regarding ground-water contamination within the bedrock. The WDNR may require additional bedrock piezometers. Therefore, for the purpose of this RAP, FISCHER has included the contingency to install, develop, and sample (for VOC and Dissolved Lead) three additional bedrock piezometers.

Documentation of the soil excavation and post-monitoring results will be submitted to the WDNR for review. A remediation documentation report will be submitted after the excavation phase has been completed. A subsequent submittal will include ground-water monitoring results. A request for closure or recommendations for additional monitoring will also be submitted.

It is FISCHER's opinion that "flexible" closure or closure can be requested within eight sampling events subsequent to soil excavation. Therefore, the total remedial costs for a closed remedial action are estimated to be $140,558 (Table 1). If RNA as the final remedy after source control does not appear to be feasible, based on the additional data, another remedial alternative may need to be implemented. Additional funds, if required, would be requested at that time.

4.0 LIMITATIONS OF DATA

The conclusions and recommendations of this Remedial Action Plan are formulated based on site conditions known to have existed prior to, and encountered during, field exploration activities on the site and are based on FISCHER's Site Investigation Report, dated October 2, 1998. Additional exploration and analysis is desirable, but would not be expected to significantly alter the conditions reported herein and the scope of the corrective action measures developed in the Remedial Action Plan. Estimated costs for the Remedial Action Alternatives are based on design criteria established for other sites with similar characteristics.

5.0 REFERENCES

- COMM 47, April 1998
- NR 700s Wisconsin Administrative Code, February 1997 update
- "Technical Protocol of Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater", Volume II, T. Wiedemeier, J. Wilson, D Kampbell, R. Miller and J. Hansen, 1995
- "Natural Attenuation for Remediation of Contaminated Sites", T. Wiedemeier, M. Barden, 1997
- "Site Investigation Report", FISCHER, October 2, 1998

TABLE 1 COSTS FOR RECOMMENDED REMEDIAL ALTERNATIVE

Project # 398132 **Project Name:** Kaukauna Maintenance Garage

Source Control (soil excavation - 1020 cubic yards) and Remediation by Natural Attenuation

						Consulting	Commodity	Totals
Bidding/coordination/permits								
Senior Hydrogeologist	$	85	/hr.	3	hours	$255		
Proj. Engineer/Manager	$	77	/hr.	24	hours	$1,848		
Clerical	$	35	/hr.	4	hours	$140		
Field Work - Excavation								
Remove/Disp.Pavement	$	0.50	/sq ft	4000	sq ft		$2,000	
Excavate Cont. soil	$	4.00	/ton	1836	tons		$7,344	
Mobilization/Misc	$	350	/ea	2			$700	
Transportation	$	8.00	/ton	1836	tons		$14,688	
Fill	$	11.00	/cu yd	1026	cu yds		$11,286	
Fill - gravel	$	13.00	/cu yd	300	cu yds		$3,900	
Backfill/Compaction	$	4.00	/cu yds	1326	cu yds		$5,304	
PID	$	75	/day	2	days	$150		
Proj Engineer/Manager	$	77	/hr.	32	hours	$2,464		
Senior Hydrogeologist	$	85	/hr.	4	hours	$340		
Technician	$	55	/hr.	8	hours	$440		
Equipment/Mileage						$150		
Ground-water pump/disposal							$3,000	
Install Three Sumps - Contingency								
Proj Engineer/Manager	$	77	/hr.	3	hours	$231		
Technician	$	55	/hr.	1	hours	$55		
Labor/Materials							$2,300	
Analytical								
Confirmatory Soil	$	55	/sample	14	samples		$770	
Soil Treatment Fee	$	18	/ton	1836	tons		$33,048	
Project Management/Correspondence/Remediation Documentation Report								
Senior Hydrogeologist	$	90	/hr.	10	hours	$900		
Proj Engineer/Manager	$	80	/hr.	40	hours	$3,200		
Clerical	$	40	/hr.	10	hours	$400		
Drafting	$	55	/hr.	6	hours	$330		
Excavation/Submittal of Documentation Report						**$10,903**	**$84,340**	**$95,243**
Install, Survey, Develop Three Bedrock Piezometers - Contingency								
Proj Engineer/Manager	$	80	/hr.	4	hours	$320		
Technician	$	65	/hr.	32	hours	$2,080		
Equipment/Mileage						$250		
Labor/Materials							$3,500	
Eight Monitoring Events (includes 3 bedrock wells and 3 sumps as contingency)								
Proj Engineer/Manager	$	80	/hr.	32	hours	$2,560		
Senior Hydrogeologist	$	90	/hr.	20	hours	$1,800		
Technician	$	65	/hr.	176	hours	$11,440		
GW Analytical	$	50	/sample	80	samples		$4,000	
GW Analytical	$	75	/sample	3	samples		$225	
GW Analytical - NA	$	100	/sample	9	samples		$900	
Equipment/Mileage						$3,200		
RNA Modeling								
Senior Hydrogeologist	$	90	/hr.	30	hours	$2,700		
Proj Engineer/Manager	$	80	/hr.	12	hours	$960		
Clerical	$	40	/hr.	2	hours	$80		
Project Management/Correspondence								
Senior Hydrogeologist	$	90	/hr.	6	hours	$540		
Proj Engineer/Manager	$	80	/hr.	20	hours	$1,600		
Clerical	$	40	/hr.	4	hours	$160		
Drafting	$	55	/hr.	2	hours	$110		
Monitoring						**$27,800**	**$8,625**	**$36,425**

TABLE 1 (continued)

Project # 398132 **Project Name:** Kaukauna Maintenance Garage

					Consulting	***Commodity***	***Totals***
RNA Closure Request and Filing Ground-Water Use Restriction,if needed							
Senior Hydrogeologist	$	90	/hr.	8 hours	$720		
Proj Engineer/Manager	$	80	/hr.	30 hours	$2,400		
Drafting	$	55	/hr.	6 hours	$330		
Clerical	$	40	/hr.	10 hours	$400		
WDNR Closure Report Review Fee						$750	
PECFA Claim					$500		
Abandon MWs/Sumps/Piezometers/Documentation							
Mobilization						$200	
Abandon	$	15	/foot	150 feet		$2,250	
Field Hydrogeologist	$	65	/hr.	12 hours	$780		
Proj Engineer/Manager	$	80	/hr.	4 hours	$320		
Clerical	$	40	/hr.	6 hours	$240		
Closure					**$5,690**	**$3,200**	**$8,890**
TOTALS:					**$44,393**	**$96,165**	**$140,558**

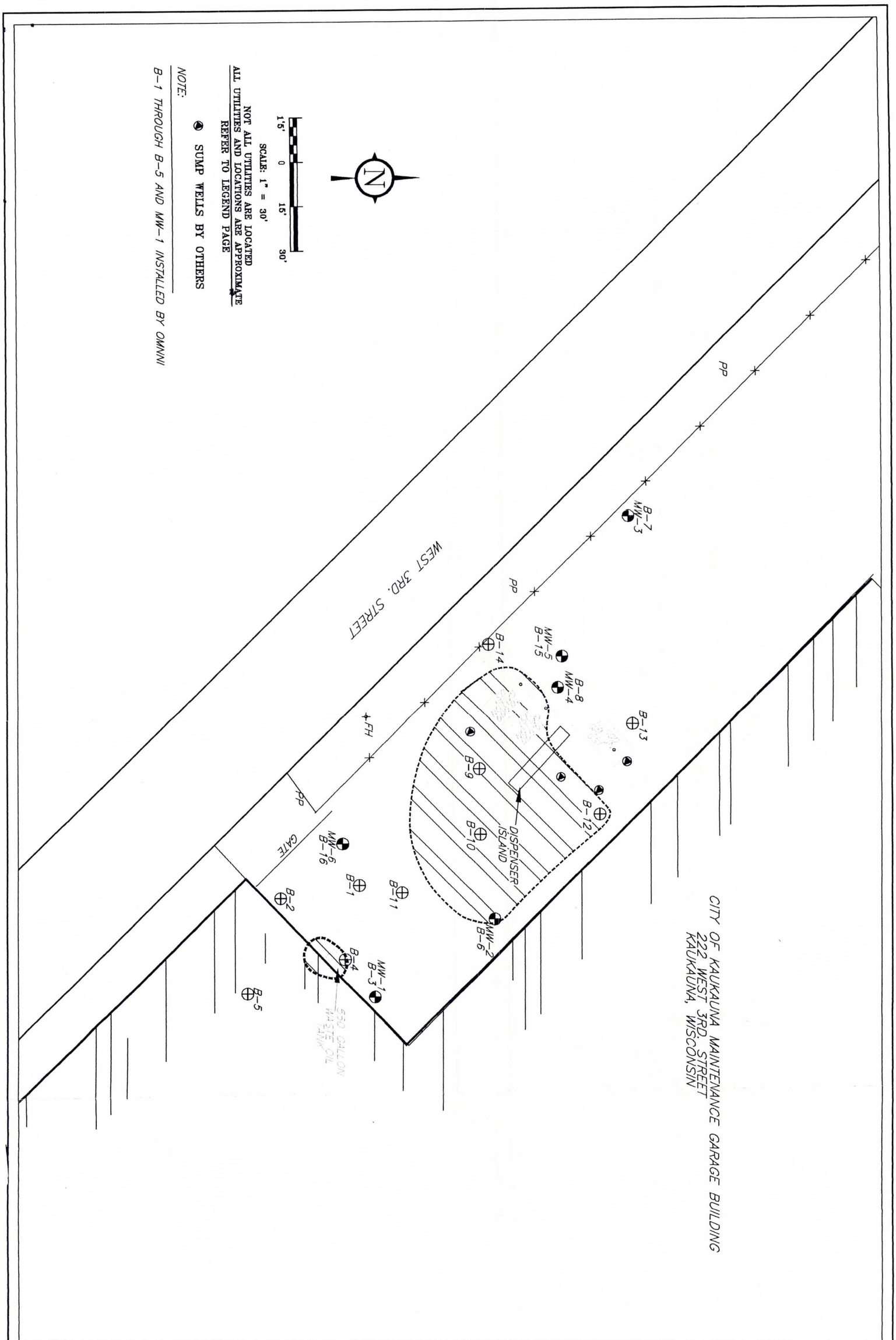


FIGURE 1: PROPOSED SOIL EXCAVATION AREAS

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 ■ FAX (920) 759-2669

398132.002	
DRAWN BY: KP	REVIEWED BY: JF
DATE: 9/28/98	APPROVED BY: KB
ID#: CITY-KAU-1	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
REMEDIAL ACTION PLAN

ACRONYMS

1,2 - DCA	1,2 - Dichloroethane
AST	Aboveground Storage Tank
bgs	Below the Ground Surface
cm/sec	Centimeters per Second
COMM	Department of Commerce (formerly DILHR)
DILHR	Department of Industry, Labor and Human Relations
DO	Dissolved Oxygen
DOT	Department of Transportation
DRO	Diesel Range Organics
ES	Enforcement Standards
EPA	Environmental Protection Agency
ERP	Environmental Repair Program
ft	Feet
FISCHER	Fischer Environmental, Inc.
GNHS	Geological and Natural History Survey
GRO	Gasoline Range Organics
lbs	Pounds
LOD	Limits of Detection
LOQ	Limits of Quantitation
LSA	Limited Site Assessment
LUST	Leaking Underground Storage Tank
MDL	Method Detection Limit
mg/kg	Milligram per Kilogram (ppm)
mg/l	Milligram per Liter (ppm)
MTBE	Methyl-Tert-Butyl-Ether
NA	Natural Attenuation
ND	No Analyte Detected Above the Method Detection Limit
NE	No Established Compound Regulations
PAH	Polynuclear Aromatic Hydrocarbons
PAL	Preventive Action Limit
PID	Photoionization Detector
PVC	Polyvinyl Chloride
PVOC	Petroleum Volatile Organic Compounds
ppb	Parts per Billion
ppm	Parts per Million
RAP	Remedial Action Plan
RCL	Residual Contaminant Levels
RNA	Remediation by Natural Attenuation
SPT	Standard Penetration Test
TOC	Total Organic Carbon
TKN	Total Kjeldahl Nitrogen
ug/kg	Microgram per Kilogram (ppb)
ug/l	Microgram per Liter (ppm)
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
WI	Wisconsin

FISCHER
ENVIRONMENTAL, INC.
P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: madkauk@athenet.com

RECEIVED
OCT 07 1998
WDNR OSH
LUST PROGRAM

SITE INVESTIGATION REPORT

Prepared For:

Kaukauna Maintenance Garage
222 West 3rd Street
Kaukauna, WI

Project # 398132.002
WDNR LUST ID # 03-45-1729
PECFA # 54130-2406-22

October 2, 1998

FISCHER
ENVIRONMENTAL, INC.
P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 · FAX: 920-759-2669
E-mail: madkauk@athenet.com

October 2, 1998

Mr. Dino Tsoris
Wisconsin Department of Natural Resources
P.O. Box 2565
Oshkosh, Wisconsin 54903

RE: **SITE INVESTIGATION REPORT for the Kaukauna Maintenance Garage**
222 West 3rd Street, Kaukauna, WI (Outagamie County)
FISCHER Project #398132.002
WDNR LUST ID # 03-45-1729
PECFA # 54130-2406-22

Dear Mr. Tsoris:

On behalf of the City of Kaukauna, the party responsible for the release at the above referenced property, Fischer Environmental, Inc. (FISCHER) is pleased to submit the Site Investigation Report for the Kaukauna Maintenance Garage.

If you have any questions regarding this report, feel free to contact Ms. Karen Burkman at (920) 766-2069.

Respectfully Submitted,

FISCHER ENVIRONMENTAL, INC.

Karen A. Burkman
Senior Project Manager

Herbert E. Berger, Jr.
Senior Hydrogeologist

KAB/heb/kb

cc: City of Kaukauna
Department of Commerce

TABLE OF CONTENTS
SITE INVESTIGATION REPORT
Kaukauna Maintenance Garage
10/2/98

SECTION **PAGE**

EXECUTIVE SUMMARY ..... **i**

SUBMITTAL CERTIFICATION ..... **iii**

1.0 INTRODUCTION **1**

1.1 PURPOSE AND SCOPE 1
1.2 SITE INFORMATION AND CONTACTS 1
1.3 PROJECT BACKGROUND 2

2.0 SITE CHARACTERIZATION **3**

2.1 TOPOGRAPHY AND SURFACE HYDROLOGY 3
2.2 SOILS 3
2.3 GEOLOGY 4
2.4 HYDROGEOLOGY AND POTABLE WELLS 4

3.0 SITE INVESTIGATION **5**

3.1 GENERAL 5
3.2 SOIL INVESTIGATION 5
3.2.1 Soil Borings 5
3.2.2 Soil Contamination Assessment 6
3.3 GROUND-WATER INVESTIGATION 7
3.3.1 Ground-Water Monitoring Wells 7
3.3.2 Ground-Water Contamination Assessment 8
3.4 DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS 10

4.0 LIMITATIONS OF DATA **12**

5.0 REFERENCES **13**

ACRONYMS

TABLES

Table 1	Soil Analytical Results – April 15, 1998
Table 2	Summary of Laboratory Analysis Soil Boring Samples – March 21, 1994 Sampling Event (OMNNI)
Table 3	Summary of Ground-Water Monitoring Well Results (compounds detected)

FIGURES

Figure 1	Site Location Map
Figure 2	Site Plan
Figure 3	Soil Boring and Monitoring Well Locations
Figure 4	Geologic Cross-Section – A-A'
Figure 5	Ground-Water Flow Direction – April 21, 1998
Figure 6	Ground-Water Flow Direction – September 16, 1998
Figure 7	Estimated Extent of Contamination Exceeding RCLs in the Vadose and Smear Zones
Figure 8	Estimated Extent of Ground-Water Contamination Exceeding the Enforcement Standards

APPENDICES

Appendix A	Soil Boring Logs, Borehole Abandonment Forms and Hydraulic Conductivity Test Result
Appendix B	Soil Analytical Results
Appendix C	Ground-Water Monitoring Well Construction Forms, Monitoring Well Development Forms and Ground-Water Level Data Sheet
Appendix D	Ground-Water Analytical Results

EXECUTIVE SUMMARY

The Kaukauna Maintenance Garage is located at 222 West 3rd Street in the City of Kaukauna, Outagamie County, Wisconsin (WI). The site presently operates as a maintenance garage and is owned by the City of Kaukauna. Four registered underground storage tanks (USTs) are located on-site: one 10,000 gallon diesel fuel, one 10,000 gallon leaded gasoline, one 10,000 gallon unleaded gasoline and one 550 gallon waste oil UST. The USTs are in use, with the exception of the UST formerly containing leaded gasoline.

OMNNI Associates (OMNNI) has been conducting a Site Investigation with regards to the waste oil UST since contamination was discovered in December of 1993. OMNNI drilled five soil borings at the site and one boring was converted into a ground-water monitoring well (MW-1). Based on review of OMNNI's Site Investigation report, dated June 1994, the extent of contamination from the waste oil UST was not yet defined at that time. Reportedly, OMNNI collected a ground-water sample from a sump located near the remaining USTs and the analytical results indicated contamination from the other USTs.

Since the City of Kaukauna is in the process of upgrading or removing the UST systems, and since OMNNI detected contamination from the diesel fuel and gasoline USTs, the City contracted Fischer Environmental, Inc. (FISCHER) to perform a Site Investigation.

As part of the Site Investigation services, 11 soil borings were drilled and four were converted into water table ground-water monitoring wells (MW-2, MW-3, MW-4 and MW-6). One of the 11 soil borings was converted into a bedrock piezometer (MW-5).

Of the soil samples exhibiting contaminant concentrations exceeding Wisconsin Department of Natural Resources' (WDNR's) generic Residual Contaminant Levels (RCLs), only samples collected from borings B-6, 1-3 feet (ft), B-8, 1-3 ft, and B-9, 1-3 ft appear to have been collected from above the subsequent water table, as measured in the ground-water monitoring wells. Petroleum compounds detected in soil samples collected beneath or at the static water table are generally considered to be dissolved in ground water. The soil zone where ground water fluctuates can be identified as the smear zone. At this site, the vadose zone appears to be the most impacted, relative to the smear zone. The extent of soil contamination, in the vadose and smear zones, appears to have been defined.

Depth to ground water on the site, based on water levels in the monitoring wells, is approximately 3.5 to 4.5 ft below ground surface (bgs). The ground-water flow is interpreted to be in a southeasterly or easterly direction.

The most recent analytical results indicate WDNR's Enforcement Standards (ES) were exceeded in ground-water monitoring wells MW-2 and MW-4 and in piezometer MW-5. The horizontal extent of ground-water contamination, based on ES exceedances, appears to have been defined. The detection of 1,2-Dichloroethane, which is generally associated with gasoline, in well MW-1 appears to indicate one ground-water contaminant plume.

Piezometer MW-5 was installed in the most impacted portion of the ground-water contaminant plume. Since Benzene was the only compound detected in piezometer MW-5 above the ES, and since it was detected at a concentration [5.5 micrograms per liter (ug/l)] only slightly exceeding the

WDNR's ES of 5 ug/l, the vertical extent of contamination will be considered defined for the purposes of this Site Investigation.

"Environmentally sensitive areas", such as wetlands and surface waters, do not appear to be located adjacent to, or immediately down gradient of, the site. A potable well is not reportedly located on the subject site and was not evident during several site inspections. It is FISCHER's opinion that contamination has been detected within one meter of bedrock. Bedrock appeared to be present on-site as shallow as 8.5 ft bgs. Therefore, an "environmental factor" appears to be present and active remedial treatment can be justified, based on review of COMM 47. A Remedial Action Plan (RAP) will be submitted under a separate cover.

SUBMITTAL CERTIFICATION

"I, Karen A. Burkman, hereby certify that I am a scientist as that term is defined in s. NR 712.03(3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Karen A. Burkman
Senior Project Manager

10/2/98
Date

"I, Herbert E. Berger, Jr., hereby certify that I am a hydrogeologist as that term is defined in s.NR 712.03(1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Herbert E. Berger, Jr.
Senior Hydrogeologist

10/2/98
Date

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this report is to fulfill WDNR requirements pertaining to Site Investigations. This report documents the Site Investigation activities, which include determining the degree and extent of soil and ground-water contamination associated with USTs at the Kaukauna Maintenance Garage facility located at 222 West 3rd Street, Kaukauna, WI.

Specific objectives of this study include:

- Review existing data regarding area and site geology, past and present land uses, and soil and ground-water contamination.
- Determine the lateral and vertical extents of petroleum-affected soils and ground water.

1.2 SITE INFORMATION AND CONTACTS

Site Name and Location: Kaukauna Maintenance Garage
222 West 3rd Street
Kaukauna, WI 54130
NE ¼ Government Lot 22, T21N, R18E of Outagamie County
(Figure 1 - Site Location Map and Figure 2 - Site Plan)

Current Site Owner: City of Kaukauna
Department of Public Works
P.O. Box 890
Kaukauna, WI 54130
Contact: Mr. John Sundelius – Street Superintendent
Phone: (920) 766-6337

Consultant: Fischer Environmental, Inc.
P.O. Box 127
Kaukauna, WI 54130
Phone: (920) 766-2069

Project Manager: Ms. Karen Burkman
Fischer Environmental, Inc.
P.O. Box 127
Kaukauna, WI 54130
Phone: (920) 766-2069

Project Hydrogeologist: Mr. Herbert E. Berger, Jr.
Fischer Environmental, Inc.
P.O. Box 552
Ripon, WI 54971
Phone: (920) 745-2200

Site Operations: The property is used as a municipal maintenance garage.

1.3 PROJECT BACKGROUND

The Kaukauna Maintenance Garage site is owned and operated by the City of Kaukauna and currently operates as a municipal maintenance garage. Four registered USTs are located on-site: one 10,000 gallon diesel fuel, one 10,000 gallon leaded gasoline, one 10,000 gallon unleaded gasoline and one 500 or 550 gallon waste oil UST. The USTs are in use, with the exception of the UST formerly containing leaded gasoline.

OMNNI has been conducting a Site Investigation with regards to the waste oil UST since contamination was discovered in December of 1993. OMNNI drilled five soil borings at the site and one boring was converted into a ground-water monitoring well (MW-1). Based on review of OMNNI's Site Investigation report, dated June 1994, the extent of contamination from the waste oil UST was not yet defined at that time. Reportedly, OMNNI collected a ground-water sample from a sump located near the remaining USTs and the analytical result indicated contamination from the other USTs.

Since the City of Kaukauna is in the process of upgrading or removing the UST systems, and since OMNNI detected contamination from the diesel fuel and gasoline USTs, the City contracted FISCHER to perform a Site Investigation. Mr. John Sundelius, Street Superintendent for the City of Kaukauna, retained FISCHER on February 18, 1998. The contracted services included review of existing pertinent information, preparation of a Site Investigation Work Plan, performance of a Site Investigation to determine the extent of petroleum-affected soils and/or ground water, preparation of a Site Investigation Report and Remedial Action Plan, oversight of soil and ground water requiring remediation, and completion of submittals per WDNR and Department of Commerce (COMM) requirements.

2.0 SITE CHARACTERIZATION

2.1 TOPOGRAPHY AND SURFACE HYDROLOGY

Based on review of the United States Geological Survey (USGS) Kaukauna, WI Quadrangle map, dated 1974 and photorevised 1984, the elevation of the site is approximately 655+/- 5 ft above mean sea level. The Fox River is located approximately 600 feet northeast of the site. The Fox River and Kankapot Creek confluence is located approximately 2,000 ft southeast of the site.

2.2 SOILS

According to the "Soil Survey of Outagamie County, WI", the soil in the subject site area typically consists of Udorthents. This is well drained, mainly level and gently sloping soil in filled areas, where the fill is mainly loamy and clayey. The permeability varies but is mostly slow or very slow.

Local potable well construction reports and geologic logs were requested from the Geological Natural History Survey (GNHS) office located in Madison, WI. Based on three well construction reports for wells located in the site vicinity, the following formations were encountered during well installation.

- Clay 0-10 ft bgs; till 10-55 ft bgs; Dolomite 55-240 ft bgs; Sandstone 240-245 ft bgs; Dolomite 245-250 ft bgs; Sandstone 250-260 ft bgs; Dolomite 260-440 ft bgs; Siltstone 440-450 ft bgs; Dolomite 450-459 ft bgs; Shale 459-460 ft bgs; Dolomite 460-465 ft bgs; Sandstone 465-550 ft bgs; Siltstone 550-557 ft bgs
- Drift 0-8 ft bgs; Dolomite 8-172 ft bgs; Sandstone 172-228 ft bgs; Dolomite 228-403 ft bgs; Sandstone 403-733.5 ft bgs
- Clay 0-26 ft bgs; Limestone 26-353 ft bgs; Shale 353-355 ft bgs; Limestone 355-395 ft bgs; Sandstone 395-795 ft bgs; "Broken" Granite 795-806 ft bgs

Based on review of OMNNI's Soil Boring Logs previously submitted to the WDNR, in general, silt, sand and fill overlay clay on the site.

A description of subsurface conditions encountered at each boring drilled during FISCHER's Site Investigation, is shown on the Soil Boring Logs (Appendix A). The lines of demarcation on the boring logs represent an approximate boundary between the various soil classifications since the transition is likely to be more gradual. Soil descriptions are representative for the specific boring location, but variation may occur between and beyond the sampling intervals and boring locations.

The surface of the site is covered with asphalt. The soils at the site generally consist of fill to a depth ranging from approximately five to seven ft. These soils are underlain by clay with varying amounts of silt and gravel overlying silt, with varying amounts of sand and gravel, to the termination depth of the borings. A geologic cross-section is presented in Figure 4.

A hydraulic conductivity test was conducted on a soil sample collected with a Shelby tube from boring B-8 at three to five ft bgs. The result indicated a hydraulic conductivity of 2.2×10^{-7} centimeters per second (cm/sec). Soil testing results are provided in Appendix A.

2.3 GEOLOGY

Glacial geology in the site vicinity consists of lacustrine deposits. The bedrock is Ordovician age Sinnipee dolomite with some limestone and shale. Glacial sediments in the Fox-Wolf basin include morainal deposits of unsorted silt, clay, sand, and gravel; outwash deposits of sand and gravel; and lacustrine deposits consisting of mainly silt and clay. Depth to bedrock in the area appears to be between zero and 50 ft bgs.

Based on review of the aforementioned well construction reports obtained from the GNHS office, bedrock was first encountered at depths ranging from eight to ten ft bgs. According to OMNNI's Soil Boring Logs, bedrock was encountered at approximately ten ft bgs on the site.

Auger refusal, probably bedrock, was encountered in four of the borings performed by FISCHER, at approximately 8.5 and nine ft bgs. In boring B-15, weathered bedrock appeared to be encountered at approximately 8.5 ft bgs, and unweathered bedrock appeared to be encountered at approximately 13.5 ft bgs.

2.4 HYDROGEOLOGY AND POTABLE WELLS

Depth to ground water at the site is approximately 3.5 to 4.5 ft bgs, based on ground-water elevations recorded during sampling events. The ground-water flow is interpreted to be in a southeasterly or easterly direction (Figures 5 and 6). However, additional ground-water monitoring wells and measurements over a longer period of time would be required to accurately evaluate hydraulic gradients and ground-water flow direction. Ground-water flow direction and levels may fluctuate due to variations in seasonal precipitation, lateral drainage conditions, and soil permeability characteristics.

A review of the aforementioned well construction reports supplied by the GNHS office, indicated the depth to ground water ranged from 48 to 72 ft bgs during well installation. OMNNI stated in its previously submitted Site Investigation report the "depth to ground water at this site is approximately four feet."

A potable well is not reportedly located on the subject site and was not evident during several site inspections. FISCHER is unaware of potable wells located down gradient of, or adjacent to, the subject site.

3.0 SITE INVESTIGATION

3.1 GENERAL

The purpose of the Site Investigation was to delineate the area of petroleum-affected soil and ground water, and to assess public health concerns. These goals were achieved in general accordance with WDNR and COMM requirements.

3.2 SOIL INVESTIGATION

3.2.1 Soil Borings

On April 15, 1998, nine soil borings (B-6 through B-14) were drilled by Midwest Engineering Services, Inc. (MES). On August 28, 1998, two soil borings (B-15 and B-16) were drilled by STS Consultants, Ltd. (STS). The soil borings, which are identified on Figure 3, were advanced to depths ranging from five to 18 ft bgs.

The soil borings were advanced by a truck-mounted rotary drill rig utilizing either 3¼ or 4¼-inch inner diameter continuous flight hollow stem augers. Soil samples were obtained by the Standard Penetration Testing (SPT) method in general accordance with American Society for Testing Materials (ASTM) D1586 procedures at the intervals indicated on the boring logs. The SPT provides a means of estimating the relative density of granular soils and the comparative consistency of cohesive soils, thereby providing a method of evaluating the soil's relative strength and compressibility characteristics. Soil samples were visually classified in accordance with the Unified Soil Classification System. Soil Boring Logs are included in Appendix A.

Since boring B-15 was advanced into the bedrock for the purpose of installing a bedrock piezometer, care was taken to prevent contaminant drawdown. This boring was drilled using the following procedure, which was pre-approved by Mr. Dino Tsoris, representative of the WDNR. Hollow stem augers were drilled to the top of bedrock and the borehole was backfilled with 3/8" bentonite chips. A steel casing was then driven through the bentonite into the top of the bedrock to form a seal. A rock bit was then used to drill through the casing into the bedrock to the desired depth. The steel casing was later removed. Although the desired depth was 18.5 ft bgs, to allow placement of a five foot screen in the "solid" bedrock and not the weathered bedrock, the drill rig malfunctioned. Mr. Dino Tsoris was contacted regarding the situation. He approved placement of the well screen at 13 to 18 ft bgs, only 0.5 feet in the upper weathered bedrock. His approval allowed installation of the well and removal of the drill rig from the site for repairs.

Sampling tools and hollow stem augers were decontaminated prior to mobilization to the project site and clean augers were utilized for each soil boring. Sampling tools were decontaminated between each sampling event and each soil boring location. Decontamination procedures consisted of steam cleaning the augers and the use of a detergent solution and potable water rinse for the split-spoon sampling devices.

Each soil sample was placed in a clean container and later screened with a Photoionization Detector (PID), which was calibrated prior to use. The samples were

permitted to equilibrate at 70 degrees Fahrenheit for a period of at least 10 minutes, based upon the ambient outdoor temperature. The sample was then screened by inserting the probe into the headspace.

Soil samples were field screened for the presence of total volatile vapors using a Thermal Environmental Instrument, Model 580B, 10.6 eV lamp, PID. The PID is an electronic instrument that measures the relative concentration of volatile organic vapors in the headspace of a container. The response of the instrument is dependent upon compound volatility, ambient temperature, and the ionization potential of gases measured. Because the individual gases measured and their concentrations in the headspace are not known, the response of the meter only serves as a relative indicator of the presence of volatile vapor and does not provide an exact measurement of the gases present. The PID is therefore a qualitative tool and not a quantitative measuring device.

Soil cuttings were field screened to determine if they were impacted with petroleum compounds. Cuttings were placed into Department of Transportation (DOT) approved 55-gallon drums and remain on-site for future disposal. Upon completion, the soil borings not converted to ground-water monitoring wells were backfilled with bentonite chips in accordance with NR 141.25 (Appendix A).

Based on the results of field screening and visual and olfactory observations, one or two samples from each boring were selected for laboratory analysis. Soil samples collected from the borings were submitted for Gasoline Range Organics (GRO), Diesel Range Organics (DRO) and Petroleum Volatile Organic Compounds (PVOC) analyses. Soil samples collected from the following borings were also analyzed for Total Lead, B-6, B-8, B-9, and B-12. Soil samples collected from boring B-9 and B-12 were analyzed for Volatile Organic Compounds (VOC) instead of PVOC. The soil sample collected from boring B-9, at the one to three foot interval, was also analyzed for Polynuclear Aromatic Hydrocarbons (PAH).

The GRO, DRO, PVOC and VOC samples were weighed in the field with a digital scale. Approximately 25 grams of soil were placed into a clean laboratory prepared jar. Samples collected for GRO, PVOC and VOC were subsequently preserved utilizing premeasured laboratory grade methanol. All of the samples were then transported, on ice, to En Chem, Inc. (WDNR #405132750) using standard chain-of-custody procedures.

3.2.2 Soil Contamination Assessment

The WDNR has established a reporting and action level of 10 milligrams per kilogram (mg/kg) GRO and DRO. If this level is exceeded, an investigation, to evaluate the extent of contamination, will generally be required. The action level is not usually considered a cleanup standard. The WDNR currently utilizes an RCL for GRO and DRO in soil of 100 mg/kg or 250 mg/kg, depending on the hydraulic conductivity of the soil. An RCL of 250 mg/kg will be utilized for this site, based on a hydraulic conductivity test result of 2.2×10^{-7} cm/sec.

The WDNR has also established RCLs for Total Lead and various VOC that present a human or environmental health hazard. When these levels are exceeded, remedial action

may be required. The RCLs may be used as Soil Cleanup Standards, however the WDNR does allow the development of Site Specific Soil Cleanup Standards.

Soil samples obtained during the field exploration were field screened using a PID. The results are presented on the boring logs (Appendix A). The results indicated the presence of total organic vapors significantly exceeding background readings in borings B-8, B-9, B-12, and B-15. Based on these PID results and the apparent water table, 18 soil samples were selected for laboratory analysis. Analytical results are presented in Appendix B and are summarized in Table 1. A summary of the analytical results for soil borings drilled by OMNNI are presented in Table 2.

GRO and DRO were not detected in any of the soil samples at concentrations exceeding the WDNR's RCL of 250 mg/kg, except in the two samples collected from boring B-15. Lead was detected at concentrations exceeding the RCL of 50 mg/kg in samples collected from borings B-6 (one to three ft) and B-9 (one to three ft). PAH were detected at concentrations exceeding the Limits of Detection (LOD). However, RCLs for PAH are not yet established. PVOC and VOC were detected in concentrations exceeding the WDNR's RCLs in the following soil samples: B-8, 1-3 ft; B-9, 1-3 ft; B-9, 3-5 ft; B-10, 5-7 ft; B-12, 5-7 ft; B-15, 2.5-4.5 ft; and B-15, 4.5-6.5 ft.

Of those samples having contaminant concentrations exceeding RCLs, only samples B-6, 1-3 ft; B-8, 1-3 ft; and B-9, 1-3 ft appeared to be collected from above the subsequent water table, as measured in the ground-water monitoring wells. Petroleum compounds detected in soil samples collected beneath or at the static water table are generally considered to be dissolved in ground water. The soil zone where ground water fluctuates can be identified as the smear zone. At this site, the vadose zone appears to be the most impacted, relative to the smear zone. The extent of soil contamination, in the vadose and smear zones, appears to have been defined (Figure 7).

3.3 GROUND-WATER INVESTIGATION

3.3.1 Ground-Water Monitoring Wells

Three ground-water monitoring wells were installed on-site on April 15, 1998 (MW-2 through MW-4) by MES and two were installed on-site on August 28, 1998 by STS in general accordance with NR 141 (Figure 3). MW-1 had been installed in March 1994 by OMNNI. Wells installed with FISCHER's oversight were constructed with five or ten feet of two-inch diameter polyvinyl chloride (PVC) screen with 0.010-inch machine slots, and 2-inch diameter PVC flush-threaded riser pipe extending to the top of the borehole. Well screen and riser pipes were inserted into the borehole through the center of the auger during its progressive removal.

A sand filter pack was poured around the screen to approximately six inches above the screen joint. The sand filter pack did not extend above the top of the well screen in piezometer MW-5 to create a better surface seal. Approximately six inches of fine silica sand was poured above the filter pack in well MW-2. Fine silica sand was not used in construction of wells MW-3 and MW-4 due to a high water table. Fine silica sand was also not used in construction of piezometer MW-5 in order to create a surface seal to the top of

bedrock. The remaining annular space was filled to within approximately one foot of the ground surface with bentonite chips. The well top was covered by a flush-mounted protective cover. An expandable cap was fitted onto the top of the well riser and the cap was fitted with a lock. Monitoring Well Construction Forms are presented in Appendix C.

Monitoring wells MW-2 through MW-4 were developed on April 17, 1998, while well MW-6 and piezometer MW-5 were developed on August 28, 1998. Monitoring well MW-1 reportedly was developed on March 31, 1994 by OMNNI. Monitoring wells MW-2, MW-3, MW-4 and MW-6 and piezometer MW-5 were developed first surging with a block and then purging with an electric submersible pump until the wells purged "dry" three times (MW-5 did not purge "dry"). Monitoring Well Development Forms are included in Appendix C. The development tools were decontaminated between wells with a detergent solution and potable water rinse.

Monitoring well MW-1 was sampled on April 12, 1994, January 23, 1995 and September 26, 1995 by OMNNI. All of the wells (MW-1 through MW-4) were sampled on April 21 and June 5, 1998 by FISCHER. Piezometer MW-5 and well MW-6 were sampled on August 28, 1998.

During the April 21, 1998 sampling event, ground-water samples collected from monitoring wells MW-2 through MW-4 were analyzed for VOC and Dissolved Lead and the sample obtained from well MW-1 was analyzed for PVOC. On April 21, 1998, a sample from well MW-4 was also analyzed for PAH.

Ground-water samples collected from four wells (MW-1 through MW-4) were analyzed for PVOC during the June 5, 1998, sampling event. During the June 5 sampling event, a sample obtained from well MW-1 was also analyzed for 1,2-Dichloroethane (1,2-DCA) and a sample collected from well MW-4 was also analyzed for Naphthalene.

On August 28, 1998, ground-water samples were collected from piezometer MW-5 and well MW-6 for VOC and Dissolved Lead analyses.

Prior to ground-water sampling, the wells were purged "dry" three times utilizing a submersible electric pump (piezometer MW-5 did not purge 'dry"). The ground-water samples were collected from each well with a separate disposable polyethylene bailer and disposable nylon string. Samples for PVOC or VOC analyses were transferred directly from the bailer to 40-milliliter (ml) glass vials and sealed with Teflon caps. Each vial was preserved with 1:1 Hydrochloric Acid. Samples for Dissolved Lead were transferred to 250 ml plastic containers, after field filtering with a 45 micron disposable filter, and preserved with nitric acid. All samples were placed on ice and transported to EnChem, Inc. following standard chain-of-custody procedures.

3.3.2 Ground-Water Contamination Assessment

The WDNR has established Ground-Water Quality Standards in Section NR 140.10 of the Wisconsin Administrative Code. Enforcement Standards and Preventive Action Limits (PALs) have been established for Lead and several VOC of concern to the public health, as determined by the WDNR. If the ES or PAL for a given compound in ground water is exceeded, the WDNR is authorized to take action to restore ground-water quality.

Exceeding an ES may warrant active ground-water remediation, whereas exceedance of a PAL may not require active remediation.

Analytical reports are presented in Appendix D. A summary of the analytical results is presented in Table 3, which includes a graphical presentation.

In well MW-1, Methyl-tert-Butyl Ether (MTBE) was detected at a concentration exceeding the PAL during the initial April 12, 1994 sampling event. During the four subsequent sampling rounds, MTBE was not detected at concentrations above the PAL. 1,2-DCA was detected at concentrations exceeding the PAL during the first two and most recent sampling events. The 1,2-DCA concentration detected during the September 26, 1995 event exceeded WDNR's ES. The concentrations of 1,2-DCA detected during sampling events conducted over a four year timeframe appear to be relatively stable (4.9, 4.7, 7.8 and 4.0 ug/l).

Benzene was detected in ground-water samples collected from well MW-2 at concentrations exceeding the ES during both sampling rounds. MTBE concentrations detected during both sampling events were above the PAL. Concentrations of both of these compounds appear to be relatively stable.

VOC/PVOC were not detected above the LOD in ground-water samples collected from well MW-3 during both sampling events. Dissolved Lead was not detected above the LOD in well MW-3 during the initial sampling event (it was not analyzed for during the most recent event).

In well MW-4, Benzene, Naphthalene and Xylenes were detected at concentrations exceeding WDNR's ES during both sampling events. Ethylbenzene and MTBE were detected at concentrations, during both sampling rounds, exceeding the PALs. However, the initial concentration of MTBE detected was "flagged" by the chemist, meaning it is present but the actual concentration may be slightly different than that reported. The concentrations of all five of these compounds appear relatively stable.

In the ground-water ample collected from piezometer MW-5, Benzene was detected at a concentration (5.5 ug/l) only slightly exceeding the WDNR's ES of 5 ug/l during the August 28, 1998 sampling event. Chloroform was detected at a concentration exceeding the WDNR's PAL, but the chemist "flagged" the result. Ethylbenzene, Toluene, Xylenes, Trimethylbenzenes, Naphthalene and four other VOC were detected above the LOD but not above the WDNR's PAL or ES, where established (two of these compounds were "flagged" by the chemist). Dissolved Lead was not detected above the LOD.

During the August 28, 1998 sampling event, Dissolved Lead and VOC were not detected above the LOD in a ground-water sample collected from monitoring well MW-6.

The horizontal extent of petroleum-impacted ground water exceeding WDNR's Enforcement Standards appears to have been defined and is estimated on Figure 8. The detection of 1,2-Dichloroethane, which is generally associated with gasoline, in well MW-1 appears to indicate one ground-water contaminant plume.

Piezometer MW-5 was installed in the most impacted portion of the ground-water contaminant plume. Since Benzene was the only compound detected in piezometer MW-

5 and since it was detected at a concentration (5.5 ug/l) only slightly exceeding the WDNR's ES of 5 ug/l, the vertical extent of contamination will be considered defined for the purposes of this Site Investigation.

3.4 DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

Based on observations, field screening and comparison of the analytical results to the WDNR's RCLs, the extent of petroleum-affected soil appears to have been defined (Figure 7). Results of the investigation indicate approximately 1300 cubic yards of impacted soil, exceeding WDNR's RCLs, are present in the vadose zone and smear zone, assuming an average thickness of seven ft.

Based on ground-water analytical results in comparison to WDNR's Enforcement Standards, the extent of petroleum-affected ground water appears to have been defined (Figure 8). At this time, the ground-water contaminant plume appears to be relatively stable (Table 3). The extent of ground-water contamination within the bedrock may be defined, depending upon contaminant concentration detected in piezometer MW-5 in the future. Based on the contaminant concentrations detected in piezometer MW-5 thus far, and discussions with Mr. Dino Tsoris of the WDNR, the WDNR may not require additional bedrock wells in the future.

There may be exposure by direct contact if surficial and/or subsurface soils near the USTs are excavated in the future. The UST area and the majority of the subject site are paved and will be paved after the USTs are upgraded/removed, which reduces surface water infiltration into the impacted soils.

A subsurface utility trench appears to be present from the 10,000 gallon USTs to the building. Soil borings were drilled on each side of this utility trench. Since contamination was detected, there is a possibility the trench is a preferential migration pathway. Subsurface utility trenches appear to be present near the waste oil UST. However, based on analytical results for samples collected from nearby borings, these trenches do not appear to be preferential migration pathways.

"Environmentally sensitive areas", such as wetlands and surface waters, do not appear to be located adjacent to, or immediately down gradient of, the site. A potable well is not reportedly located on the subject site and was not evident during several site inspections. FISCHER is not aware of potable wells located down gradient of, or adjacent to, the subject site. Therefore, there do not appear to be any known potential receptors, with the possible exception of the Fox River, located approximately 600 feet northeast of the Kaukauna Maintenance Garage.

In a previous report, OMNNI indicated bedrock was encountered at the site at ten ft bgs. During FISCHER's Site Investigation, auger refusal, probably bedrock, was encountered at 8.5 to nine ft bgs. In boring B-15, weathered bedrock appeared to be encountered at approximately 8.5 ft bgs, and unweathered bedrock appeared to be encountered at approximately 13.5 ft bgs. Soil contamination has been detected in samples collected from seven ft bgs and ground-water contamination has been detected in monitoring wells screened just above what appears to be bedrock. One of the COMM 47 "environmental factors" is presence of contamination within one

meter (three feet) of bedrock. It is FISCHER's opinion that contamination has been detected within one meter of bedrock. Therefore, an "environmental factor" appears to be present and active remedial treatment can be justified, based on review of COMM 47.

Remedial alternatives will be addressed in a Remedial Action Plan, which will be submitted as a separate report.

4.0 LIMITATIONS OF DATA

The conclusions of this Site Investigation Report are formulated based on site conditions known to have existed prior to, and encountered during, field exploration activities on the site. Additional exploration and analysis is desirable, but would not be expected to significantly alter the conditions reported herein and the scope of the corrective action measures developed in the Remedial Action Plan.

5.0 REFERENCES

- NR 141 Wisconsin Administrative Code, September 1995 update
- NR 700s Wisconsin Administrative Code, February 1997 update
- "Soil Survey of Outagamie County", SCS, 1980
- Well Constructor's Reports and Geologic Logs for site vicinity, GNHS
- "Glacial Deposits of Wisconsin", GNHS, 1985
- "Bedrock Geology of Wisconsin", GNHS, 1982
- 7.5 minute series topographic map (Kaukauna Quadrangle), USGS, 1974, photorevised 1984
- Site Investigation report (title unknown), OMNNI, June 1994
- "Quarterly Sampling Repot". OMNNI, March 17, 1995
- "Quarterly Sampling Report", OMNNI, October 25, 1995
- "NR 716.09 Site Investigation Work Plan", FISCHER, March 4, 1998

ACRONYMS

1,2 - DCA	1,2 - Dichloroethane
AST	Aboveground Storage Tank
bgs	Below the Ground Surface
cm/sec	centimeters per second
COMM	Department of Commerce (formerly DILHR)
DILHR	Department of Industry, Labor and Human Relations
DO	Dissolved Oxygen
DOT	Department of Transportation
DRO	Diesel Range Organics
ES	Enforcement Standards
EQL	Estimated Quantitation Limit
EPA	Environmental Protection Agency
ERP	Environmental Repair Program
ft	Feet
FISCHER	Fischer Environmental, Inc.
GNHS	Geological and Natural History Survey
GRO	Gasoline Range Organics
lbs	pounds
LOD	Limits of Detection
LOQ	Limits of Quantitation
LSA	Limited Site Assessment
LUST	Leaking Underground Storage Tank
MDL	Method Detection Limit
mg/kg	Milligram per Kilogram (ppm)
mg/l	Milligram per Liter (ppm)
MTBE	Methyl-Tert-Butyl-Ether
NA	Natural Attenuation
ND	No Analyte Detected Above the Method Detection Limit
NE	No Established Compound Regulations
PAH	Polynuclear Aromatic Hydrocarbons
PAL	Preventive Action Limit
PID	Photoionization Detector
PVC	Polyvinyl Chloride
PVOC	Petroleum Volatile Organic Compounds
ppb	Parts per Billion
ppm	Parts per Million
RAP	Remedial Action Plan
RCL	Residual Contaminant Levels
RNA	Remediation by Natural Attenuation
SPT	Standard Penetration Test
TOC	Total Organic Carbon
TKN	Total Kjeldahl Nitrogen
ug/kg	Microgram per Kilogram (ppb)
ug/l	Microgram per Liter (ppm)
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
WI	Wisconsin

TABLE 1

Soil Analytical Results - April 15, 1998 and August 28, 1998

Kaukauna Maintenance Garage - FISCHER Project #398132.002

Parameter	B-6 1-3'	B-7 3-5'	B-8 1-3'	B-9 1-3'	B-9 3-5'	B-10 1-3'	B-10 5-7'	B-11 1-3'	B-11 2-5'	RCL
GRO (mg/kg)	<3.9	<2.8	22	85	16	<2.9	3.3	<2.9	<3.2	250
DRO (mg/kg)	19	<4.0	47	27	<4.3	9.0	12	8.0	<4.4	250
Lead (mg/kg)	**150**		40	**370**						50
Naphthalene (ug/kg)				48						NE
1,2-Dichloroethane (ug/kg)				<25						4.9
s-Butylbenzene (ug/kg)				47						NE
n-Butylbenzene (ug/kg)				74						NE
Isopropylbenzene (ug/kg)				340						NE
p-Isopropylbenzene (ug/kg)				42						NE
n-Propylbenzene (ug/kg)				330						NE
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOCs) ug/kg										
Benzene	<25	<25	**2300**	**1500**	**190**	<25	**71**	<25	<25	5.5
Ethylbenzene	<25	<25	550	1900	460	30	<25	<25	<25	2900
Methyl-Tert-Butyl-Ether	<25	<25	<25	<25	<25	<25	<25	<25	<25	NE
Toluene	<25	<25	160	160	<25	92	<25	110	<25	1500
1,2,4-Trimethylbenzene	45	<25	590	2600	2200	65	300	<25	<25	NE
1,3,5-Trimethylbenzene	44	<25	230	1600	610	<25	73	<25	<25	NE
Xylenes, Total	110	<25	1600	**11190**	2200	136	130	<25	<25	4100
POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) ug/kg (Compounds Detected)										
Benzo(a)anthracene			16							NE
Fluoranthene			27							NE
1-Methylnaphthalene			430							NE
2-Methylnaphthalene			790							NE
Naphthalene			630							NE
Phenanthrene			23							NE
Pyrene			17							NE

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
Blank - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - Residual Contaminant Levels (WDNR NR 720)
NE - RCL not established

TABLE 1 (Continued)

Soil Analytical Results - April 15, 1998 and August 28, 1998

Kaukauna Maintenance Garage - FISCHER Project #398132.002

Parameter	B-12 1-3'	B-12 5-7'	B-13 1-3'	B-13 5-7'	B-14 1-3'	B-14 3-5'	B-15 2.5-4.5'	B-15 4.5-6.5'	B-16 4.5-6.5'	RCL
GRO (mg/kg)	<3.0	100	<2.7	<2.9	3.9	<2.9	**2200**	**1100**	<2.9	250
DRO (mg/kg)	33	48	56	<3.7	23	<4.1	**3500**	**920**	140	250
Lead (mg/kg)		6.5								50
Naphthalene (ug/kg)		6400								NE
1,2-Dichloroethane (ug/kg)		<250								4.9
p-Isopropyltoluene (ug/kg)		1400								NE
s-Butylbenzene (ug/kg)		1400								NE
n-Butylbenzene (ug/kg)		4400								NE
Isopropylbenzene (ug/kg)		2100								NE
p-Isopropyltoluene (ug/kg)		750								NE
n-Propylbenzene (ug/kg)		8400								NE
PETROLEUM VOLATILE ORGANIC COMPOUNDS (PVOCs) ug/kg										
Benzene	<25	**2100**	<25	<25	<25	<25	**13000**	**7100**	<25	5.5
Ethylbenzene	<25	**15000**	36	<25	<25	<25	**54000**	**32000**	<25	2900
Methyl-Tert-Butyl-Ether	<25	<250	<25	<25	<25	<25	<1000	3200	<25	NE
Toluene	34	1500	30	<25	<25	<25	**3500**	850	<25	1500
1,2,4-Trimethylbenzene	47	45000	70	<25	55	<25	120000	69000	<25	NE
1,3,5-Trimethylbenzene	<25	14000	27	<25	38	<25	39000	23000	<25	NE
Xylenes, Total	69	**55000**	153	<25	86	<25	**166800**	**94800**	66	4100

mg/kg - milligrams per kilogram = parts per million (ppm)
ug/kg - micrograms per kilogram = parts per billion (ppb)
Blank - not analyzed for parameter
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
RCL - Residual Contaminant Levels (WDNR NR 720)
NE - RCL not established

TABLE 2
SUMMARY OF LABORATORY ANALYSIS
SOIL BORING SAMPLES - OMNNI
MARCH 21, 1994 SAMPLING EVENT

PARAMETER	GUIDE	B1-2	B2-3	B3-2	B4-3	B5-2
SAMPLE DEPTH (feet)	-	4.0 - 6.0	6.0 - 8.0	4.0 - 6.0	6.0 - 8.0	2.0 - 4.0
DIESEL RANGE ORGANICS (mg/kg)	250	ND	ND	ND	280	12
DETECTED PCBs (µg/kg)	-	NA	NA	NA	ND	NA
CADMIUM (mg/kg)	-	NA	NA	NA	0.03	NA
LEAD (mg/kg)	50	NA	NA	NA	4.4	NA
DETECTED PAHs (µg/kg)	-	NA	NA	NA	ND	NA
DETECTED PVOCs (µg/kg)						
BENZENE	5.5	1.7	ND	ND	ND	ND
ETHYLBENZENE	2900	ND	ND	ND	2.4	ND
MTBE	-	3.1	ND	ND	ND	ND
m,p-XYLENE	4100	ND	ND	380	12	ND
o-XYLENE	4100	ND	ND	ND	1.1	ND

NA = not analyzed
ND = not detected
= sample concentrations detected over the DNR guideline

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-1

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date						
Parameter	**4/12/94**	**1/23/95**	**9/26/95**	**4/21/98**	**6/5/98**	**ES**	**PAL**
Cadmium	0.1					5	0.5
Volatile Organic Compounds (VOCs)							
Benzene	**1.2**	<0.6	<0.6	<0.27	<0.27	5	0.5
1,2-Dichloroethane	**4.9**	**4.7**	**7.8**		**4.0**	5	0.5
Ethylbenzene	3.6	<1.0	<1.0	<0.32	<0.32	700	140
Methyl-Tert-Butyl-Ether	**17**	5.2	9.6	6.4	6.7	60	12
Xylenes, Total	23	<1.0	<1.0	<0.43	<0.43	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established
Note: April 12, 1994, Jan 23, 1995, Sept 26, 1995, sampling events by OMNNI Associates

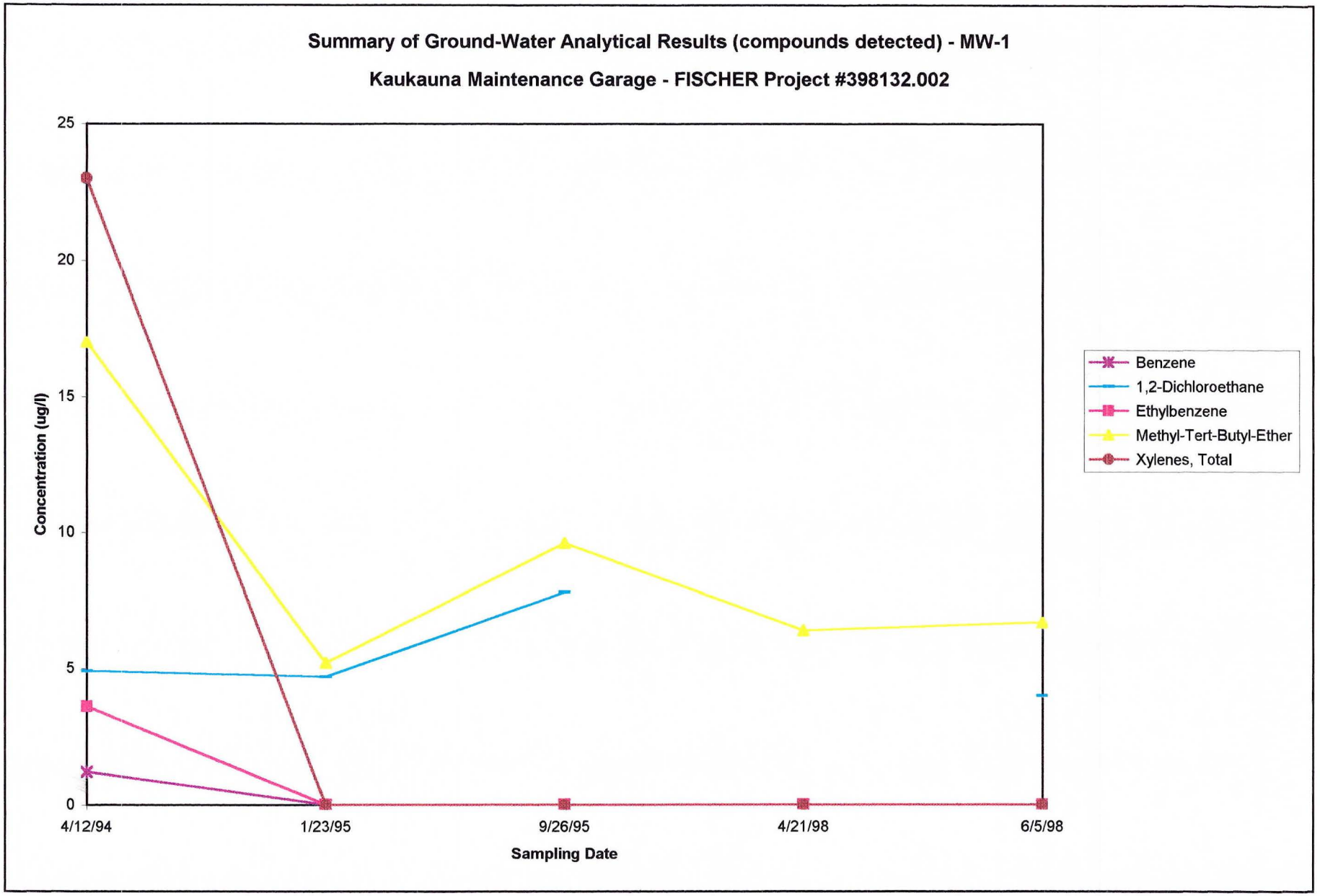

Summary of Ground-Water Analytical Results (compounds detected) - MW-1
Kaukauna Maintenance Garage - FISCHER Project #398132.002
25
20
15
10
5
0
Concentration (ug/l)
4/12/94
1/23/95
9/26/95
4/21/98
6/5/98
Sampling Date
Benzene
1,2-Dichloroethane
Ethylbenzene
Methyl-Tert-Butyl-Ether
Xylenes, Total

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-2

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date			
Parameter	**4/21/98**	**6/5/98**	**ES**	**PAL**
Lead	<1.6		15	1.5
Volatile Organic Compounds (VOCs)				
Benzene	**150**	**170**	5	0.5
Ethylbenzene	11	38	700	140
Isopropylbenzene	1.4		NE	NE
Methyl-Tert-Butyl-Ether	**19**	**17**	60	12
n-Propylbenzene	1.2		NE	NE
Toluene	5.5	1.9	343	68.6
Trimethylbenzenes	3.7	15.32	NE	NE
Xylenes, Total	9.38	26.37	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established

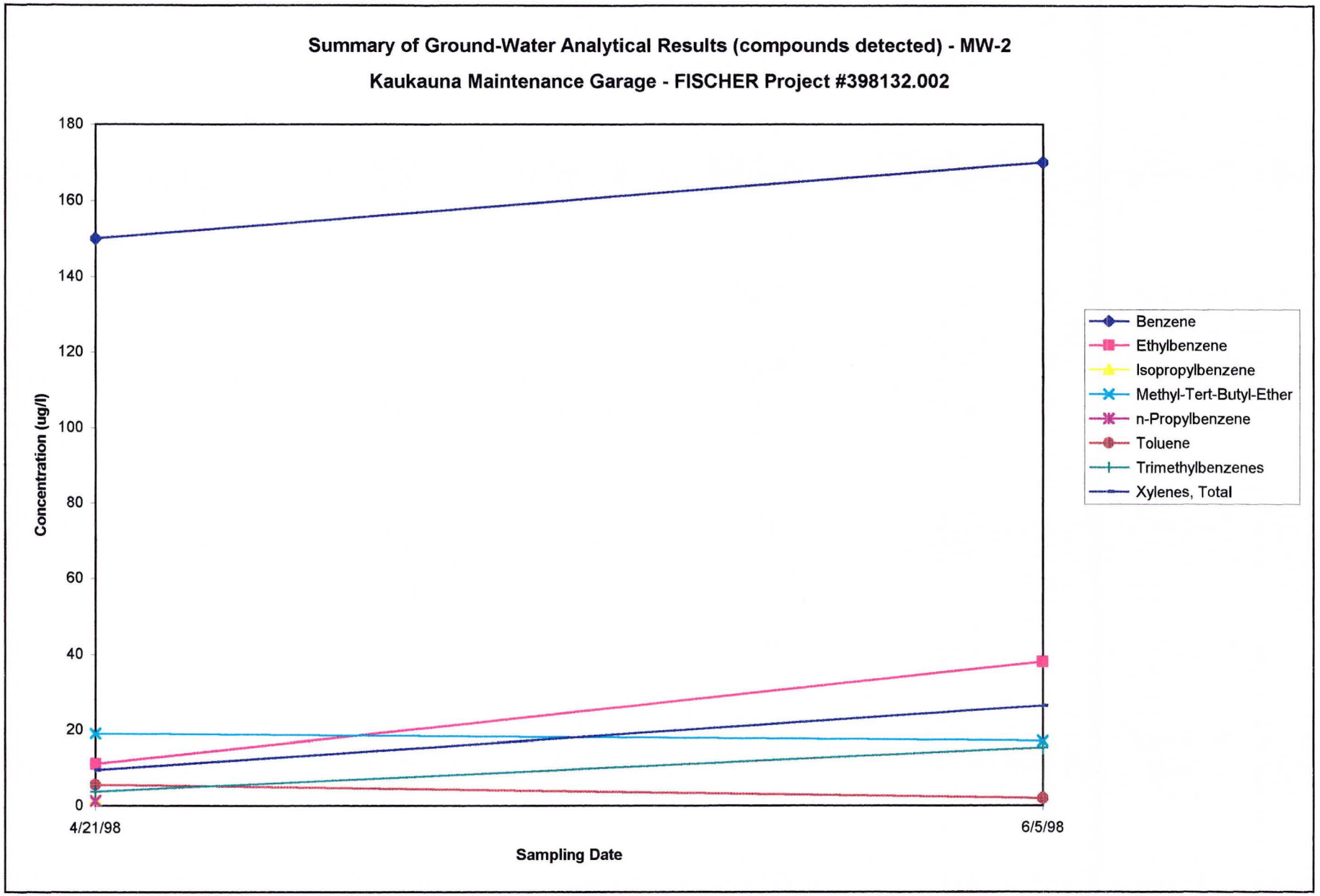

Summary of Ground-Water Analytical Results (compounds detected) - MW-2
Kaukauna Maintenance Garage - FISCHER Project #398132.002
180
160
140
120
100
80
60
40
20
0
Concentration (ug/l)
4/21/98
6/5/98
Sampling Date
Benzene
Ethylbenzene
Isopropylbenzene
Methyl-Tert-Butyl-Ether
n-Propylbenzene
Toluene
Trimethylbenzenes
Xylenes, Total

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-3

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date			
Parameter	**4/21/98**	**6/5/98**	**ES**	**PAL**
Lead	<1.6		15	1.5
Volatile Organic Compounds (VOCs)				
	<varies	<varies	varies	varies

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-4

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date			
Parameter	**4/21/98**	**6/5/98**	**ES**	**PAL**
Lead	<1.6		15	1.5
Volatile Organic Compounds (VOCs)				
Benzene	**2400**	**2300**	5	0.5
s-Butylbenzene	11		NE	NE
n-Butylbenzene	23		NE	NE
Ethylbenzene	**560**	**470**	700	140
Isopropylbenzene	43		NE	NE
p-Isopropyltoluene	7.0		NE	NE
Methyl-Tert-Butyl-Ether	**15**	**20**	60	12
Naphthalene	**130**	**110**	40	8
n-Propylbenzene	110		NE	NE
Toluene	67	58	343	68.6
Trimethylbenzenes	820	590	NE	NE
Xylenes, Total	**1741**	**1340**	620	124
Polynuclear Aromatic Hydrocarbons (PAH)				
Flourene	2.0		400	80
1-methylnaphthalene	30		NE	NE
2-methylnaphthalene	41		NE	NE
Naphthalene	**60**	**110**	40	8
Phenanthrene	15		NE	NE

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)

Blank - not analyzed for parameter
NE - not established

Summary of Ground-Water Analytical Results (compounds detected) - MW-4

Kaukauna Maintenance Garage - FISCHER Project #398132.002

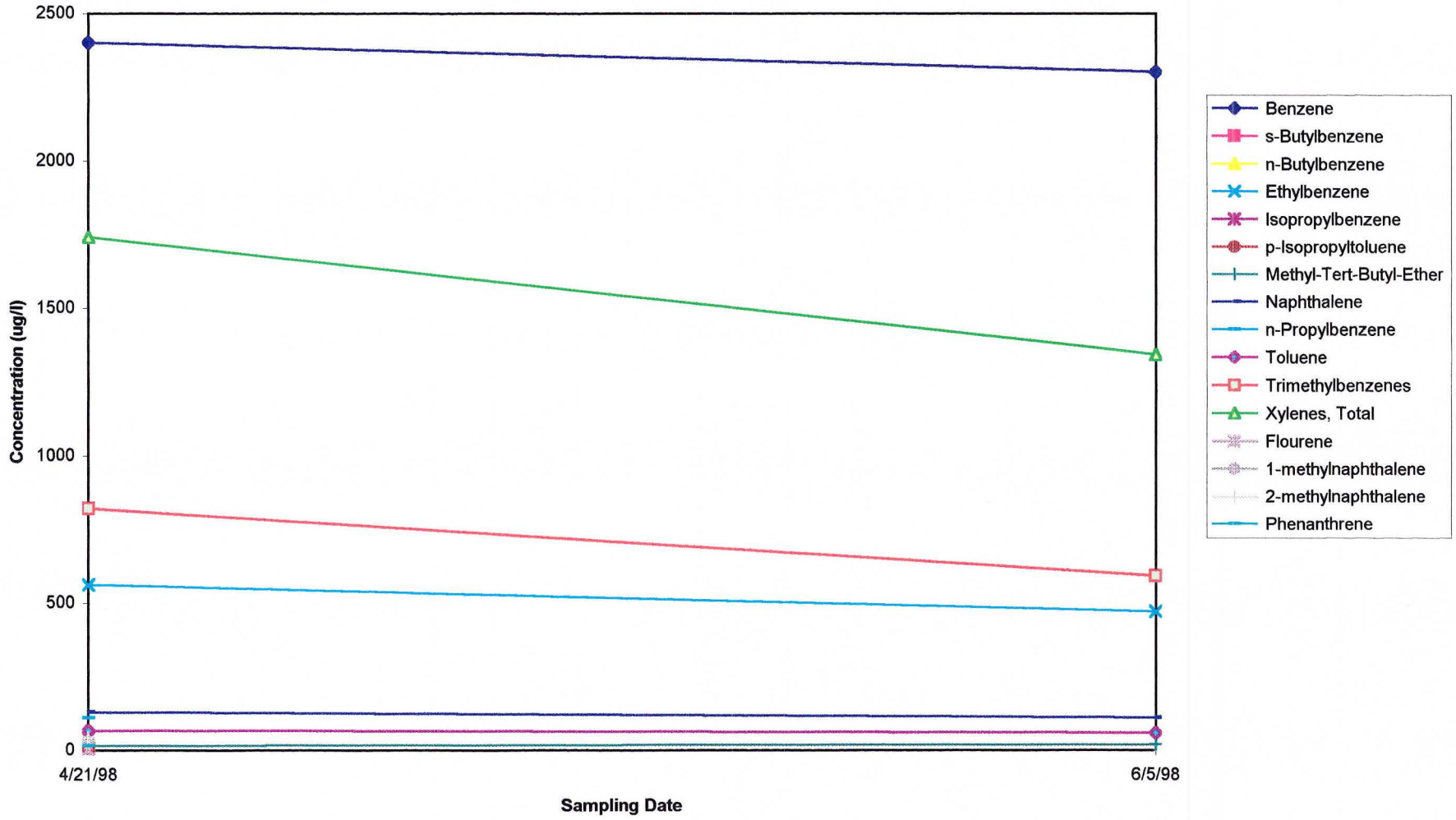


TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-5

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date		
Parameter	**8/31/98**	**ES**	**PAL**
Lead	<1.6	15	1.5
Volatile Organic Compounds (VOCs)			
Benzene	**5.5**	5	0.5
s-Butylbenzene	0.53	NE	NE
n-Butylbenzene	1.4	NE	NE
Chloroform	**0.68**	6	0.6
Ethylbenzene	8.2	700	140
Isopropylbenzene	0.90	NE	NE
Naphthalene	3.2	40	8
n-Propylbenzene	2.8	NE	NE
Toluene	0.63	343	68.6
Trimethylbenzenes	19.0	NE	NE
Xylenes, Total	24.3	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established

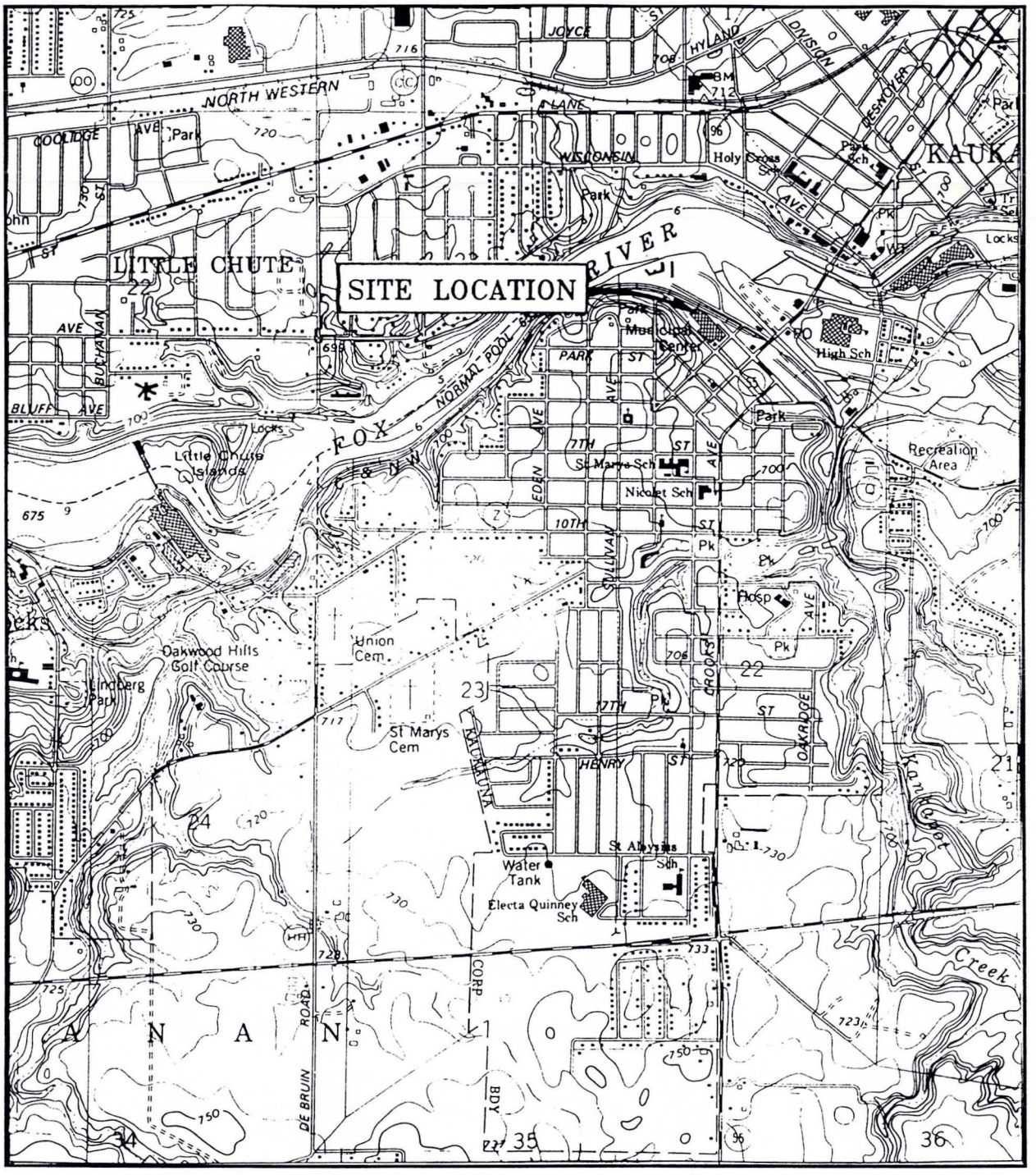
TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-6

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date		
Parameter	**8/31/98**	**ES**	**PAL**
Lead	<1.6	15	1.5
Volatile Organic Compounds (VOCs)			
	<varies	varies	varies

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established



KAUKAUNA QUADRANGLE
U.S.G.S. 7.5 MINUTE SERIES
(TOPOGRAPHIC) OUTAGAMIE COUNTY
WISCONSIN

N

SCALE: 1:24,000

FIGURE 1: SITE LOCATION MAP

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 ■ FAX (920) 759-2669

398132.002	CITY OF KAUKAUNA MAINTENANCE GARAGE
DATE: 9/28/98	KAUKAUNA, WISCONSIN
IDN: FIG1	SITE INVESTIGATION

LEGEND

- Property Line
- Centerline of Roadway
- SA — Sanitary Sewer Line
- ST — Storm Sewer Line
- W — Water Line
- G — Gas Line
- E — Overhead Electric Lines
- E — Underground Electric Lines
- C — Communication Lines
- C — Underground Communication Lines
- 1015.1 — Ground-water Contour Line and Elevation
- 1015.1 — Surface Contour Line and Elevation
- GW Extraction Piping
- SVE Extraction Piping
- Air Sparging Piping
- MH — Manhole
- PP — Utility Power Pole
- FH — Fire Hydrant
- Light Pole
- Traffic Signal
- 999 — Pid Reading

- or — Estimated Lateral Area of Ground-water Contamination Exceeding NR140 Enforcement Standards
- or — Estimated Lateral Area of Unsaturated Soil Contaminant Concentrations Exceeding NR720 Residual Contaminant Levels
- S-2 — Soil Sample
- UST/AST — Existing UST or AST
- UST/AST — Removed UST or AST
- Limits of Excavation
- MW-2 — Monitoring Well
- TW-2 — Temporary Monitoring Well
- MW-2 — Proposed Monitoring Well
- B-2 — Soil Boring
- SP-2 — Soil probe
- SP-2 — Soil & Water probe
- Proposed Soil Boring/Soil probe
- Extraction/Recovery Sump
- PW — Private Well
- Abandoned Well
- Backhoe Test Pit

REVISED 4/29/98

Fischer Environmental, Inc.

P.O. BOX 127
KAUKAUNA, WI 54130-2404
TEL. (920) 766-2069
FAX (920) 759-2669

CITY OF KAUKAUNA MAINTENANCE GARAGE BUILDING
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

WEST 3RD STREET

FILL PIPES

19,999 GALLON UST

19,999 GALLON UST

19,999 GALLON UST

DISPENSER ISLAND

550 GALLON WASTE OIL TANK

GATE

PP

W

E

G

FH

SA

B-1

B-2

B-3

B-5

MW-1

N

1'5' 0 15' 30'

SCALE: 1" = 30'

NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

- SUMP WELLS BY OTHERS
- MONITORING WELL BY OMNNI
- ⊕ SOIL BORING BY OMNNI

FIGURE 2: SITE PLAN

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 6/18/98	APPROVED BY: KB
ID#: CITY-KAU-1	

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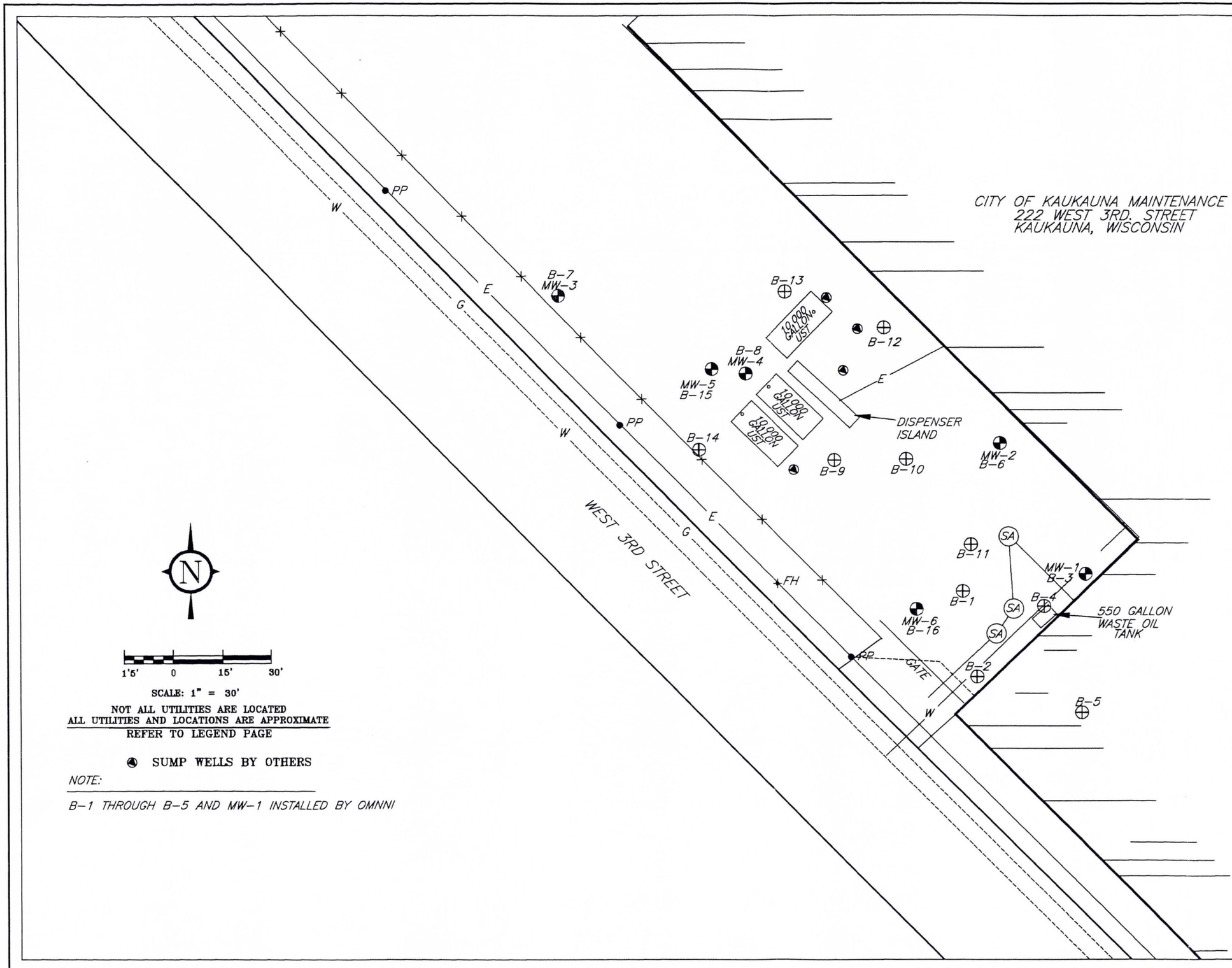
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 ■ FAX (920) 759-2669



1'5' 0 15' 30'

SCALE: 1" = 30'

NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

◔ SUMP WELLS BY OTHERS

NOTE:

B-1 THROUGH B-5 AND MW-1 INSTALLED BY OMNNI

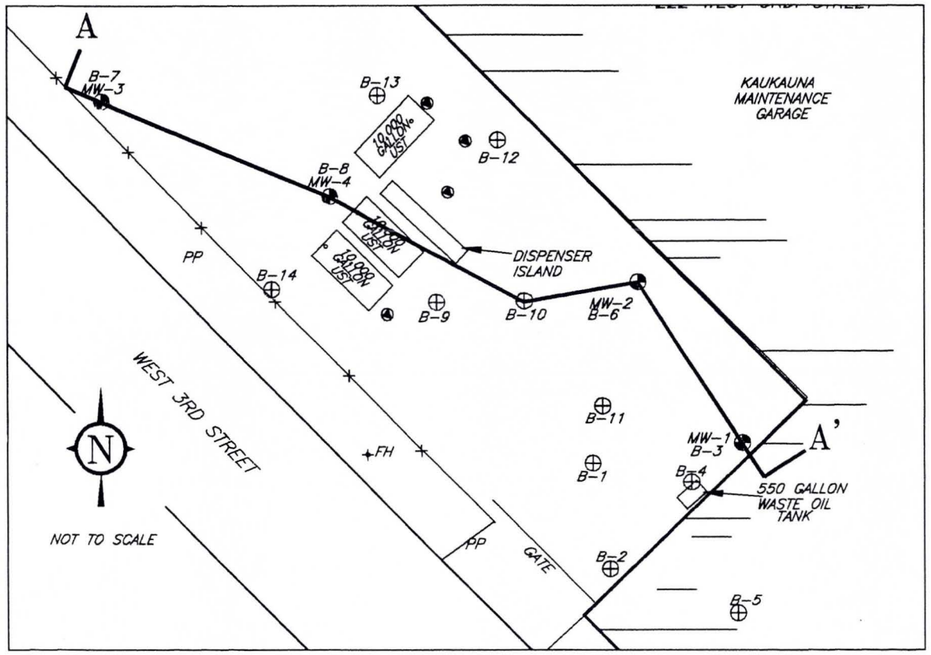
FIGURE 3: SOIL BORING AND MONITORING WELL LOCATIONS

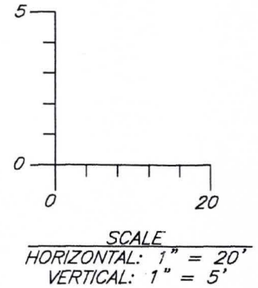
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 8/15/98	APPROVED BY: KB
ITM#: CITY-KAU-1	

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 • FAX (920) 739-2669





EXPLANATION	
SOILS CLASSIFICATION	**MONITORING WELL**
ASPHALT — See bore logs	Bentonite Seal
FILL — See bore logs	Well Screen
CL — Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
GM — Silty gravels, gravel–sand–silt mixtures.	
BEDROCK — See bore logs	
WEATHERED BEDROCK — See bore logs	

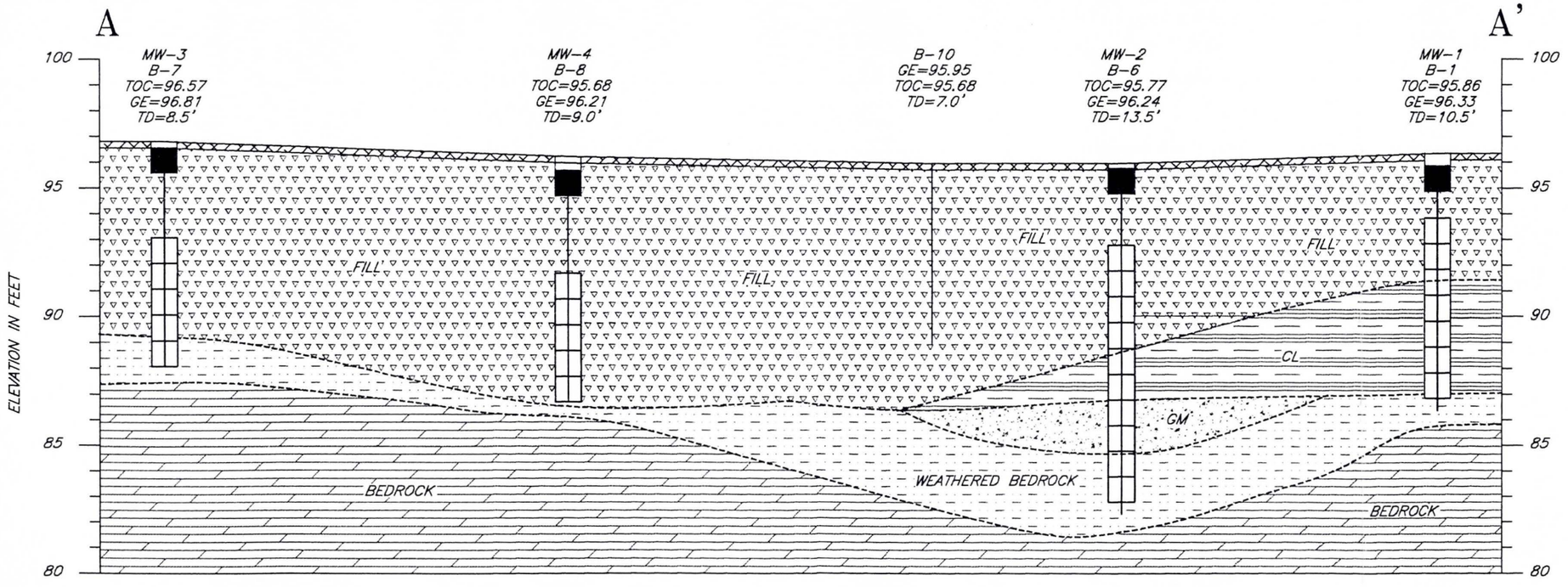


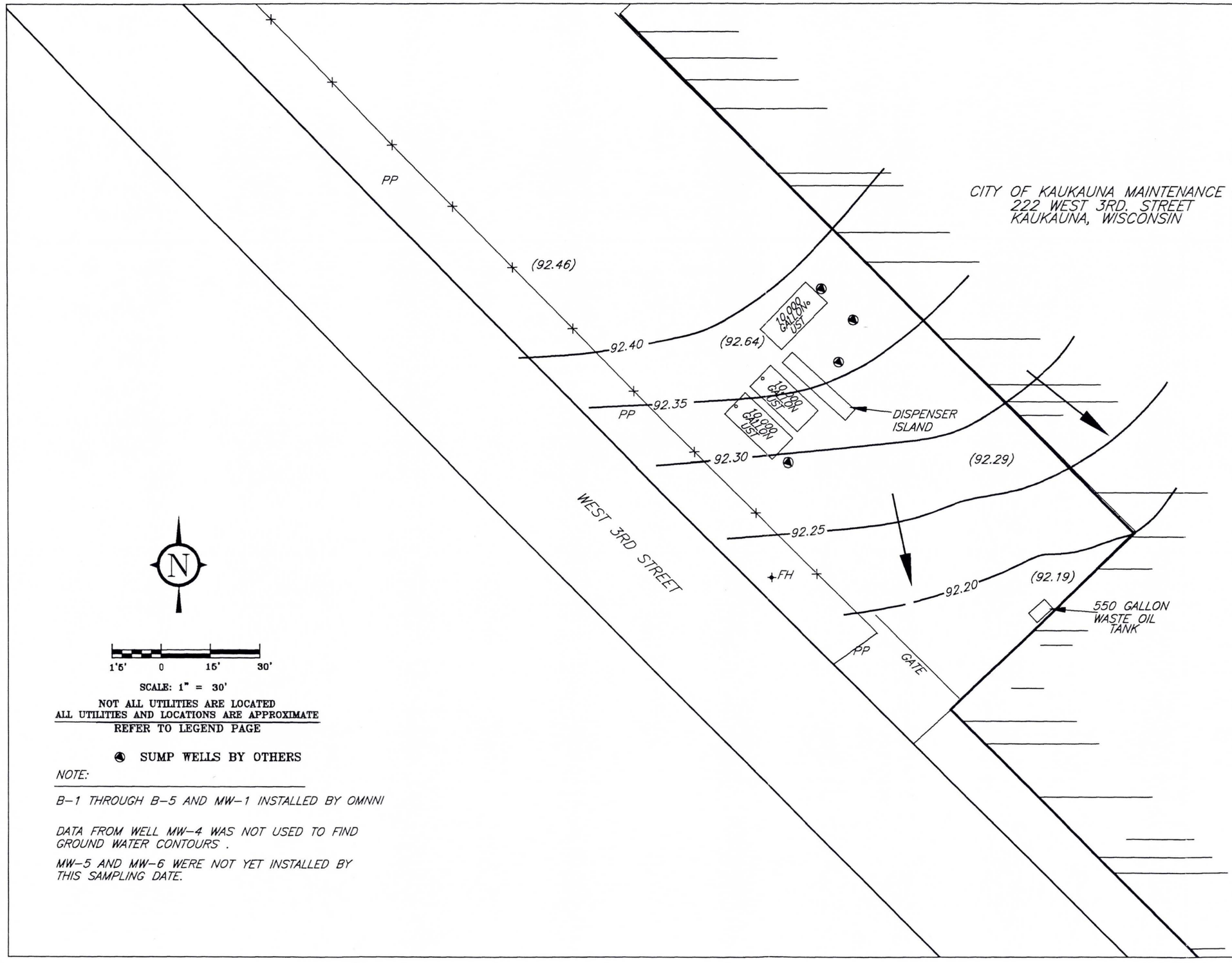
FIGURE 4: GEOLOGIC CROSS -SECTION A-A'

CITY OF KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 9/15/98	APPROVED BY: KB
ID#: CROSS	

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 ■ FAX (920) 759-2669



NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

◀ SUMP WELLS BY OTHERS

NOTE:

B-1 THROUGH B-5 AND MW-1 INSTALLED BY OMNNI

DATA FROM WELL MW-4 WAS NOT USED TO FIND GROUND WATER CONTOURS .

MW-5 AND MW-6 WERE NOT YET INSTALLED BY THIS SAMPLING DATE.

FIGURE 5: GROUND-WATER FLOW DIRECTION - APRIL 21, 1998

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 6/15/98	APPROVED BY: KB
ID#: CITY-KAU-1	

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-8969 • FAX (920) 759-8669

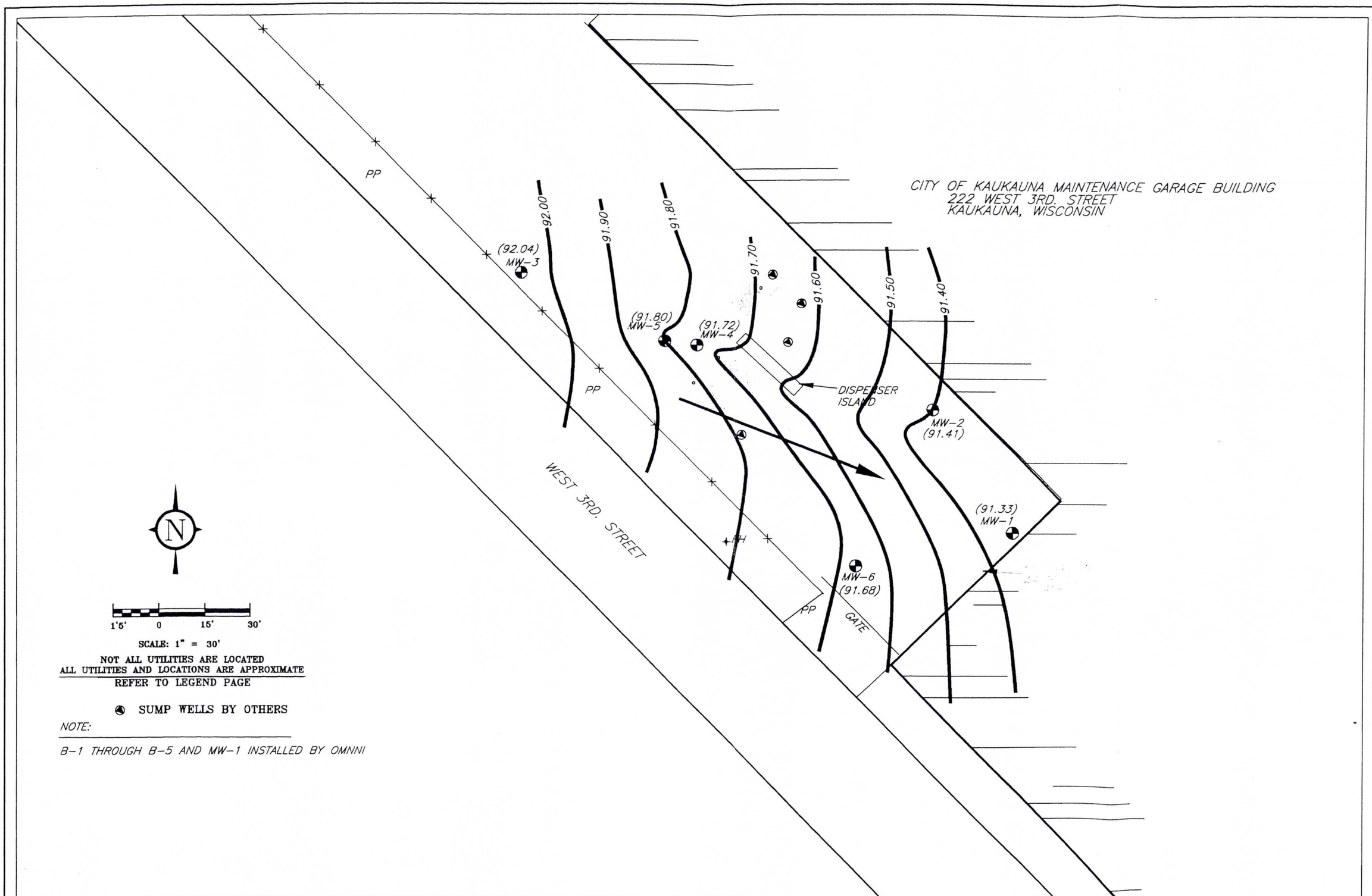


FIGURE 6: GROUND-WATER FLOW DIRECTION - SEPTEMBER 16,1998

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 8/15/98	APPROVED BY: KB
ID#: CITY-KAU-1	

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P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 • FAX (920) 739-2669

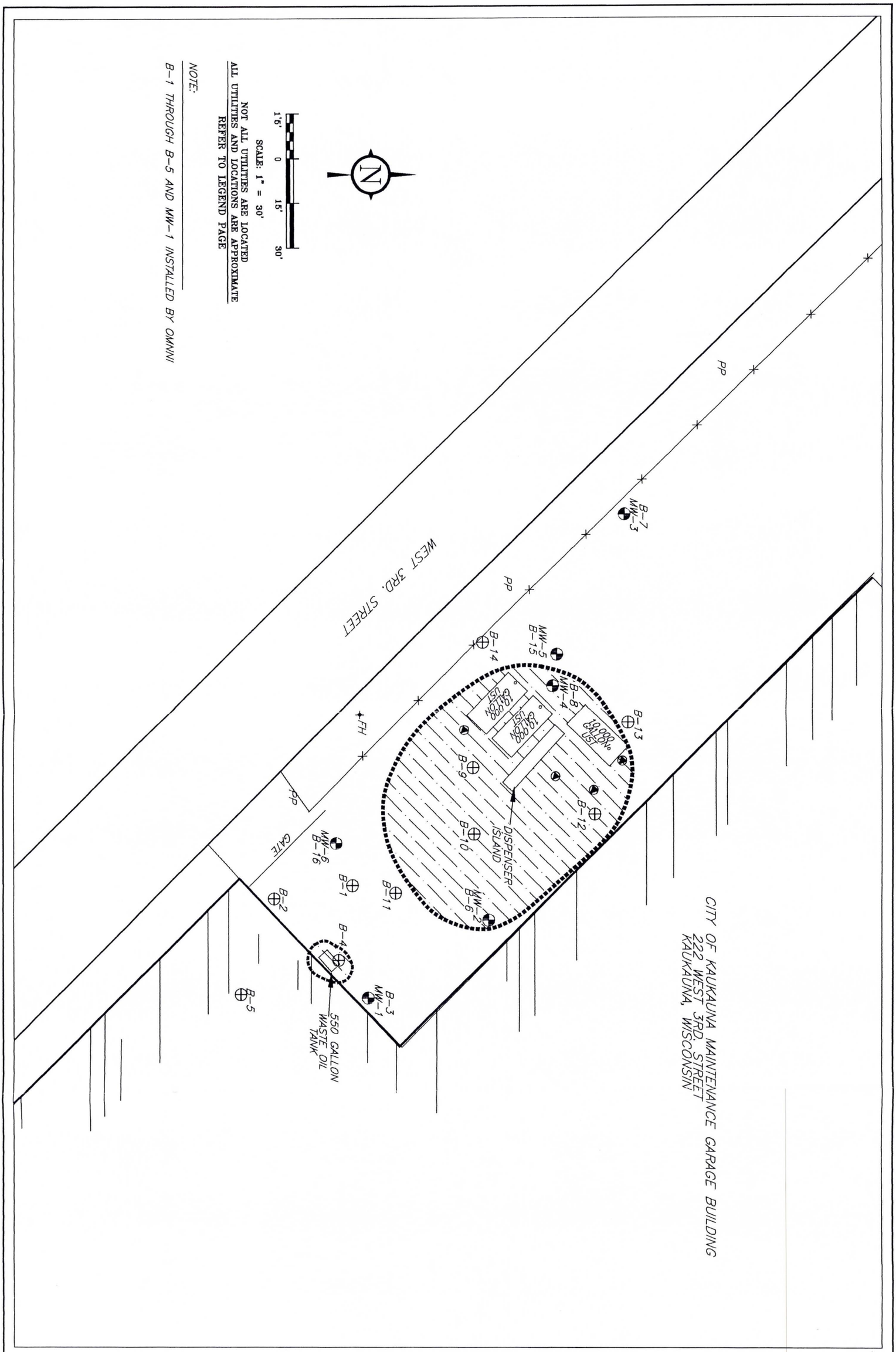

FIGURE 7: ESTIMATED EXTENT OF CONTAMINATION EXCEEDING RCLs IN THE VADOSE AND SMEAR ZONES

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 ▪ FAX (920) 759-2669

398132.002	
DRAWN BY: KP	REVIEWED BY: JF
DATE: 6/16/98	APPROVED BY: KB
ID#: CITY-KAU-1	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

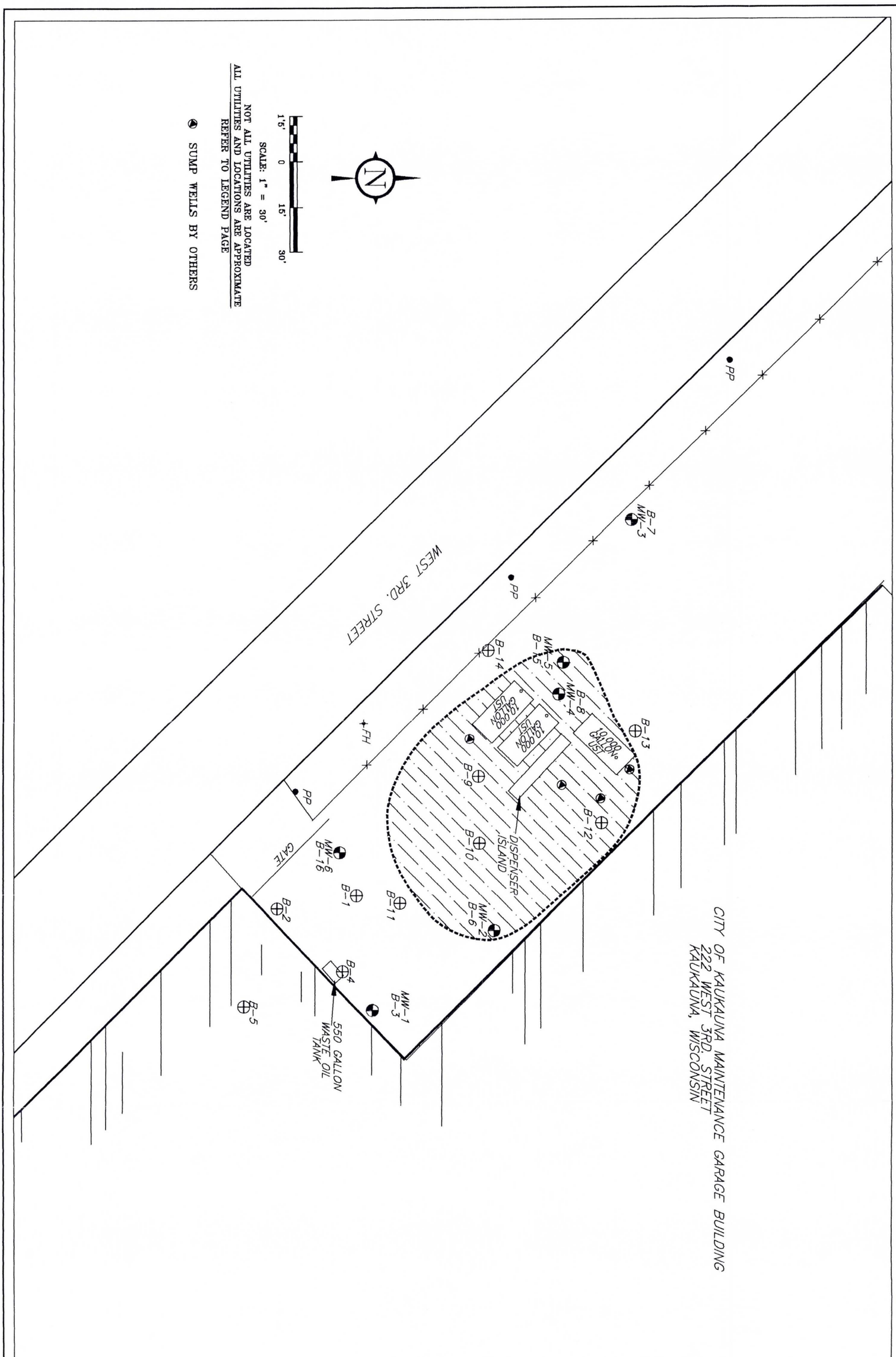

FIGURE 8: ESTIMATED EXTENT OF GROUND-WATER CONTAMINATION EXCEEDING THE ENFORCEMENT STANDARDS

Fischer Environmental, Inc.
P.O. BOX 127, KAUKAUNA, WI 54130
TEL. (920) 766-2069 ■ FAX (920) 759-2669

398132.002	
DRAWN BY: KP	REVIEWED BY: JF
DATE: 8/18/98	APPROVED BY: KB
ID#: CITY-KAU-1	

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

APPENDIX A

SOIL BORING LOGS, BOREHOLE ABANDONMENT FORMS AND HYDRAULIC CONDUCTIVITY TEST RESULT

State of Wisconsin
Department of Natural Resources

Route To:
- ☐ Solid Waste
- ☐ Emergency Response
- ☐ Wastewater
- ☐ Haz. Waste
- ☐ Underground Tanks
- ☐ Water Resources
- ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.002	*N/A*	*B-6/MW-2*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
MES *Gary*	*4/15/98*	*4/15/98*	*HSA*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	*N/A*	*MW-2*	*Feet MSL*	*Feet MSL*	*8 inches*

Boring Location		Local Grid Location (if applicable)
State Plane *N, E* *N1/4 of Gov. Lot 22, T 21N, R 18E*	**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	*Feet* ***S*** *Feet* ***W***

County	DNR County Code	Civil Town/City/ or Village
Outagamie	*45*	*Kaukauna*

Sample Number	Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			12	FA					
SS1		3,4,4,8	2	Gravelly Sandy Silt **FILL**, black, wood pieces, moist Sandy Silt **FILL**, black, wood pieces, moist	Fill			9	8					
SS2		6,2,1,1	4	Sandy Silt **FILL**, black, wood pieces, wet				4.2	3					Poor Recovery
SS3		2,2,4,7	6	**FILL**, black, wood, moist Gravelly, Clayey Silt **FILL**, brown, moist				6.6	6					
SS4		3,6,7,10	8	**CLAY**, trace Gravel, brown, gray mottling, very stiff, moist	CL			2	13					
SS5		21,15 12,7	10	Silty Sandy **GRAVEL**, brown, wet Sandy **SILT**, trace Gravel, brown, wet	GM			2.8	27					
SS6		7,12 12,50	12	Gravelly Sandy **SILT**, possible weathered or broken bedrock, brown, wet				2.8	24					
			14	*E.O.B at 13.5 feet*										
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen Burkman	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

Route To:
- ☐ Solid Waste
- ☐ Emergency Response
- ☐ Wastewater
- ☐ Haz. Waste
- ☐ Underground Tanks
- ☐ Water Resources
- ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.002	N/A	B-7/MW-3

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
MES Gary	4/15/98	4/15/98	HSA

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	N/A	MW-3	Feet MSL	Feet MSL	8 inches

Boring Location		Local Grid Location (If applicable)
State Plane N, E N1/4 of Gov. Lot 22, T 21N, R 18E	Lat N44° 0' 38" Long W88° 32'33"	Feet S Feet W

County	DNR County Code	Civil Town/City/ or Village
Outagamie	45	Kaukauna

Sample Number	Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
SS1		7,10 20,50	2	Silty Sand and Gravel **FILL**, brown, moist Obstruction, not observed	Fill			--	30					No recovery
SS2		2,3,4,4	4	Silty **CLAY**, brown, wet				ND	7					
SS3		2,3,5,5	6	Sand and Gravelly **SILT**, brown, moist Sandy **SILT**, brown, wet				0.8	8					
SS4		7,10 15,50	8	Sand and Gravelly **SILT**, brown, moist Rock Pieces				--	25					Poor recovery
				E.O.B at 8.5 feet; Auger Refusal										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen Burkman	FISCHER ENVIRONMENTAL CONSULTING, LLC.

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State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION
Form 4400-122 7-91

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*		**License/Permit/Monitoring Number** *N/A*	**Boring Number** *B-8/MW-4*
Boring Drilled By (Firm name and name of crew chief) *MES* *Gary*		**Date Drilling Started** *4/15/98*	**Date Drilling Completed** *4/15/98*	**Drilling Method** *HSA*
DNR Facility Well No. *N/A*	**WI Unique Well No.** *N/A*	**Common Well Name** *MW-4*	**Final Static Water Level** *Feet MSL*	**Surface Elevation** *Feet MSL*	**Borehole Diameter** *8 inches*
Boring Location **State Plane** *N, E* *N1/4 of Gov. Lot 22, T 21N, R 18E*			**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	**Local Grid Location (if applicable)** *Feet* **S** *Feet* **W**	
County *Outagamie*		**DNR County Code** *45*	**Civil Town/City/ or Village** *Kaukauna*		

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
				Not Observed										
SS1		2,3,4,5	2	Sand and Gravelly Silt **FILL**, black, wood, moist				--	7					
SS2		--	4	Shelby Tube Pushed	Fill			--	--					
SS3		2,7,11,7	6	Sand and Gravelly Silt **FILL**, black and brown, wood, wet				789	18					
SS4		4,4,9,13	8	Silty Gravelly **SAND**, brown, wet				105	13					
			10	*E.O.B at 9 feet; Auger Refusal*										
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Karen Buhman Firm FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 182, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 182.08, Wis. Stats.

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.002	*N/A*	*B-9*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
MES *Gary*	*4/15/98*	*4/15/98*	*HSA*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	*N/A*		*Feet MSL*	*Feet MSL*	*8 inches*

Boring Location		Local Grid Location (If applicable)	
State Plane *N, E* *NI/4 of Gov. Lot 22, T 21N, R 18E*	**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	*Feet* **S**	*Feet* **W**

County	DNR County Code	Civil Town/City/ or Village
Outagamie	*45*	*Kaukauna*

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plastic Limit	Soil Properties: P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
SS1		4,4,3,2	2	Not Observed Sandy Silt **FILL**, trace Gravel, black, wood, moist	Fill			245	7					
SS2		1,2,4,4	4	Sandy Clayey Silt **FILL**, trace Gravel, gray and brown, wet				62	6					
			6	*E.O.B at 5 feet*										
			8											
			10											
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen A Burkhardt	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *B-9*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*
Present Well Owner: *Same as above*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable): *B-9*
WI Unique Well No.:
Reason For Abandonment: *No longer needed*
Date of Abandonment: *4/15/98*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

- ☐ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☒ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *5* (From groundsurface) Casing Diameter (ins.)

Casing Depth (ft.)

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet)

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
3/8" Chipped Bentonite	*Surface*	*5*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: *Midwest Engineering Services, Inc.*
Signature of Person Doing Work: *Gary Ibg KJB* Date Signed: *7-23-98*
Street or Route: *1125 Tuckaway Lane, Suite B* Telephone Number: *(920) 735-1200*
City, State, Zip Code: *Menasha, WI 54952*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

Route To:
- ☐ Solid Waste
- ☐ Emergency Response
- ☐ Wastewater
- ☐ Haz. Waste
- ☐ Underground Tanks
- ☐ Water Resources
- ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*			**License/Permit/Monitoring Number** *N/A*		**Boring Number** *B-10*
Boring Drilled By (Firm name and name of crew chief) *MES* *Gary*			**Date Drilling Started** *4/15/98*	**Date Drilling Completed** *4/15/98*	**Drilling Method** *HSA*
DNR Facility Well No. *N/A*	**WI Unique Well No.** *N/A*	**Common Well Name**	**Final Static Water Level** *Feet MSL*	**Surface Elevation** *Feet MSL*	**Borehole Diameter** *6 inches*
Boring Location **State Plane** *N, E* *N1/4 of Gov. Lot 22, T 21N, R 18E*			**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	**Local Grid Location (if applicable)** *Feet S* *Feet W*	
County *Outagamie*			**DNR County Code** *45*	**Civil Town/City/ or Village** *Kaukauna*	

Sample Number	Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
				Not Observed										
SS1		4,3,2,1	2	Sandy Silt **FILL**, trace Gravel, black, wood, moist	Fill			ND	5					
SS2		1,1,2,3	4	Sandy Gravelly Silt **FILL**, black, wood, moist				ND	3					
SS3		2,3,3,4	6	Sandy Gravelly Silt **FILL**, black and brown, wet				10	6					
			8	*E.O.B at 7 feet*										
			10											
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature]	Firm FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *B-10*	County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*	
(If applicable) Gov't Lot	Grid Number
Grid Location: *Feet S, Feet W*	
Civil Town Name	
Street Address of Well: *222 W. 3rd Street*	
City, Village: *Kaukauna, WI 54130*	

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*	
Present Well Owner: *Same as above*	
Street or Route: *222 W. 3rd Street*	
City, State, Zip Code: *Kaukauna, WI*	
Facility Well No. and/or Name (If Applicable)	WI Unique Well No.
Reason For Abandonment: *No longer needed*	
Date of Abandonment: *4/15/98*	

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On

(Date) *4/15/98*

- ☐ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☒ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *7* Casing Diameter (ins.) _____
(From groundsurface)

Casing Depth (ft.) _____

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet) _____

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7)

Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
3/8" Chipped Bentonite	*Surface*	*7*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work
Midwest Engineering Services, Inc.

Signature of Person Doing Work: Gary Iby KAB	Date Signed: 7-23-98
Street or Route: *1125 Tuckaway Lane, Suite B*	Telephone Number: *(920) 735-1200*
City, State, Zip Code: *Menasha, WI 54952*	

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

tate of Wisconsin
Department of Natural Resources

Route To:
- ☐ Solid Waste
- ☐ Emergency Response
- ☐ Wastewater
- ☐ Haz. Waste
- ☐ Underground Tanks
- ☐ Water Resources
- ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*			**License/Permit/Monitoring Number** *N/A*		**Boring Number** *B-11*
Boring Drilled By (Firm name and name of crew chief) *MES* *Gary*			**Date Drilling Started** *4/15/98*	**Date Drilling Completed** *4/15/98*	**Drilling Method** *HSA*
DNR Facility Well No. *N/A*	**WI Unique Well No.** *N/A*	**Common Well Name**	**Final Static Water Level** *Feet MSL*	**Surface Elevation** *Feet MSL*	**Borehole Diameter** *6 inches*
Boring Location **State Plane** *N, E* *N1/4 of Gov. Lot 22, T 21N, R 18E*			**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	**Local Grid Location (if applicable)** *Feet S* *Feet W*	
County *Outagamie*			**DNR County Code** *45*	**Civil Town/City/ or Village** *Kaukauna*	

Sample Number	Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
				Not Observed										
SS1		14,6,2,8	2	Sandy Silt **FILL**, black, wood, moist	Fill			ND	8					
SS2		2,2,4,3	4	Silty Gravelly Sand **FILL**, brown, wood, wet				ND	6					
				E.O.B at 5 feet										

Depth scale: 6, 8, 10, 12, 14, 16, 18, 20, 22

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen A Dukas	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *B-11*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*
Present Well Owner: *Same as above*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable):
WI Unique Well No.:
Reason For Abandonment: *No longer needed*
Date of Abandonment: *4/15/98*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

- ☐ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☒ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *5* (From groundsurface)
Casing Diameter (ins.)
Casing Depth (ft.)

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet)

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
3/8" Chipped Bentonite	*Surface*	*5*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work
Midwest Engineering Services, Inc.
Signature of Person Doing Work: *Gary Jby KMB*
Date Signed: *7-23-98*
Street or Route: *1125 Tuckaway Lane, Suite B*
Telephone Number: *(920) 735-1200*
City, State, Zip Code: *Menasha, WI 54952*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/398132.002	N/A	B-12

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
MES Gary	4/15/98	4/15/98	HSA

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	N/A		Feet MSL	Feet MSL	8 inches

Boring Location		Local Grid Location (if applicable)	
State Plane N, E N1/4 of Gov. Lot 22, T 21N, R 18E	Lat N44° 0' 38" Long W88° 32'33"	Feet S	Feet W

County	DNR County Code	Civil Town/City/ or Village
Outagamie	45	Kaukauna

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
				Not Observed										
SS1		1,2,5,9	2	Sandy Silt **FILL**, trace Gravel, black, wood, moist				4	7					
SS2		3,2,2,3	4	Silty Gravelly Sand **FILL**, brown, moist to wet	Fill			--	4					Very poor recovery
SS3		4,8,10,7	6	Sandy Gravelly Silt **FILL**, gray and brown, wet				781	18					
			8	*E.O.B at 7 feet*										
			10											
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen A. Wilson	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 182, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 182.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *B-12*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*
Present Well Owner: *Same as above*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable):
WI Unique Well No.:
Reason For Abandonment: *No longer needed*
Date of Abandonment: *4/15/98*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

☐ Monitoring Well
☐ Water Well
☐ Drillhole
☒ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *7* Casing Diameter (ins.) _____
(From groundsurface)

Casing Depth (ft.) _____

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet) _____

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete)Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite
☐ Bentonite-Cement Grout

(7)

Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
3/8" Chipped Bentonite	*Surface*	*7*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work
Midwest Engineering Services, Inc.
Signature of Person Doing Work: Gary Iby KDB
Date Signed: 7-23-98
Street or Route: *1125 Tuckaway Lane, Suite B*
Telephone Number: *(920) 735-1200*
City, State, Zip Code: *Menasha, WI 54952*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste ☐ Haz. Waste
☐ Emergency Response ☐ Underground Tanks
☐ Wastewater ☐ Water Resources
☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Kaukauna Maintenance Garage/#398132.002	*N/A*	*B-13*

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
MES *Gary*	*4/15/98*	*4/15/98*	*HSA*

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
N/A	*N/A*		*Feet MSL*	*Feet MSL*	*8 inches*

Boring Location		Local Grid Location (if applicable)	
State Plane *N, E* *NI/4 of Gov. Lot 22, T 21N, R 18E*	Lat *N44° 0' 38"* Long *W88° 32'33"*	*Feet S*	*Feet W*

County	DNR County Code	Civil Town/City/ or Village
Outagamie	*45*	*Kaukauna*

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
				Not Observed										
SS1		4,12,8,8	2	Sandy Silt **FILL**, trace Gravel, black, wood, moist				ND	20					
SS2		3,3,3,5	4	Silty Gravelly Sand **FILL**, brown, moist	Fill			ND	8					
				Sandy Silty Clay **FILL**, trace Gravel, black and brown, moist										
SS3		1,2,3,3	6	Sandy Gravelly **SILT**, brown, wet				2	5					
				E.O.B at 7 feet										
			8											
			10											
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen D Burbank	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-58 Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *B-13*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*
Present Well Owner: *Same as above*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable)
WI Unique Well No.
Reason For Abandonment: *No longer needed*
Date of Abandonment: *4/15/98*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

- ☐ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☒ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *7* (From groundsurface)
Casing Diameter (ins.)
Casing Depth (ft.)

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet)

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
3/8" Chipped Bentonite	*Surface*	*7*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work
Midwest Engineering Services, Inc.
Signature of Person Doing Work: *Gary Ibe KSB*
Date Signed: *7-22-98*
Street or Route: *1125 Tuckaway Lane, Suite B*
Telephone Number: *(920) 735-1200*
City, State, Zip Code: *Menasha, WI 54952*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

Route To:
- ☐ Solid Waste
- ☐ Emergency Response
- ☐ Wastewater
- ☐ Haz. Waste
- ☐ Underground Tanks
- ☐ Water Resources
- ☐ Other:

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*			**License/Permit/Monitoring Number** *N/A*		**Boring Number** *B-14*
Boring Drilled By (Firm name and name of crew chief) *MES* *Gary*			**Date Drilling Started** *4/15/98*	**Date Drilling Completed** *4/15/98*	**Drilling Method** *HSA*
DNR Facility Well No. *N/A*	**WI Unique Well No.** *N/A*	**Common Well Name**	**Final Static Water Level** *Feet MSL*	**Surface Elevation** *Feet MSL*	**Borehole Diameter** *8 inches*
Boring Location **State Plane** *N, E* *N1/4 of Gov. Lot 22, T 21N, R 18E*			**Lat** *N44° 0' 38"* **Long** *W88° 32'33"*	**Local Grid Location (if applicable)** *Feet S* *Feet W*	
County *Outagamie*			**DNR County Code** *45*	**Civil Town/City/ or Village** *Kaukauna*	

Sample Number	Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/ Comments
AS		FA		Asphalt	Asphalt			--	FA					
				Not Observed										
SS1		1,2,3,5	2	Sandy Gavelly **FILL**, black and brown, wood, moist	Fill			ND	5					
SS2		1,1,2,3	4	Sandy Gravelly Silt **FILL**, brown, wet				ND	3					
			6	*E.O.B at 5 feet*										
			8											
			10											
			12											
			14											
			16											
			18											
			20											
			22											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen A Burkman	FISCHER ENVIRONMENTAL INC.

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 12-91

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: *B-14*
County: *Outagamie*
Section Location: *N 1/4 of Gov. Lot 22, T 21N, R 18E*
(If applicable) Gov't Lot / Grid Number
Grid Location: *Feet S, Feet W*
Civil Town Name:
Street Address of Well: *222 W. 3rd Street*
City, Village: *Kaukauna, WI 54130*

(2) FACILITY NAME

Original Well Owner (If Known): *Kaukauna Maintenance Garage*
Present Well Owner: *Same as above*
Street or Route: *222 W. 3rd Street*
City, State, Zip Code: *Kaukauna, WI*
Facility Well No. and/or Name (If Applicable):
WI Unique Well No.:
Reason For Abandonment: *No longer needed*
Date of Abandonment: *4/15/98*

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On
(Date) *4/15/98*

- ☐ Monitoring Well
- ☐ Water Well
- ☐ Drillhole
- ☒ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) *5* Casing Diameter (ins.) _____
(From groundsurface)

Casing Depth (ft.) _____

Was Well Annular Space Grouted? ☐ Yes ☒ No ☐ Unknown
If Yes, To What Depth? *Feet*

(4) Depth to Water (Feet) _____

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☒ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☒ Other (Explain) *Gravity*

(6) Sealing Materials
- ☐ Neat Cement Grout
- ☐ Sand-Cement (Concrete)Grout
- ☐ Concrete
- ☐ Clay-Sand Slurry
- ☐ Bentonite-Sand Slurry
- ☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
- ☐ Bentonite Pellets
- ☐ Granular Bentonite
- ☐ Bentonite-Cement Grout

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
3/8" Chipped Bentonite	*Surface*	*5*	*1 Bag*	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work
Midwest Engineering Services, Inc.
Signature of Person Doing Work: *Gary Ibg KAB* Date Signed: *7-27-98*
Street or Route: *1125 Tuckaway Lane, Suite B* Telephone Number: *(920) 735-1200*
City, State, Zip Code: *Menasha, WI 54952*

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

Report Of Falling Head Hydraulic Conductivity Test

Client: Fischer Environmental

Project: Kaukauna Maintenance Garage
222 West 3rd Street
Kaukauna, Wisconsin 54130

Date: 5/1/98

Project No.: 3-83060

Laboratory No.: IOB98024
Sample Location: B-8, 3.0-5.0 Ft.
Sample Description: Yellowish Brown Silty Clay, tracesand, trace gravel

Material Properties

Natural Moisture:	---	Percent Finer No 200:	-----
Specific Gravity:	-----	Percent Finer .005 mm:	-----
Max. Dry Density:	---	Liquid Limit:	-----
Optimum Moisture	-----	Plasiticity Index.	-----

Sample Characteristics

Height,cm:	8.09
Diameter,cm:	7.13
Wet Weight,gm:	639.2
Moisture, %:	25.2
Dry Density,pcf:	98.4
Compaction, %:	---

Test Parameters

Permeameter:	Flexible Wall
Permeant Fluid:	Deaired Water
Cell Pressure:	45
Back Pressure:	39
Test Pressure:	42
Differential Head	3

(Hydraulic Conductivity,ASTM D5084,method C)

Run No.	Time t (sec)	Head Loss, cm ho	hi	Inflow/ Outflow	Coeff. of Permeability, cm/sec k=aL/2At[ln(ho/hi)]
1	5940	258.10	254.50	0.89	2.4E-07
2	3000	254.50	252.85	0.94	2.2E-07
3	660	252.85	252.45	1.00	2.4E-07
4	12000	252.45	246.40	0.95	2.0E-07
5	9120	246.40	242.05	0.89	2.0E-07
AVERAGE STEADY HYDRAULIC CONDUCTIVITY				**K=**	**2.2E-07 cm/sec**

APPENDIX B

SOIL ANALYTICAL RESULTS

Company Name: Fischer Env. Consulting
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.002
Project Name: Kaukauna Maint.
Project Location:
Sampled By (Print): Karen Burkman

Regulatory Program (circle): UST RCRA CLP SDWA
NPDES/WPDES CAA NR
Other PECFA

NR720 Confirmation Analysis Required? (circle): Y N
(En Chem will not confirm unless otherwise instructed.)

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436 • 1-800-736-2436
FAX 920-469-8827

802 Deming Way
Madison, WI 53717
608-827-5501 • 1-888-536-2436
Fax: 608-827-5503

1423 N. 8th Street., Suite 122
Superior, WI 54880
715-392-5844 • 1-800-837-8238
FAX 715-392-5843

CHAIN OF CUSTODY

17032

① Added per Karen Burkman on 4/16/98 TJT

Page 1 of 2
P.O. # Quote #
Mail Report To: Karen Burkman
Company: Fischer Env. Con.
Address: PO Box 127
Kaukauna, WI
Invoice To: City of Kaukauna
Company: c/o Fischer
Address:
Mail Invoice To: Fischer

FILTERED? (YES/NO) N
PRESERVATION (CODE)* F A A A F

ANALYSES REQUESTED: PVOC/GRO, DRO, PAH, Lead, VOC/GRO

SHADED AREA FOR LABORATORY USE ONLY

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	PVOC/GRO	DRO	PAH	Lead	VOC/GRO				FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
TB		4/15/98	am									+		✓	1-2		001
B-6,	1-3 ft			X	X		X					-	S		2-2		002
B-7,	3-5 ft			X	X							-					003
B-8,	1-3 ft			X	X	① X	X					+					004
B-9,	1-3 ft				X		X	X				+					005
B-9,	3-5 ft			X	X							+					006
B-10,	1-3 ft			X	X							-					007
B-10,	5-7 ft			X	X							-					008
B-11,	1-3 ft			X	X							-					009
B-11,	3-5 ft			X	X							-					010
B-12,	1-3 ft		pm	X	X							+					011
B-12,	5-7 ft				X		X	X				+					012
B-13,	1-3 ft			X	X							-					013

Preservation Code
A=None B=HCl C=H2SO4
D=HNO3 E=EnCore F=Methanol
G=NaOH O=Other (Indicate)

*If not using EnChem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:	En Chem Project No.
Karen Burkman	4/16/98	A Wecker	4/16/98	882142
A Wecker	4/16/98 1520			Sample Receipt Temp. R02
				Sample Receipt pH (Wet/Metals)
		Received By (En Chem): [signature]	4/16/98 15:20	

PAGE 2 of 2

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436 • 1-800-736-2436
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802 Deming Way
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1423 N. 8th Street., Suite 122
Superior, WI 54880
715-392-5844 • 1-800-837-8238
FAX 715-392-5843

CHAIN OF CUSTODY

17031

Company Name: Fischer Env. Consulting
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.002
Project Name: Kaukauna Maint.
Project Location:
Sampled By (Print): Karen Burkman

Regulatory Program (circle): UST RCRA CLP SDWA
NPDES/WPDES CAA NR
Other PECFA

NR720 Confirmation Analysis Required? (circle): Y N
(En Chem will not confirm unless otherwise instructed.)

Page 2 of 2
P.O. # Quote #
Mail Report To: Karen B.
Company: Fischer Env Con.
Address: PO Box 127
Kaukauna, WI
Invoice To: City of Kaukauna
Company: c/o Fischer
Address:
Mail Invoice To: Fischer

FILTERED? (YES/NO): N N
PRESERVATION (CODE)*: F A

ANALYSES REQUESTED: PVOC/GRO, DRO

SHADED AREA FOR LABORATORY USE ONLY

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	PVOC/GRO	DRO	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
B-13	5-7 ft	4/15/98	pm	X	X	-	S	✓	2 2 2	M 1 502	014
B-14	1-3 ft	↓	↓	X	X	-	↓	↓	↓		015
B-14	3-5 ft	↓	↓	X	X	-	↓	↓	↓		016

*Preservation Code
A=None B=HCL C=H2SO4
D=HNO3 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:	En Chem Project No.
Karen Burkman	4/16/98	A Wecker - 4/16/98	1550	88[illegible]
A Wecker 4/16/98	1520			Sample Receipt Temp. 1.0
				Sample Receipt pH (Wet/Metals)
		Received By (En Chem): [signature]	4/16/98 15:20	

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 4/29/98

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
882112-001	TB	4/15/98			
882112-002	B-6, 1-3 FT	4/15/98			
882112-003	B-7, 3-5 FT	4/15/98			
882112-004	B-8, 1-3 FT	4/15/98			
882112-005	B-9, 1-3 FT	4/15/98			
882112-006	B-9, 3-5 FT	4/15/98			
882112-007	B-10, 1-3 FT	4/15/98			
882112-008	B-10, 5-7 FT	4/15/98			
882112-009	B-11, 1-3 FT	4/15/98			
882112-010	B-11, 3-5 FT	4/15/98			
882112-011	B-12, 1-3 FT	4/15/98			
882112-012	B-12, 5-7 FT	4/15/98			
882112-013	B-13, 1-3 FT	4/15/98			
882112-014	B-13, 5-7 FT	4/15/98			
882112-015	B-14, 1-3 FT	4/15/98			
882112-016	B-14, 3-5 FT	4/15/98			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

Approval Signature

4/29/98
Date

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

Lab#:	TestGroupID:	Comment:
882112-002 B-6, 1-3 FT	PVOC-S-ME	The presence of 1,3,5-Trimethylbenzene was confirmed on 4/27/98 by a GC/MS analysis.
	PVOC-S-ME	The presence of 1,2,4-Trimethylbenzene was confirmed on 4/27/98 by a GC/MS analysis.
	DRO-S	Peaks present late in and beyond window.
882112-004 B-8, 1-3 FT	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling gasoline. Early and late peaks were present outside of window.
	DRO-S	Late eluting peaks present along with diesel range peaks.
882112-005 B-9, 1-3 FT	GRO-S-ME	The PVOC surrogate recovery was above limits due to co-elution with non-target compounds.
	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling gasoline. Early peaks were present outside of window.
	DRO-S	Front peaks and late eluting peaks present in the chromatogram.
882112-006 B-9, 3-5 FT	GRO-S-ME	Sample has a typical gas pattern.
882112-007 B-10, 1-3 FT	PVOC-S-ME	The presence of 1,2,4-Trimethylbenzene was confirmed on 4/27/98 by a GC/MS analysis.
	DRO-S	Peaks present late in and beyond window.
882112-008 B-10, 5-7 FT	GRO-S-ME	Low level peaks present in chromatogram.
	DRO-S	Peaks present late in and beyond window.
882112-009 B-11, 1-3 FT	DRO-S	Peaks present late in and beyond window.
882112-011 B-12, 1-3 FT	DRO-S	Late eluting peaks present along with diesel range peaks.
	GRO-S-ME	Low level peaks present in chromatogram.
882112-012 B-12, 5-7 FT	DRO-S	Front peaks present along with mainly diesel peaks.
	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling gasoline. Early and late peaks were present outside of window.
882112-013 B-13, 1-3 FT	DRO-S	Late eluting peaks present along with diesel range peaks.
	GRO-S-ME	Low level peaks present in chromatogram.
	PVOC-S-ME	The presence of 1,3,5-Trimethylbenzene was confirmed on 4/21/98 by a GC/MS analysis.

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

Lab#:	TestGroupID:	Comment:
882112-015	DRO-S	Front peaks and late eluting hump present in the chromatogram.
B-14, 1-3 FT		
	GRO-S-ME	Low level peaks present in chromatogram.
	PVOC-S-ME	The presence of 1,3,5-Trimethylbenzene was confirmed on 4/21/98 by a GC/MS analysis.
	PVOC-S-ME	The presence of 1,2,4-Trimethylbenzene was confirmed on 4/21/98 by a GC/MS analysis.

EN CHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TB

Report Date : 4/22/98

Lab Sample Number : 882112-001

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : METHANOL

Organic Results

EPA 8260 VOLATILE LIST - METHANOL Prep Method: SW846 5030 Prep Date: 4/17/98 Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
Bromobenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
Bromochloromethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
Bromoform	< 25	25	60		ug/L		4/17/98	SW846 8260B
Bromomethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/L		4/17/98	SW846 8260B
Chloroform	< 25	25	60		ug/L		4/17/98	SW846 8260B
Chlorobenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
Chloroethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
Chloromethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/L		4/17/98	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
Dibromomethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/L		4/17/98	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/L		4/17/98	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/L		4/17/98	SW846 8260B
Dichlorodifluoromethane	< 25	25	60		ug/L		4/17/98	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60		ug/L		4/17/98	SW846 8260B

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Client : FISCHER ENVIRONMENTAL CONSULTING
Field ID : TB
Report Date : 4/22/98
Lab Sample Number : 882112-001
Collection Date : 4/15/98
WI DNR LAB ID : 405132750
Matrix Type : METHANOL

1,2-Dichloropropane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,1-Dichloroethane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,3-Dichloropropane	< 25	25	60	ug/L	4/17/98	SW846 8260B
2,2-Dichloropropane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,1-Dichloropropene	< 25	25	60	ug/L	4/17/98	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/L	4/17/98	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/L	4/17/98	SW846 8260B
Ethylbenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/L	4/17/98	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Isopropylbenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
p-Isopropyltoluene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Methylene chloride	< 25	25	60	ug/L	4/17/98	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/L	4/17/98	SW846 8260B
Naphthalene	< 25	25	60	ug/L	4/17/98	SW846 8260B
n-Propylbenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Styrene	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 25	25	60	ug/L	4/17/98	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Toluene	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,2,4-Trimethylbenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Trichloroethene	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/L	4/17/98	SW846 8260B
1,3,5-Trimethylbenzene	< 25	25	60	ug/L	4/17/98	SW846 8260B
Vinyl chloride	< 25	25	60	ug/L	4/17/98	SW846 8260B
Xylenes, -m, -p	< 25	25	60	ug/L	4/17/98	SW846 8260B
Xylene, -o	< 25	25	60	ug/L	4/17/98	SW846 8260B
4-Bromofluorobenzene	99			%Recov	4/17/98	SW846 8260B
Dibromofluoromethane	98			%Recov	4/17/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Client : FISCHER ENVIRONMENTAL CONSULTING
Field ID : TB
Report Date : 4/22/98
Lab Sample Number : 882112-001
Collection Date : 4/15/98
WI DNR LAB ID : 405132750
Matrix Type : METHANOL

Toluene-d8	98		%Recov	4/17/98	SW846 8260B

Organic Results

GASOLINE RANGE ORGANICS - METHANOL **Prep Method:** WI MOD.GRO **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2500			2500	ug/L		4/21/98	Wi MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	Wi MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	Wi MOD GRO
Blank	< 50			50	ug/L		4/21/98	Wi MOD GRO

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-6, 1-3 FT
Lab Sample Number : 882112-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/24/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead	150	5.3	17		mg/kg		4/23/98	SW846 3051	SW846 7421	MSB
Solids, percent	64.3				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	19			5.6	mg/kg		4/18/98	Wi MOD DRO
Blank spike	88			50	%Recov		4/18/98	Wi MOD DRO
Blank spike duplicate	74			50	%Recov		4/18/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/18/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD.GRO **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 3.9			3.9	mg/kg		4/21/98	Wi MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	Wi MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/21/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-6, 1-3 FT
Lab Sample Number : 882112-002
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/24/98
Collection Date : 4/15/98
Matrix Type : SOIL

Benzene	< 25	25	60	ug/kg		4/21/98	MOD 8021B
Ethylbenzene	< 25	25	60	ug/kg		4/21/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		4/21/98	MOD 8021B
Toluene	< 25	25	60	ug/kg		4/21/98	MOD 8021B
1,3,5-Trimethylbenzene	44	39	94	ug/kg	Q	4/21/98	MOD 8021B
1,2,4-Trimethylbenzene	45	39	94	ug/kg	Q	4/21/98	MOD 8021B
Xylenes, -m, -p	110	39	94	ug/kg		4/21/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg		4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-7, 3-5 FT
Lab Sample Number : 882112-003
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/22/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	90.4				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** WI MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.0			4.0	mg/kg		4/17/98	WI MOD DRO
Blank spike	88			50	%Recov		4/17/98	WI MOD DRO
Blank spike duplicate	74			50	%Recov		4/17/98	WI MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	WI MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** WI MOD.GRO **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.8			2.8	mg/kg		4/21/98	WI MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	WI MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	WI MOD GRO
Blank	< 2.5			2.5	mg/kg		4/21/98	WI MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		4/21/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-7, 3-5 FT
Lab Sample Number : 882112-003
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/22/98
Collection Date : 4/15/98
Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg	4/21/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	4/21/98	MOD 8021B
Toluene	< 25	25	60	ug/kg	4/21/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	4/21/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	4/21/98	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	4/21/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-8, 1-3 FT
Lab Sample Number : 882112-004
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/24/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead	40	3.6	11		mg/kg		4/23/98	SW846 3051	SW846 7421	MSB
Solids, percent	91.8				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	47			4.0	mg/kg		4/18/98	Wi MOD DRO
Blank spike	88			50	%Recov		4/18/98	Wi MOD DRO
Blank spike duplicate	74			50	%Recov		4/18/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/18/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** Wi MOD.GRO **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	22			2.7	mg/kg		4/21/98	Wi MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	Wi MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/21/98	Wi MOD GRO

Organic Results

PAH - WI LUST LIST - SEMIVOLATILES — **Prep Method:** SW846 3550 **Prep Date:** 4/17/98 **Analyst:** NJS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	< 14	14	45		ug/kg		4/20/98	SW846 8270

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-8, 1-3 FT
Lab Sample Number : 882112-004
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/24/98
Collection Date : 4/15/98
Matrix Type : SOIL

Acenaphthylene	< 16	16	51	ug/kg		4/20/98	SW846 8270
Anthracene	< 15	15	48	ug/kg		4/20/98	SW846 8270
Benzo(a)anthracene	16	16	51	ug/kg	Q	4/20/98	SW846 8270
Benzo(a)pyrene	< 14	14	45	ug/kg		4/20/98	SW846 8270
Benzo(b)fluoranthene	< 16	16	51	ug/kg		4/20/98	SW846 8270
Benzo(g,h,i)perylene	< 17	17	54	ug/kg		4/20/98	SW846 8270
Benzo(k)fluoranthene	< 16	16	51	ug/kg		4/20/98	SW846 8270
Chrysene	< 16	16	51	ug/kg		4/20/98	SW846 8270
Dibenzo(a,h)anthracene	< 17	17	54	ug/kg		4/20/98	SW846 8270
Fluoranthene	27	15	48	ug/kg	Q	4/20/98	SW846 8270
Fluorene	< 15	15	48	ug/kg		4/20/98	SW846 8270
Indeno(1,2,3-cd)pyrene	< 17	17	54	ug/kg		4/20/98	SW846 8270
1-Methylnaphthalene	430	16	51	ug/kg		4/20/98	SW846 8270
2-Methylnaphthalene	790	14	45	ug/kg		4/20/98	SW846 8270
Naphthalene	630	17	54	ug/kg		4/20/98	SW846 8270
Phenanthrene	23	14	45	ug/kg	Q	4/20/98	SW846 8270
Pyrene	17	16	51	ug/kg	Q	4/20/98	SW846 8270
Nitrobenzene-d5	88			%Recov		4/20/98	SW846 8270
2-Fluorobiphenyl	76			%Recov		4/20/98	SW846 8270
Terphenyl-d14	72			%Recov		4/20/98	SW846 8270

Organic Results

PVOC - METHANOL PRESERVED SOIL **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103				%Recov		4/21/98	MOD 8021B
Benzene	2300	27	65		ug/kg		4/21/98	MOD 8021B
Ethylbenzene	550	27	65		ug/kg		4/21/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/kg		4/21/98	MOD 8021B
Toluene	160	27	65		ug/kg		4/21/98	MOD 8021B
1,3,5-Trimethylbenzene	230	27	65		ug/kg		4/21/98	MOD 8021B
1,2,4-Trimethylbenzene	590	27	65		ug/kg		4/21/98	MOD 8021B
Xylenes, -m, -p	1500	27	65		ug/kg		4/21/98	MOD 8021B
Xylene, -o	100	27	65		ug/kg		4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-9, 1-3 FT
Lab Sample Number : 882112-005
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/29/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead	370	18	57		mg/kg		4/23/98	SW846 3051	SW846 7421	MSB
Solids, percent	79.4				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	27			4.7	mg/kg		4/18/98	Wi MOD DRO
Blank spike	88			50	%Recov		4/18/98	Wi MOD DRO
Blank spike duplicate	74			50	%Recov		4/18/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/18/98	Wi MOD DRO

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	1500	31	74		ug/kg		4/20/98	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		4/20/98	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		4/20/98	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		4/20/98	SW846 8260B
Bromoform	< 25	25	60		ug/kg		4/20/98	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		4/20/98	SW846 8260B
s-Butylbenzene	47	31	74		ug/kg	Q	4/20/98	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		4/20/98	SW846 8260B
n-Butylbenzene	74	31	74		ug/kg		4/20/98	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		4/20/98	SW846 8260B
Chloroform	< 25	25	60		ug/kg		4/20/98	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		4/20/98	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-9, 1-3 FT
Lab Sample Number : 882112-005
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/29/98
Collection Date : 4/15/98
Matrix Type : SOIL

Chlorodibromomethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Chloroethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Chloromethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
2-Chlorotoluene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
4-Chlorotoluene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,2-Dibromoethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Dibromomethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,2-Dichloroethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,1-Dichloroethene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Dichlorodifluoromethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,2-Dichloropropane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,1-Dichloroethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,3-Dichloropropane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
2,2-Dichloropropane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,1-Dichloropropene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Ethylbenzene	1900	31	74	ug/kg		4/20/98	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Isopropylbenzene	340	31	74	ug/kg		4/20/98	SW846 8260B
p-Isopropyltoluene	42	31	74	ug/kg	Q	4/20/98	SW846 8260B
Methylene chloride	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		4/20/98	SW846 8260B
Naphthalene	48	31	74	ug/kg	Q	4/20/98	SW846 8260B
n-Propylbenzene	330	31	74	ug/kg		4/20/98	SW846 8260B
Styrene	< 25	25	60	ug/kg		4/20/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/kg		4/20/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-9, 1-3 FT

Report Date : 4/29/98

Lab Sample Number : 882112-005

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,1,1,2-Tetrachloroethane	< 25	25	60	ug/kg	4/20/98	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/kg	4/20/98	SW846 8260B
Toluene	160	31	74	ug/kg	4/20/98	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/kg	4/20/98	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/kg	4/20/98	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/kg	4/20/98	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/kg	4/20/98	SW846 8260B
1,2,4-Trimethylbenzene	2600	31	74	ug/kg	4/20/98	SW846 8260B
Trichloroethene	< 25	25	60	ug/kg	4/20/98	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/kg	4/20/98	SW846 8260B
1,3,5-Trimethylbenzene	1600	31	74	ug/kg	4/20/98	SW846 8260B
Vinyl chloride	< 25	25	60	ug/kg	4/20/98	SW846 8260B
Xylenes, -m, -p	11000	31	74	ug/kg	4/20/98	SW846 8260B
Xylene, -o	190	31	74	ug/kg	4/20/98	SW846 8260B
4-Bromofluorobenzene	66			%Recov	4/20/98	SW846 8260B
Dibromofluoromethane	76			%Recov	4/20/98	SW846 8260B
Toluene-d8	75			%Recov	4/20/98	SW846 8260B

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL **Prep Method:** WI MOD.GRO **Prep Date:** 4/17/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	85			3.1	mg/kg		4/21/98	Wi MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	Wi MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/21/98	Wi MOD GRO

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-9, 3-5 FT
Lab Sample Number : 882112-006
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/22/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	88.4				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: WI MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.3			4.3	mg/kg		4/17/98	WI MOD DRO
Blank spike	87			50	%Recov		4/17/98	WI MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	WI MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	WI MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	16			2.8	mg/kg		4/21/98	WI MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	WI MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	WI MOD GRO
Blank	< 2.5			2.5	mg/kg		4/21/98	WI MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	105				%Recov		4/21/98	MOD 8021B
Benzene	190	28	67		ug/kg		4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-9, 3-5 FT
Lab Sample Number : 882112-006
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/22/98
Collection Date : 4/15/98
Matrix Type : SOIL

Ethylbenzene		460	28	67	ug/kg	4/21/98	MOD 8021B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg	4/21/98	MOD 8021B
Toluene	<	25	25	60	ug/kg	4/21/98	MOD 8021B
1,3,5-Trimethylbenzene		610	28	67	ug/kg	4/21/98	MOD 8021B
1,2,4-Trimethylbenzene		2200	28	67	ug/kg	4/21/98	MOD 8021B
Xylenes, -m, -p		2200	28	67	ug/kg	4/21/98	MOD 8021B
Xylene, -o	<	25	25	60	ug/kg	4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-10, 1-3 FT
Lab Sample Number : 882112-007
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/22/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	84.9				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: WI MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	9.0			4.4	mg/kg		4/17/98	WI MOD DRO
Blank spike	87			50	%Recov		4/17/98	WI MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	WI MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	WI MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.9			2.9	mg/kg		4/21/98	WI MOD GRO
Blank Spike	113			1.00	%Recov		4/21/98	WI MOD GRO
Blank Spike Duplicate	115			1.00	%Recov		4/21/98	WI MOD GRO
Blank	< 2.5			2.5	mg/kg		4/21/98	WI MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		4/21/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Client : FISCHER ENVIRONMENTAL CONSULTING
Field ID : B-10, 1-3 FT
Report Date : 4/22/98
Lab Sample Number : 882112-007
Collection Date : 4/15/98
WI DNR LAB ID : 405132750
Matrix Type : SOIL

Ethylbenzene	30	29	70	ug/kg	Q	4/21/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		4/21/98	MOD 8021B
Toluene	92	29	70	ug/kg		4/21/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg		4/21/98	MOD 8021B
1,2,4-Trimethylbenzene	65	29	70	ug/kg	Q	4/21/98	MOD 8021B
Xylenes, -m, -p	94	29	70	ug/kg		4/21/98	MOD 8021B
Xylene, -o	42	29	70	ug/kg	Q	4/21/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-10, 5-7 FT
Lab Sample Number : 882112-008
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	95.6				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: WI MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	12			3.5	mg/kg		4/17/98	WI MOD DRO
Blank spike	87			50	%Recov		4/17/98	WI MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	WI MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	WI MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	3.3			2.6	mg/kg		4/17/98	WI MOD GRO
Blank Spike	106			1.00	%Recov		4/17/98	WI MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/17/98	WI MOD GRO
Blank	< 2.5			2.5	mg/kg		4/17/98	WI MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		4/17/98	MOD 8021B
Benzene	71	26	62		ug/kg		4/17/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-10, 5-7 FT

Report Date : 4/20/98

Lab Sample Number : 882112-008

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg	4/17/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	4/17/98	MOD 8021B
Toluene	< 25	25	60	ug/kg	4/17/98	MOD 8021B
1,3,5-Trimethylbenzene	73	26	62	ug/kg	4/17/98	MOD 8021B
1,2,4-Trimethylbenzene	300	26	62	ug/kg	4/17/98	MOD 8021B
Xylenes, -m, -p	130	26	62	ug/kg	4/17/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	4/17/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-11, 1-3 FT
Lab Sample Number : 882112-009
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	84.9				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** WI MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	8.0			4.5	mg/kg		4/17/98	Wi MOD DRO
Blank spike	87			50	%Recov		4/17/98	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** WI MOD.GRO **Prep Date:** 4/17/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.9			2.9	mg/kg		4/18/98	Wi MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	Wi MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	108				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-11, 1-3 FT

Report Date : 4/20/98

Lab Sample Number : 882112-009

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Toluene	110	29	70	ug/kg	4/18/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-11, 3-5 FT
Lab Sample Number : 882112-010
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	78.1				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.4			4.4	mg/kg		4/17/98	Wi MOD DRO
Blank spike	87			50	%Recov		4/17/98	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** WI MOD.GRO **Prep Date:** 4/17/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 3.2			3.2	mg/kg		4/18/98	Wi MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	Wi MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-11, 3-5 FT

Report Date : 4/20/98

Lab Sample Number : 882112-010

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Toluene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-12, 1-3 FT
Lab Sample Number : 882112-011
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	83.1				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	33			4.8	mg/kg		4/17/98	Wi MOD DRO
Blank spike	87			50	%Recov		4/17/98	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 3.0			3.0	mg/kg		4/18/98	Wi MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	Wi MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-12, 1-3 FT

Report Date : 4/20/98

Lab Sample Number : 882112-011

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg		4/18/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		4/18/98	MOD 8021B
Toluene	34	30	72	ug/kg	Q	4/18/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg		4/18/98	MOD 8021B
1,2,4-Trimethylbenzene	47	30	72	ug/kg	Q	4/18/98	MOD 8021B
Xylenes, -m, -p	69	30	72	ug/kg	Q	4/18/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Field ID : B-12, 5-7 FT

Lab Sample Number : 882112-012

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 4/24/98

Collection Date : 4/15/98

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead	6.5	4.4	14		mg/kg	Q	4/23/98	SW846 3051	SW846 7421	MSB
Solids, percent	77.8				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** Wi MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	48			5.0	mg/kg		4/17/98	Wi MOD DRO
Blank spike	87			50	%Recov		4/17/98	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	Wi MOD DRO

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	2100	320	770		ug/kg		4/17/98	SW846 8260B
Bromobenzene	< 250	250	600		ug/kg		4/17/98	SW846 8260B
Bromochloromethane	< 250	250	600		ug/kg		4/17/98	SW846 8260B
Bromodichloromethane	< 250	250	600		ug/kg		4/17/98	SW846 8260B
Bromoform	< 250	250	600		ug/kg		4/17/98	SW846 8260B
Bromomethane	< 250	250	600		ug/kg		4/17/98	SW846 8260B
s-Butylbenzene	1400	320	770		ug/kg		4/17/98	SW846 8260B
t-Butylbenzene	< 250	250	600		ug/kg		4/17/98	SW846 8260B
n-Butylbenzene	4400	320	770		ug/kg		4/17/98	SW846 8260B
Carbon tetrachloride	< 250	250	600		ug/kg		4/17/98	SW846 8260B
Chloroform	< 250	250	600		ug/kg		4/17/98	SW846 8260B
Chlorobenzene	< 250	250	600		ug/kg		4/17/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-12, 5-7 FT **Report Date :** 4/24/98

Lab Sample Number : 882112-012 **Collection Date :** 4/15/98

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Chlorodibromomethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Chloroethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Chloromethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
2-Chlorotoluene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
4-Chlorotoluene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,2-Dibromoethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Dibromomethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,3-Dichlorobenzene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,4-Dichlorobenzene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,2-Dichloroethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,2-Dichlorobenzene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,1-Dichloroethene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
cis-1,2-Dichloroethene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Dichlorodifluoromethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
trans-1,2-Dichloroethene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,2-Dichloropropane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,1-Dichloroethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,3-Dichloropropane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
2,2-Dichloropropane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,1-Dichloropropene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
cis-1,3-Dichloropropene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
trans-1,3-Dichloropropene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Diisopropyl ether	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Ethylbenzene	15000	320	770	ug/kg		4/17/98	SW846 8260B
Fluorotrichloromethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Hexachlorobutadiene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Isopropylbenzene	2100	320	770	ug/kg		4/17/98	SW846 8260B
p-Isopropyltoluene	750	320	770	ug/kg	Q	4/17/98	SW846 8260B
Methylene chloride	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Methyl-tert-butyl-ether	< 250	250	600	ug/kg		4/17/98	SW846 8260B
Naphthalene	6400	320	770	ug/kg		4/17/98	SW846 8260B
n-Propylbenzene	8400	320	770	ug/kg		4/17/98	SW846 8260B
Styrene	< 250	250	600	ug/kg		4/17/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 250	250	600	ug/kg		4/17/98	SW846 8260B

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Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-12, 5-7 FT

Report Date : 4/24/98

Lab Sample Number : 882112-012

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

1,1,1,2-Tetrachloroethane	< 250	250	600	ug/kg	4/17/98	SW846 8260B
Tetrachloroethene	< 250	250	600	ug/kg	4/17/98	SW846 8260B
Toluene	1500	320	770	ug/kg	4/17/98	SW846 8260B
1,2,3-Trichlorobenzene	< 250	250	600	ug/kg	4/17/98	SW846 8260B
1,2,4-Trichlorobenzene	< 250	250	600	ug/kg	4/17/98	SW846 8260B
1,1,1-Trichloroethane	< 250	250	600	ug/kg	4/17/98	SW846 8260B
1,1,2-Trichloroethane	< 250	250	600	ug/kg	4/17/98	SW846 8260B
1,2,4-Trimethylbenzene	45000	320	770	ug/kg	4/17/98	SW846 8260B
Trichloroethene	< 250	250	600	ug/kg	4/17/98	SW846 8260B
1,2,3-Trichloropropane	< 250	250	600	ug/kg	4/17/98	SW846 8260B
1,3,5-Trimethylbenzene	14000	320	770	ug/kg	4/17/98	SW846 8260B
Vinyl chloride	< 250	250	600	ug/kg	4/17/98	SW846 8260B
Xylenes, -m, -p	44000	320	770	ug/kg	4/17/98	SW846 8260B
Xylene, -o	11000	320	770	ug/kg	4/17/98	SW846 8260B
4-Bromofluorobenzene	97			%Recov	4/17/98	SW846 8260B
Dibromofluoromethane	89			%Recov	4/17/98	SW846 8260B
Toluene-d8	100			%Recov	4/17/98	SW846 8260B

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL Prep Method: WI MOD.GRO Prep Date: 4/17/98 Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	100			5.1	mg/kg		4/18/98	Wi MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	Wi MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	Wi MOD GRO

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ENCHEM INC.

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-13, 1-3 FT
Lab Sample Number : 882112-013
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	94.1				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: WI MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	56			4.1	mg/kg		4/17/98	Wi MOD DRO
Blank spike	87			50	%Recov		4/17/98	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.7			2.7	mg/kg		4/18/98	Wi MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	Wi MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-13, 1-3 FT
Lab Sample Number : 882112-013
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Ethylbenzene		36	27	65	ug/kg	Q	4/18/98	MOD 8021B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		4/18/98	MOD 8021B
Toluene		30	27	65	ug/kg	Q	4/18/98	MOD 8021B
1,3,5-Trimethylbenzene		27	27	65	ug/kg	Q	4/18/98	MOD 8021B
1,2,4-Trimethylbenzene		70	27	65	ug/kg		4/18/98	MOD 8021B
Xylenes, -m, -p		110	27	65	ug/kg		4/18/98	MOD 8021B
Xylene, -o		43	27	65	ug/kg	Q	4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-13, 5-7 FT
Lab Sample Number : 882112-014
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	86.2				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: WI MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 3.7			3.7	mg/kg		4/17/98	WI MOD DRO
Blank spike	87			50	%Recov		4/17/98	WI MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	WI MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	WI MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.9			2.9	mg/kg		4/18/98	WI MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	WI MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	WI MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	WI MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	110				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-13, 5-7 FT

Report Date : 4/20/98

Lab Sample Number : 882112-014

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Toluene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-14, 1-3 FT
Lab Sample Number : 882112-015
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	87.3				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: WI MOD DRO — Prep Date: 4/17/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	23			3.7	mg/kg		4/17/98	WI MOD DRO
Blank spike	87			50	%Recov		4/17/98	WI MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	WI MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	WI MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	3.9			2.9	mg/kg		4/18/98	WI MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	WI MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	WI MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	WI MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 4/17/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	113				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINT.

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : B-14, 1-3 FT

Report Date : 4/20/98

Lab Sample Number : 882112-015

Collection Date : 4/15/98

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg		4/18/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		4/18/98	MOD 8021B
Toluene	< 25	25	60	ug/kg		4/18/98	MOD 8021B
1,3,5-Trimethylbenzene	38	29	70	ug/kg	Q	4/18/98	MOD 8021B
1,2,4-Trimethylbenzene	55	29	70	ug/kg	Q	4/18/98	MOD 8021B
Xylenes, -m, -p	46	29	70	ug/kg	Q	4/18/98	MOD 8021B
Xylene, -o	40	29	70	ug/kg	Q	4/18/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-14, 3-5 FT
Lab Sample Number : 882112-016
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	85.7				%		4/17/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 4/17/98

DIESEL RANGE ORGANICS - SOIL — **Prep Method:** WI MOD DRO **Prep Date:** 4/17/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 4.1			4.1	mg/kg		4/17/98	Wi MOD DRO
Blank spike	87			50	%Recov		4/17/98	Wi MOD DRO
Blank spike duplicate	80			50	%Recov		4/17/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		4/17/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — **Prep Method:** WI MOD.GRO **Prep Date:** 4/17/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.9			2.9	mg/kg		4/18/98	Wi MOD GRO
Blank Spike	106			1.00	%Recov		4/18/98	Wi MOD GRO
Blank Spike Duplicate	114			1.00	%Recov		4/18/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		4/18/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — **Prep Method:** SW846 5030 **Prep Date:** 4/17/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		4/18/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		4/18/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA MAINT.
Project Number : 398132.002
Field ID : B-14, 3-5 FT
Lab Sample Number : 882112-016
WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/20/98
Collection Date : 4/15/98
Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Toluene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylenes, -m, -p	< 25	25	60	ug/kg	4/18/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg	4/18/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

Company Name: Fischer Environmental
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2009
Project Number: 398132.002
Project Name: Kaukauna Maintenance Garage
Project Location: Kaukauna
Sampled By (Print): Brian Y Shad W

Regulatory Program (circle): (UST) RCRA CLP SDWA NPDES/WPDES CAA NR____ Other ____

NR720 Confirmation Analysis Required? (circle): (Y) N
(En Chem will not confirm unless otherwise instructed.)

EN CHEM INC.

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☐ 525 Science Drive, Madison, WI 53711, 608-232-3300 • 1-888-536-2436, FAX: 608-233-0502
☐ 1423 N. 8th Street, Suite 122, Superior, WI 54880, 715-392-5844 • 1-800-837-8238, FAX 715-392-5843

CHAIN OF CUSTODY

30051

Page ____ of ____
P.O. # ____ Quote # ____
Mail Report To: Karen Burkman
Company: Fischer Environmental
Address: PO Box 127, Kaukauna WI 54130-0404
Invoice To: —
Company: Kaukauna Maintenance Garage
Address: C/O Fischer
Mail Invoice To: Karen Burkman

FILTERED? (YES/NO): N N N
PRESERVATION (CODE)*: E A E

ANALYSES REQUESTED: GRO, DRO, PVOC

SHADED AREA FOR LABORATORY USE ONLY

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	GRO	DRO	PVOC					FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
233953 233959	MW5 2.5-4.5'	8/28/98		↓	↓	↓					679	Soil	✓	1-202 1-202-M 1-5oz		001
233940 233951	MW6 4.5-6.5'	↓		↓	↓	↓					7.8	↓	↓	↓		002
	Field Blank	↓				↓							↓	1-202-M		003
*	MW5 4.5-6.5	↓		X①	X①	X①							✓	1-202 1-202-M 1-5oz		004
				① Added per Karen Burkman MAR 9/1/98												
*	Included w/shipment not on COC added by Lab 8/31/98 GD															

*Preservation Code
A=None B=HCL C=H2SO4
D=HNO3 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:	En Chem Project No.
Brian Youngwood	8/31/98	B Kempen	8/31/98 1000	885154
B Kempen	8/31/98 1545			Sample Receipt Temp. ROI
				Sample Receipt pH (Wet/Metals)
		Received By (En Chem): [illegible]	8/31/98 1545	

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 9/8/98

B-15 2.5-4.5'

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
885154-001	MW5 2.5-4.5'	8/28/98			
885154-002	MW6 4.5-6.5'	8/28/98			
885154-003	FIELD BLANK	8/28/98			
885154-004	MW5 4.5-6.5'	8/28/98			

B-16 4.5-6.5'

B-15 4.5-6.5'

KAS 9/11/98

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

J. Durocher — 9/8/98

Approval Signature — Date

ENCHEM INC.

1795 Industrial Dri
Green Bay, WI 543(
920-469-24(
800-7-ENCHE
FAX: 920-469-882

Lab#:	TestGroupID:	Comment:
885154-001 MW5 2.5-4.5'	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling diesel fuel or extremely weathered gasoline.
	DRO-S	Front peaks present along with diesel peaks.
885154-002 MW6 4.5-6.5'	DRO-S	Late eluting hump present along with diesel range peaks.
885154-004 MW5 4.5-6.5'	GRO-S-ME	Sample exhibits hydrocarbon pattern resembling diesel fuel or extremely weathered gasoline.
	DRO-S	Front peaks present along with diesel peaks.

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800-7-ENCHE
FAX: 920-469-882

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 D-15

Field ID : MW5 2.5-4.5'

Lab Sample Number : 885154-001 KBS

WI DNR LAB ID : 405132750 9-11-98

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 9/4/98

Collection Date : 8/28/98

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	77.3				%		9/1/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 9/1/98

DIESEL RANGE ORGANICS - SOIL **Prep Method:** Wi MOD DRO **Prep Date:** 9/1/98 **Analyst:** DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	3500			93	mg/kg		9/1/98	Wi MOD DRO
Blank spike	87			50	%Recov		9/1/98	Wi MOD DRO
Blank spike duplicate	81			50	%Recov		9/1/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		9/1/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL **Prep Method:** WI MOD.GRO **Prep Date:** 9/1/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	2200			130	mg/kg		9/3/98	Wi MOD GRO
Blank Spike	94			1.0	%Recov		9/3/98	Wi MOD GRO
Blank Spike Duplicate	98			1.0	%Recov		9/3/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		9/3/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL **Prep Method:** SW846 5030 **Prep Date:** 9/1/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	109				%Recov		9/3/98	MOD 8021B
Benzene	13000	1300	3100		ug/kg		9/3/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 D-15

Field ID : MW5 2.5-4.5'

Lab Sample Number : 885154-001 KAB

WI DNR LAB ID : 405132750 9-1-98

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 9/4/98

Collection Date : 8/28/98

Matrix Type : SOIL

Ethylbenzene		54000	1300	3100	ug/kg	9/3/98	MOD 8021B
Methyl-tert-butyl-ether	<	1000	1000	2400	ug/kg	9/3/98	MOD 8021B
Toluene		3500	1300	3100	ug/kg	9/3/98	MOD 8021B
1,3,5-Trimethylbenzene		39000	1300	3100	ug/kg	9/3/98	MOD 8021B
1,2,4-Trimethylbenzene		120000	1300	3100	ug/kg	9/3/98	MOD 8021B
Xylenes, -m, -p		160000	1300	3100	ug/kg	9/3/98	MOD 8021B
Xylene, -o		6800	1300	3100	ug/kg	9/3/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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Green Bay, WI 54302
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FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE
Project Number : 398132.002 D-16
Field ID : MW6 4.5-6.5'
Lab Sample Number : 885154-002 KAB
WI DNR LAB ID : 405132750 9-11-98
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 9/4/98
Collection Date : 8/28/98
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	86.6				%		9/1/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 9/1/98

DIESEL RANGE ORGANICS - SOIL — Prep Method: Wi MOD DRO — Prep Date: 9/1/98 — Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	140			4.4	mg/kg		9/2/98	Wi MOD DRO
Blank spike	87			50	%Recov		9/2/98	Wi MOD DRO
Blank spike duplicate	81			50	%Recov		9/2/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		9/2/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL — Prep Method: WI MOD.GRO — Prep Date: 9/1/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2.9			2.9	mg/kg		9/3/98	Wi MOD GRO
Blank Spike	94			1.0	%Recov		9/3/98	Wi MOD GRO
Blank Spike Duplicate	98			1.0	%Recov		9/3/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		9/3/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL — Prep Method: SW846 5030 — Prep Date: 9/1/98 — Analyst: CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	101				%Recov		9/3/98	MOD 8021B
Benzene	< 25	25	60		ug/kg		9/3/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 B-16

Field ID : MW6 4.5-6.5'

Lab Sample Number : 885154-002 KAB 9-11-98

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 9/4/98

Collection Date : 8/28/98

Matrix Type : SOIL

Ethylbenzene	< 25	25	60	ug/kg		9/3/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		9/3/98	MOD 8021B
Toluene	< 25	25	60	ug/kg		9/3/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg		9/3/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg		9/3/98	MOD 8021B
Xylenes, -m, -p	66	29	70	ug/kg	Q	9/3/98	MOD 8021B
Xylene, -o	< 25	25	60	ug/kg		9/3/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE
Project Number : 398132.002
Client : FISCHER ENVIRONMENTAL CONSULTING
Field ID : FIELD BLANK
Report Date : 9/4/98
Lab Sample Number : 885154-003
Collection Date : 8/28/98
WI DNR LAB ID : 405132750
Matrix Type : METHANOL

Organic Results

GASOLINE RANGE ORGANICS - METHANOL **Prep Method:** WI MOD.GRO **Prep Date:** 9/1/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	< 2500			2500	ug/L		9/3/98	Wi MOD GRO
Blank Spike	94			1.0	%Recov		9/3/98	Wi MOD GRO
Blank Spike Duplicate	98			1.0	%Recov		9/3/98	Wi MOD GRO
Blank	< 50			50	ug/L		9/3/98	Wi MOD GRO

Organic Results

PVOC - METHANOL **Prep Method:** SW846 5030 **Prep Date:** 9/1/98 **Analyst:** CAR

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		9/3/98	MOD 8021B
Benzene	< 25	25	60		ug/l		9/3/98	MOD 8021B
Ethylbenzene	< 25	25	60		ug/l		9/3/98	MOD 8021B
Methyl-tert-butyl-ether	< 25	25	60		ug/l		9/3/98	MOD 8021B
Toluene	< 25	25	60		ug/l		9/3/98	MOD 8021B
1,3,5-Trimethylbenzene	< 25	25	60		ug/l		9/3/98	MOD 8021B
1,2,4-Trimethylbenzene	< 25	25	60		ug/l		9/3/98	MOD 8021B
Xylenes, -m, -p	< 25	25	60		ug/l		9/3/98	MOD 8021B
Xylene, -o	< 25	25	60		ug/l		9/3/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 B-15

Field ID : MW5 4.5-6.5'

Lab Sample Number : 885154-004 KJB

WI DNR LAB ID : 405132750 9/11/98

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 9/4/98

Collection Date : 8/28/98

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	87.2				%		9/1/98	SM2540G	SM2540G	DJB

Organic Results

Preservation Date : 9/1/98

DIESEL RANGE ORGANICS - SOIL Prep Method: WI MOD DRO Prep Date: 9/1/98 Analyst: DJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	920			33	mg/kg		9/2/98	Wi MOD DRO
Blank spike	87			50	%Recov		9/2/98	Wi MOD DRO
Blank spike duplicate	81			50	%Recov		9/2/98	Wi MOD DRO
Blank	< 5.0			5.0	mg/kg		9/2/98	Wi MOD DRO

Organic Results

GASOLINE RANGE ORGANICS - SOIL/METHANOL Prep Method: WI MOD.GRO Prep Date: 9/2/98 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Gasoline Range Organics	1100			57	mg/kg		9/3/98	Wi MOD GRO
Blank Spike	98			1.0	%Recov		9/3/98	Wi MOD GRO
Blank Spike Duplicate	105			1.00	%Recov		9/3/98	Wi MOD GRO
Blank	< 2.5			2.5	mg/kg		9/3/98	Wi MOD GRO

Organic Results

PVOC - METHANOL PRESERVED SOIL Prep Method: SW846 5030 Prep Date: 9/2/98 Analyst: EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102				%Recov		9/3/98	MOD 8021B
Benzene	7100	570	1400		ug/kg		9/3/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

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1795 Industrial D
Green Bay, WI 5
920-469-
800-7-ENC
FAX: 920-469-8

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 B-15

Field ID : MW5 4.5-6.5'

Lab Sample Number : 885154-004 KAB 9-11-98

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 9/4/98

Collection Date : 8/28/98

Matrix Type : SOIL

Ethylbenzene	32000	570	1400	ug/kg		9/3/98	MOD 8021B
Methyl-tert-butyl-ether	3200	570	1400	ug/kg		9/3/98	MOD 8021B
Toluene	850	570	1400	ug/kg	Q	9/3/98	MOD 8021B
1,3,5-Trimethylbenzene	23000	570	1400	ug/kg		9/3/98	MOD 8021B
1,2,4-Trimethylbenzene	69000	570	1400	ug/kg		9/3/98	MOD 8021B
Xylenes, -m, -p	91000	570	1400	ug/kg		9/3/98	MOD 8021B
Xylene, -o	3800	570	1400	ug/kg		9/3/98	MOD 8021B

All soil results are reported on a dry weight basis unless otherwise noted.

APPENDIX C

GROUND-WATER MONITORING WELL CONSTRUCTION FORMS, MONITORING WELL DEVELOPMENT FORMS, AND GROUND-WATER LEVEL DATA SHEET

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4.9(

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*	**Local Grid Location of Well** *Feet S. Feet W*	**Well Name** *MW-2*
Facility License, Permit or Monitoring Number *N/A*	**Grid Origin Location**	**Wis. Unique Well Number** *N/A* **DNR Well Number** *N/A*
Type of Well Water Table Observation Well ☒ 11 Piezometer ☐ 12	**Section Location of Waste/Source** *NI/4 of Gov. Lot 22, T 21N, R 18E*	**Date Well Installed** *4/15/98*
Distance Well is From Waste/Source Boundary	**Location of Well Relative to Waste/Source** u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☒ Not Known	**Well Installed By: (Person's Name and Firm)** *Gary* *MES*
Is Well A Point of Enforcement Std. Application? ☒ Yes ☐ No		

A. Protective pipe, top elevation _____ ft. MSL
B. Well casing, top elevation _____ ft. MSL
C. Land surface elevation _____ ft. MSL
D. Surface seal, bottom _____ ft. MSL or 1 ft.

12. USCS Classification of soil near screen:
GP ☐ GM ☒ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☒ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

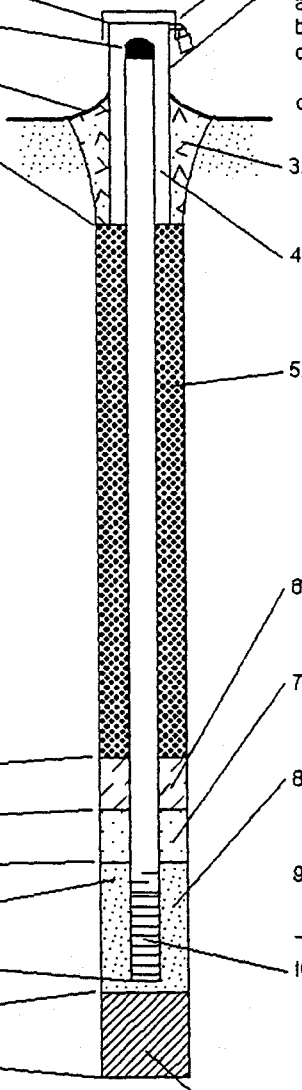
14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☒ 41
_____ Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

17. Source of water *(attach analysis)*:
_____

E. Bentonite seal, top _____ ft. MSL or 1 ft.
F. Fine sand, top _____ ft. MSL or 2 ft.
G. Filter pack, top _____ ft. MSL or 2.5 ft.
H. Screen joint, top _____ ft. MSL or 3 ft.
I. Well bottom _____ ft. MSL or 13 ft.
J. Filter pack, bottom _____ ft. MSL or 13.5 ft.
K. Borehole, bottom _____ ft. MSL or 13.5 ft.
L. Borehole, diameter 8 in.
M. O.D. well casing 2.25 in.
N. I.D. well casing 2.049 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04
Flushmount Other ☒
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Locking Expandable Cap
3. Surface seal: Bentonite ☐ 30
Concrete ☒ 01
_____ Other ☐
4. Material between well casing and protective pipe:
Bentonite ☒ 30
Annular space seal ☐
_____ Other ☐
5. Annular space seal: a. Granular Bentonite ☐ 33
b. ____ Lbs/gal mud weight .....Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
d. ____ % Bentonite .....Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01
Tremie pumped ☐ 02
Gravity ☒ 08
6. Bentonite seal: a. Bentonite Granules ☐ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. 3/8" Chipped Bentonite Other ☒ x
7. Fine sand material: Manufacturer, product name and mesh size
a. Red Flint 45/55
b. Volume added 0.33 ft^3
8. Filter pack material: Manufacturer, product name and mesh size
a. #30 Red Flint
b. Volume added 3.3 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
_____ Other ☐
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11
Continuous slot ☒ 01
_____ Other ☐
b. Manufacturer Diedrich
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☒ 14
_____ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Karen Burkara

Firm FISCHER ENVIRONMENTAL INC.

Please complete both sides of this form and return to the appropriate DNR office listted at the top of this form as required by chs. 144, 147 and 160 Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch. 144 Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147 Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4.90

Facility/Project Name	County Name	Well Name
Kaukauna Maintenance Garage/#398132.002	*Outagamie*	*MW-2*

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well Number
N/A	*45*	*N/A*	*N/A*

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☐ 61
surged with block and bailed	☐ 42
surged with block and pumped	☒ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well *27 min.*

4. Depth of well (from top of well casing) *13.28 ft.*

5. Inside diameter of well *2.049 in.*

6. Volume of water in filter pack and well casing *6.6 gal.*

7. Volume of water removed from well *17.5 gal.*

8. Volume of water added (if any) *0 gal.*

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☒ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing	a. *3.26 ft.*	*9.82 ft.*
Date *mm/dd/yy*	b. *4/17/98*	*4/17/98*
Time	c. *4:07* ☒ p.m. ☐ a.m.	*4:52* ☒ p.m. ☐ a.m.
12. Sediment in well bottom	*inches*	*inches*
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) *Light Brown Silty*	Clear ☐ 10 Turbid ☒ 15 (Describe) *Light Brown Silty*

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	*mg/l*	*mg/l*
15. COD	*mg/l*	*mg/l*

16. Additional comments on development:
Purged dry three times

Well developed by: Person's Name and Firm

Name: Jenny Diedrich

Firm: FISCHER ENVIRONMENTAL INC.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Karen A Burkman

Print Initials: KAB

Firm: FISCHER ENVIRONMENTAL INC.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4.90

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*	**Local Grid Location of Well** *Feet S, Feet W*	**Well Name** *MW-3*
Facility License, Permit or Monitoring Number *N/A*	**Grid Origin Location**	**Wis. Unique Well Number** *N/A* **DNR Well Number** *N/A*
Type of Well Water Table Observation Well ☒ 11 Piezometer ☐ 12	**Section Location of Waste/Source** *N1/4 of Gov. Lot 22, T 21N, R 18E*	**Date Well Installed** *4/15/98*
Distance Well Is From Waste/Source Boundary	**Location of Well Relative to Waste/Source** *u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☒ Not Known*	**Well Installed By: (Person's Name and Firm)** *Gary MES*
Is Well A Point of Enforcement Std. Application? ☒ Yes ☐ No		

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or 1 ft.

12. USCS Classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☒ 41
_____ Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

17. Source of water *(attach analysis)*:
_____

E. Bentonite seal, top _____ ft. MSL or 1 ft.

F. Fine sand, top _____ ft. MSL or 3 ft.

G. Filter pack, top _____ ft. MSL or 3 ft.

H. Screen joint, top _____ ft. MSL or 3.5 ft.

I. Well bottom _____ ft. MSL or 8.5 ft.

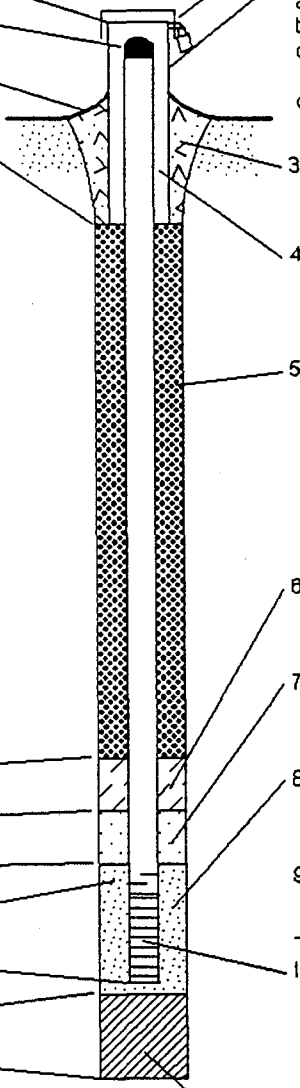
J. Filter pack, bottom _____ ft. MSL or 8.5 ft.

K. Borehole, bottom _____ ft. MSL or 8.5 ft.

L. Borehole, diameter 8 in.

M. O.D. well casing 2.25 in.

N. I.D. well casing 2.049 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04
Flushmount Other ☒
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Locking Expandable Cap

3. Surface seal: Bentonite ☐ 30
Concrete ☒ 01
_____ Other ☐

4. Material between well casing and protective pipe:
Bentonite ☒ 30
Annular space seal ☐
_____ Other ☐

5. Annular space seal: a. Granular Bentonite ☐ 33
b. ____ Lbs/gal mud weight .....Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
d. ____ % Bentonite .....Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01
Tremie pumped ☐ 02
Gravity ☒ 08

6. Bentonite seal: a. Bentonite Granules ☐ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. 3/8" Chipped Bentonite Other ☒ x

7. Fine sand material: Manufacturer, product name and mesh size
a. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name and mesh size
a. #30 Red Flint
b. Volume added 3.3 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
_____ Other ☐

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11
Continuous slot ☒ 01
_____ Other ☐
b. Manufacturer Diedrich
c. Slot size: 0.010 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☒ 14
_____ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Karen Burkman	FISCHER ENVIRONMENTAL INC.

Please complete both sides of this form and return to the appropriate DNR office listted at the top of this form as required by chs. 144, 147 and 160 Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch. 144 Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147 Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4.90

Facility/Project Name	County Name	Well Name	
Kaukauna Maintenance Garage/#398132.002	*Outagamie*	*MW-3*	
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well Number**
N/A	*45*	*N/A*	*N/A*

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☐	41
surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☒	62
surged with block, bailed and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☐	51
pumped slowly	☐	50
Other _____	☐	

3. Time spent developing well *23 min.*

4. Depth of well (from top of well casing) *8.76 ft.*

5. Inside diameter of well *2.049 in.*

6. Volume of water in filter pack and well casing *3.32 gal.*

7. Volume of water removed from well *9 gal.*

8. Volume of water added (if any) *0 gal.*

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☒ No
(If yes, attach results)

	Before Development		After Development	
11. Depth to Water (from top of well casing	a. *3.72 ft.*		*7.75 ft.*	
Date *mm/dd/yy*	b. *4/17/98*	☒ p.m.	*4/17/98*	☒ p.m.
Time	c. *2:21*	☐ a.m.	*3:34*	☐ a.m.
12. Sediment in well bottom	*inches*		*inches*	
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) *Very Turbid Silty*		Clear ☐ 10 Turbid ☒ 15 (Describe) *Trace Silt Slightly Hazy*	

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	*mg/l*	*mg/l*
15. COD	*mg/l*	*mg/l*

16. Additional comments on development:

Purged dry three times

Well developed by: Person's Name and Firm

Name: Jenny Diedrich

Firm: FISCHER ENVIRONMENTAL CONSULTING, LLC.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Karen A Bunkman

Print Initials: KAB

Firm: FISCHER ENVIRONMENTAL CONSULTING, LLC.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4.90

Facility/Project Name *Kaukauna Maintenance Garage/#398132.002*	**Local Grid Location of Well** *Feet S. Feet W*	**Well Name** *MW-4*
Facility License, Permit or Monitoring Number *N/A*	**Grid Origin Location**	**Wis. Unique Well Number** / **DNR Well Number** *N/A* / *N/A*
Type of Well Water Table Observation Well ☒ 11 Piezometer ☐ 12	**Section Location of Waste/Source** *NI/4 of Gov. Lot 22, T 21N, R 18E*	**Date Well Installed** *4/15/98*
Distance Well is From Waste/Source Boundary	**Location of Well Relative to Waste/Source** u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☒ Not Known	**Well Installed By: (Person's Name and Firm)** *Gary* *MES*
Is Well A Point of Enforcement Std. Application? ☒ Yes ☐ No		

A. Protective pipe, top elevation _____ ft. MSL
B. Well casing, top elevation _____ ft. MSL
C. Land surface elevation _____ ft. MSL
D. Surface seal, bottom _____ ft. MSL or 1 ft.

12. USCS Classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

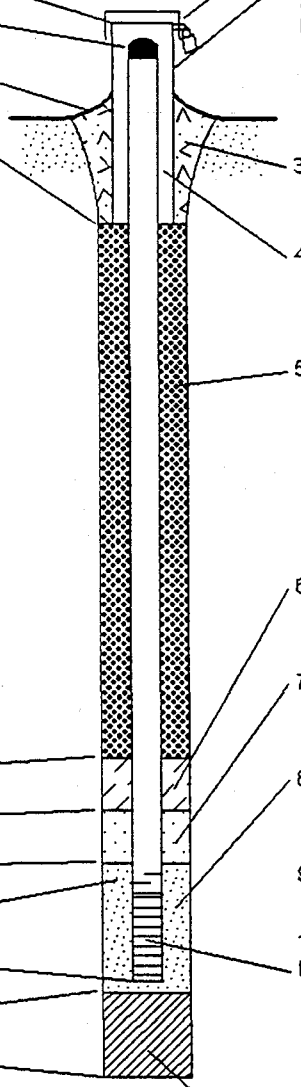
14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☒ 41
_____ Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe _____

17. Source of water *(attach analysis)*:
_____

E. Bentonite seal, top _____ ft. MSL or 1 ft.
F. Fine sand, top _____ ft. MSL or 3 ft.
G. Filter pack, top _____ ft. MSL or 3 ft.
H. Screen joint, top _____ ft. MSL or 3.5 ft.
I. Well bottom _____ ft. MSL or 8.5 ft.
J. Filter pack, bottom _____ ft. MSL or 8.5 ft.
K. Borehole, bottom _____ ft. MSL or 8.5 ft.
L. Borehole, diameter 8 in.
M. O.D. well casing 2.25 in.
N. I.D. well casing 2.049 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04
Flushmount Other ☒
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Locking Expandable Cap
3. Surface seal: Bentonite ☐ 30
Concrete ☒ 01
_____ Other ☐
4. Material between well casing and protective pipe:
Bentonite ☒ 30
Annular space seal ☐
_____ Other ☐
5. Annular space seal: a. Granular Bentonite ☐ 33
b. ____ Lbs/gal mud weight .....Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
d. ____ % Bentonite .....Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01
Tremie pumped ☐ 02
Gravity ☒ 08
6. Bentonite seal: a. Bentonite Granules ☐ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. 3/8" Chipped Bentonite Other ☒ x
7. Fine sand material: Manufacturer, product name and mesh size
a. _____
b. Volume added _____ ft^3
8. Filter pack material: Manufacturer, product name and mesh size
a. #30 Red Flint
b. Volume added 3.3 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
_____ Other ☐
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11
Continuous slot ☒ 01
_____ Other ☐
b. Manufacturer Diedrich
c. Slot size: 0.010 in.
d. Slotted length: 5 ft.
11. Backfill material (below filter pack): None ☒ 14
_____ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature *Karen D Berkman* Firm FISCHER ENVIRONMENTAL INC.

Please complete both sides of this form and return to the appropriate DNR office listted at the top of this form as required by chs. 144, 147 and 160 Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch. 144 Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147 Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route To: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4.90

Facility/Project Name	County Name	Well Name
Kaukauna Maintenance Garage/#398132.002	*Outagamie*	*MW-4*

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well Number
N/A	*45*	*N/A*	*N/A*

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☐ 81
surged with block and bailed	☐ 42
surged with block and pumped	☒ 82
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well *20 min.*

4. Depth of well (from top of well casing) *8.13 ft.*

5. Inside diameter of well *2.049 in.*

6. Volume of water in filter pack and well casing *3.44 gal.*

7. Volume of water removed from well *5 gal.*

8. Volume of water added (if any) *0 gal.*

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☒ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. *2.91 ft.*	*6.67 ft.*
Date *mm/dd/yy*	b. *4/17/98*	*4/17/98*
Time	c. *3:11* ☒ p.m. ☐ a.m.	*4:37* ☒ p.m. ☐ a.m.
12. Sediment in well bottom	*inches*	*inches*
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) *Extreme, Silty Dark Gray*	Clear ☐ 10 Turbid ☒ 15 (Describe) *Extreme, Silty Dark Gray*

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	*mg/l*	*mg/l*
15. COD	*mg/l*	*mg/l*

16. Additional comments on development:
Purged dry three times

Well developed by: Person's Name and Firm

Name: Jenny Diedrich

Firm: FISCHER ENVIRONMENTAL INC.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Karen A Buhaus

Print Initials: KAB

Firm: FISCHER ENVIRONMENTAL INC.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

GROUND-WATER LEVEL DATA SHEET

Project: Kaukauna Maintenance Garage Project Number: 398132.002

Measurements Taken By: FISCHER

Well No.	Date	Time	Depth to GW (Ft.)	TOC Reference Elevation (Ft.)	GW Elevation (Ft.)	Well Depth (Ft.)	Height of Water Column (Ft.)	Comments
MW-1	4/21/98	pm	3.67	95.86	92.19	9.57	5.90	
MW-2	4/21/98	pm	3.48	95.77	92.29	13.28	9.80	
MW-3	4/21/98	pm	4.11	96.57	92.46	8.76	4.65	
MW-4	4/21/98	pm	3.04	95.68	92.64	8.13	5.09	
MW-1	5/1/98	pm	4.05	95.86	91.81	9.57	5.52	
MW-2	5/1/98	pm	3.82	95.77	91.95	13.28	9.46	
MW-3	5/1/98	pm	4.46	96.57	92.11	8.76	4.30	
MW-4	5/1/98	pm	3.32	95.68	92.36	8.13	4.81	
MW-1	6/5/98	am	4.41	95.86	91.45	9.38	4.97	
MW-2	6/5/98	am	4.21	95.77	91.56	13.12	8.91	
MW-3	6/5/98	am	4.73	96.57	91.84	8.55	3.82	
MW-4	6/5/98	am	3.79	95.68	91.89	8.18	4.39	
MW-5*	8/28/98	am	4.13	95.65	91.52	17.38	13.25	Prior to development
MW-6	8/28/98	am	3.57	95.32	91.75	6.98	3.41	Prior to development
MW-1	9/16/98	pm	4.53	95.86	91.33	9.38	4.85	Well depth not measured
MW-2	9/16/98	pm	4.36	95.77	91.41	13.12	8.76	Well depth not measured
MW-3	9/16/98	pm	4.53	96.57	92.04	8.55	4.02	Well depth not measured
MW-4	9/16/98	pm	3.96	95.68	91.72	8.18	4.22	Well depth not measured
MW-5*	9/16/98	pm	4.135	95.65	91.515	17.38	13.245	Well depth not measured
MW-6	9/16/98	pm	3.64	95.32	91.68	6.98	3.34	Well depth not measured

Notes: All depths measured from Top of Casing (TOC). * = bedrock well

GW=ground water Ft. = feet

Elevations in feet in reference to benchmark with an assumed elevation of 100.

FISCHER ENVIRONMENTAL, INC.

P.O. Box 127, Kaukauna, WI 54130 Tel. (920) 766-2069 FAX (920) 759-2669

APPENDIX D

GROUND-WATER ANALYTICAL RESULTS

Company Name: Fischer Environmental
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: 920-766-2069
Project Number: 398132.002
Project Name: Kaukauna Maintenance Garage
Project Location: Kaukauna
Sampled By (Print): Jenny D

Regulatory Program (circle): UST RCRA CLP SDWA NPDES/WPDES CAA NR____ Other ____

NR720 Confirmation Analysis Required? (circle): Y N
(En Chem will not confirm unless otherwise instructed.)

EN CHEM INC.

☒ 1241 Bellevue St., Suite 9, Green Bay, WI 54302, 920-469-2436 • 1-800-736-2436, FAX 920-469-8827
☐ 802 Deming Way, Madison, WI 53717, 608-827-5501 • 1-888-536-2436, Fax: 608-827-5503
☐ 1423 N. 8th Street., Suite 122, Superior, WI 54880, 715-392-5844 • 1-800-837-8238, FAX 715-392-5843

(S) TN

CHAIN OF CUSTODY

17034

Page 1 of 1
P.O. # ____ Quote # ____
Mail Report To: Karen Burkman
Company: Fischer Environmental
Address: P.O. Box 127, Kaukauna WI 54130
Invoice To: John Sundelius
Company: City of Kaukauna
Address: c/o Fischer
Mail Invoice To: FISCHER

FILTERED? (YES/NO): N N Y N
PRESERVATION (CODE)*: B B D A

ANALYSES REQUESTED: PVOC, VOC, Dissolved Lead, PAH

SHADED AREA FOR LABORATORY USE ONLY

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	PVOC	VOC	Dissolved Lead	PAH	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
	MW-1	4/21/98	3:12	X						✓	3	[illegible]	001
	MW-2	↓	3:35		X	X				↓	3	[illegible]	002
	MW-3	↓	2:55		X	X				↓	↓		003
	MW-4	↓	4:00		X	X	X			↓	↓	1 L Amber	004
	DUP	↓	—	X						↓	3	[illegible]	005
	Trip Blank	↓	—							↓	1	[illegible]	006

*Preservation Code
A=None B=HCL C=H2SO4
D=HNO3 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:	
Jennifer A Diedrich	4-22-98	[signature]	4/22/98 0910	RDI
[signature]	4/22/98 1530			

En Chem Project No.: 88-2240
Sample Receipt Temp.: RDI
Sample Receipt pH (Wet/Metals):

EN CHEM INC.

1795 Industrial D
Green Bay, WI 54
920-469-24
800-7-ENCHE
FAX: 920-469-8

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 4/29/98

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
882240-001	MW-1	4/21/98			
882240-002	MW-2	4/21/98			
882240-003	MW-3	4/21/98			
882240-004	MW-4	4/21/98			
882240-005	DUP	4/21/98			
882240-006	TRIP BLANK	4/21/98			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

J. Duraceau — 4/29/98

Approval Signature — **Date**

ENCHEM INC.

1795 Industrial Dri
Green Bay, WI 543(
920-469-243
800-7-ENCHE
Fax: 920-469-882

Lab#:	TestGroupID:	Comment:
882240-006	8260+-W	Methylene chloride is present in the laboratory environment. Detects should be considered suspect.
TRIP BLANK		

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-1

Report Date : 4/24/98

Lab Sample Number : 882240-001

Collection Date : 4/21/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC - WATER — Prep Method: SW846 5030 — Prep Date: 4/23/98 — Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	102				%Recov		4/23/98	SW846 8260B
Dibromofluoromethane	100				%Recov		4/23/98	SW846 8260B
4-Bromofluorobenzene	99				%Recov		4/23/98	SW846 8260B
Benzene	< 0.27	0.27	0.86		ug/L		4/23/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		4/23/98	SW846 8260B
Methyl-tert-butyl-ether	6.4	0.32	1.0		ug/L		4/23/98	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		4/23/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		4/23/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		4/23/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		4/23/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		4/23/98	SW846 8260B

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-2

Report Date : 4/28/98

Lab Sample Number : 882240-002

Collection Date : 4/21/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead - Dissolved	< 1.6	1.6	5.1		ug/L		4/23/98	SW846 7421	SW846 7421	MSB

Organic Results

EPA 8260 VOLATILE LIST- WATER — Prep Method: SW846 5030 — Prep Date: 4/27/98 — Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	150	0.27	0.86		ug/L		4/27/98	SW846 8260B
Bromobenzene	< 0.83	0.83	2.6		ug/L		4/27/98	SW846 8260B
Bromochloromethane	< 0.42	0.42	1.3		ug/L		4/27/98	SW846 8260B
Bromodichloromethane	< 0.30	0.30	0.96		ug/L		4/27/98	SW846 8260B
Bromoform	< 0.44	0.44	1.4		ug/L		4/27/98	SW846 8260B
Bromomethane	< 0.70	0.70	2.2		ug/L		4/27/98	SW846 8260B
s-Butylbenzene	< 0.29	0.29	0.92		ug/L		4/27/98	SW846 8260B
t-Butylbenzene	< 0.32	0.32	1.0		ug/L		4/27/98	SW846 8260B
n-Butylbenzene	< 0.29	0.29	0.92		ug/L		4/27/98	SW846 8260B
Carbon tetrachloride	< 0.34	0.34	1.1		ug/L		4/27/98	SW846 8260B
Chloroform	< 0.35	0.35	1.1		ug/L		4/27/98	SW846 8260B
Chlorobenzene	< 0.23	0.23	0.73		ug/L		4/27/98	SW846 8260B
Chlorodibromomethane	< 0.42	0.42	1.3		ug/L		4/27/98	SW846 8260B
Chloroethane	< 0.54	0.54	1.7		ug/L		4/27/98	SW846 8260B
Chloromethane	< 0.61	0.61	1.9		ug/L		4/27/98	SW846 8260B
2-Chlorotoluene	< 0.31	0.31	0.99		ug/L		4/27/98	SW846 8260B
4-Chlorotoluene	< 0.32	0.32	1.0		ug/L		4/27/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 0.41	0.41	1.3		ug/L		4/27/98	SW846 8260B
1,2-Dibromoethane	< 0.39	0.39	1.2		ug/L		4/27/98	SW846 8260B
Dibromomethane	< 0.53	0.53	1.7		ug/L		4/27/98	SW846 8260B
1,3-Dichlorobenzene	< 0.34	0.34	1.1		ug/L		4/27/98	SW846 8260B
1,4-Dichlorobenzene	< 0.30	0.30	0.96		ug/L		4/27/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		4/27/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE
Project Number : 398132.002
Client : FISCHER ENVIRONMENTAL CONSULTING
Field ID : MW-2
Report Date : 4/28/98
Lab Sample Number : 882240-002
Collection Date : 4/21/98
WI DNR LAB ID : 405132750
Matrix Type : WATER

1,2-Dichlorobenzene	< 0.25	0.25	0.80	ug/L		4/27/98	SW846 8260B
1,1-Dichloroethene	< 0.43	0.43	1.4	ug/L		4/27/98	SW846 8260B
cis-1,2-Dichloroethene	< 0.28	0.28	0.89	ug/L		4/27/98	SW846 8260B
Dichlorodifluoromethane	< 0.47	0.47	1.5	ug/L		4/27/98	SW846 8260B
trans-1,2-Dichloroethene	< 0.79	0.79	2.5	ug/L		4/27/98	SW846 8260B
1,2-Dichloropropane	< 0.35	0.35	1.1	ug/L		4/27/98	SW846 8260B
1,1-Dichloroethane	< 0.35	0.35	1.1	ug/L		4/27/98	SW846 8260B
1,3-Dichloropropane	< 0.42	0.42	1.3	ug/L		4/27/98	SW846 8260B
2,2-Dichloropropane	< 0.36	0.36	1.1	ug/L		4/27/98	SW846 8260B
1,1-Dichloropropene	< 0.81	0.81	2.6	ug/L		4/27/98	SW846 8260B
cis-1,3-Dichloropropene	< 0.32	0.32	1.0	ug/L		4/27/98	SW846 8260B
trans-1,3-Dichloropropene	< 0.43	0.43	1.4	ug/L		4/27/98	SW846 8260B
Diisopropyl ether	< 0.55	0.55	1.8	ug/L		4/27/98	SW846 8260B
Ethylbenzene	11	0.32	1.0	ug/L		4/27/98	SW846 8260B
Fluorotrichloromethane	< 0.28	0.28	0.89	ug/L		4/27/98	SW846 8260B
Hexachlorobutadiene	< 0.62	0.62	2.0	ug/L		4/27/98	SW846 8260B
Isopropylbenzene	1.4	0.26	0.83	ug/L		4/27/98	SW846 8260B
p-Isopropyltoluene	< 0.24	0.24	0.76	ug/L		4/27/98	SW846 8260B
Methylene chloride	< 0.36	0.36	1.1	ug/L		4/27/98	SW846 8260B
Methyl-tert-butyl-ether	19	0.32	1.0	ug/L		4/27/98	SW846 8260B
Naphthalene	< 0.35	0.35	1.1	ug/L		4/27/98	SW846 8260B
n-Propylbenzene	1.2	0.76	2.4	ug/L	Q	4/27/98	SW846 8260B
Styrene	< 0.17	0.17	0.54	ug/L		4/27/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 0.69	0.69	2.2	ug/L		4/27/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 0.70	0.70	2.2	ug/L		4/27/98	SW846 8260B
Tetrachloroethene	< 0.43	0.43	1.4	ug/L		4/27/98	SW846 8260B
Toluene	5.5	0.27	0.86	ug/L		4/27/98	SW846 8260B
1,2,3-Trichlorobenzene	< 0.47	0.47	1.5	ug/L		4/27/98	SW846 8260B
1,2,4-Trichlorobenzene	< 0.27	0.27	0.86	ug/L		4/27/98	SW846 8260B
1,1,1-Trichloroethane	< 0.30	0.30	0.96	ug/L		4/27/98	SW846 8260B
1,1,2-Trichloroethane	< 0.61	0.61	1.9	ug/L		4/27/98	SW846 8260B
1,2,4-Trimethylbenzene	3.7	0.22	0.70	ug/L		4/27/98	SW846 8260B
Trichloroethene	< 0.37	0.37	1.2	ug/L		4/27/98	SW846 8260B
1,2,3-Trichloropropane	< 0.75	0.75	2.4	ug/L		4/27/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86	ug/L		4/27/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-2 **Report Date :** 4/28/98

Lab Sample Number : 882240-002 **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

Vinyl chloride	<	0.20	0.20	0.64	ug/L	4/27/98	SW846 8260B
Xylenes, -m, -p		8.6	0.43	1.4	ug/L	4/27/98	SW846 8260B
Xylene, -o		0.78	0.24	0.76	ug/L	4/27/98	SW846 8260B
4-Bromofluorobenzene		96			%Recov	4/27/98	SW846 8260B
Dibromofluoromethane		98			%Recov	4/27/98	SW846 8260B
Toluene-d8		102			%Recov	4/27/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-3

Report Date : 4/24/98

Lab Sample Number : 882240-003

Collection Date : 4/21/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead - Dissolved	< 1.6	1.6	5.1		ug/L		4/23/98	SW846 7421	SW846 7421	MSB

Organic Results

EPA 8260 VOLATILE LIST- WATER Prep Method: SW846 5030 Prep Date: 4/23/98 Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		4/23/98	SW846 8260B
Bromobenzene	< 0.83	0.83	2.6		ug/L		4/23/98	SW846 8260B
Bromochloromethane	< 0.42	0.42	1.3		ug/L		4/23/98	SW846 8260B
Bromodichloromethane	< 0.30	0.30	0.96		ug/L		4/23/98	SW846 8260B
Bromoform	< 0.44	0.44	1.4		ug/L		4/23/98	SW846 8260B
Bromomethane	< 0.70	0.70	2.2		ug/L		4/23/98	SW846 8260B
s-Butylbenzene	< 0.29	0.29	0.92		ug/L		4/23/98	SW846 8260B
t-Butylbenzene	< 0.32	0.32	1.0		ug/L		4/23/98	SW846 8260B
n-Butylbenzene	< 0.29	0.29	0.92		ug/L		4/23/98	SW846 8260B
Carbon tetrachloride	< 0.34	0.34	1.1		ug/L		4/23/98	SW846 8260B
Chloroform	< 0.35	0.35	1.1		ug/L		4/23/98	SW846 8260B
Chlorobenzene	< 0.23	0.23	0.73		ug/L		4/23/98	SW846 8260B
Chlorodibromomethane	< 0.42	0.42	1.3		ug/L		4/23/98	SW846 8260B
Chloroethane	< 0.54	0.54	1.7		ug/L		4/23/98	SW846 8260B
Chloromethane	< 0.61	0.61	1.9		ug/L		4/23/98	SW846 8260B
2-Chlorotoluene	< 0.31	0.31	0.99		ug/L		4/23/98	SW846 8260B
4-Chlorotoluene	< 0.32	0.32	1.0		ug/L		4/23/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 0.41	0.41	1.3		ug/L		4/23/98	SW846 8260B
1,2-Dibromoethane	< 0.39	0.39	1.2		ug/L		4/23/98	SW846 8260B
Dibromomethane	< 0.53	0.53	1.7		ug/L		4/23/98	SW846 8260B
1,3-Dichlorobenzene	< 0.34	0.34	1.1		ug/L		4/23/98	SW846 8260B
1,4-Dichlorobenzene	< 0.30	0.30	0.96		ug/L		4/23/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		4/23/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-3 **Report Date :** 4/24/98

Lab Sample Number : 882240-003 **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

1,2-Dichlorobenzene	< 0.25	0.25	0.80	ug/L	4/23/98	SW846 8260B
1,1-Dichloroethene	< 0.43	0.43	1.4	ug/L	4/23/98	SW846 8260B
cis-1,2-Dichloroethene	< 0.28	0.28	0.89	ug/L	4/23/98	SW846 8260B
Dichlorodifluoromethane	< 0.47	0.47	1.5	ug/L	4/23/98	SW846 8260B
trans-1,2-Dichloroethene	< 0.79	0.79	2.5	ug/L	4/23/98	SW846 8260B
1,2-Dichloropropane	< 0.35	0.35	1.1	ug/L	4/23/98	SW846 8260B
1,1-Dichloroethane	< 0.35	0.35	1.1	ug/L	4/23/98	SW846 8260B
1,3-Dichloropropane	< 0.42	0.42	1.3	ug/L	4/23/98	SW846 8260B
2,2-Dichloropropane	< 0.36	0.36	1.1	ug/L	4/23/98	SW846 8260B
1,1-Dichloropropene	< 0.81	0.81	2.6	ug/L	4/23/98	SW846 8260B
cis-1,3-Dichloropropene	< 0.32	0.32	1.0	ug/L	4/23/98	SW846 8260B
trans-1,3-Dichloropropene	< 0.43	0.43	1.4	ug/L	4/23/98	SW846 8260B
Diisopropyl ether	< 0.55	0.55	1.8	ug/L	4/23/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0	ug/L	4/23/98	SW846 8260B
Fluorotrichloromethane	< 0.28	0.28	0.89	ug/L	4/23/98	SW846 8260B
Hexachlorobutadiene	< 0.62	0.62	2.0	ug/L	4/23/98	SW846 8260B
Isopropylbenzene	< 0.26	0.26	0.83	ug/L	4/23/98	SW846 8260B
p-Isopropyltoluene	< 0.24	0.24	0.76	ug/L	4/23/98	SW846 8260B
Methylene chloride	< 0.36	0.36	1.1	ug/L	4/23/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0	ug/L	4/23/98	SW846 8260B
Naphthalene	< 0.35	0.35	1.1	ug/L	4/23/98	SW846 8260B
n-Propylbenzene	< 0.76	0.76	2.4	ug/L	4/23/98	SW846 8260B
Styrene	< 0.17	0.17	0.54	ug/L	4/23/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 0.69	0.69	2.2	ug/L	4/23/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 0.70	0.70	2.2	ug/L	4/23/98	SW846 8260B
Tetrachloroethene	< 0.43	0.43	1.4	ug/L	4/23/98	SW846 8260B
Toluene	< 0.27	0.27	0.86	ug/L	4/23/98	SW846 8260B
1,2,3-Trichlorobenzene	< 0.47	0.47	1.5	ug/L	4/23/98	SW846 8260B
1,2,4-Trichlorobenzene	< 0.27	0.27	0.86	ug/L	4/23/98	SW846 8260B
1,1,1-Trichloroethane	< 0.30	0.30	0.96	ug/L	4/23/98	SW846 8260B
1,1,2-Trichloroethane	< 0.61	0.61	1.9	ug/L	4/23/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70	ug/L	4/23/98	SW846 8260B
Trichloroethene	< 0.37	0.37	1.2	ug/L	4/23/98	SW846 8260B
1,2,3-Trichloropropane	< 0.75	0.75	2.4	ug/L	4/23/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86	ug/L	4/23/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-3

Report Date : 4/24/98

Lab Sample Number : 882240-003

Collection Date : 4/21/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Vinyl chloride	< 0.20	0.20	0.64	ug/L	4/23/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4	ug/L	4/23/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76	ug/L	4/23/98	SW846 8260B
4-Bromofluorobenzene	100			%Recov	4/23/98	SW846 8260B
Dibromofluoromethane	100			%Recov	4/23/98	SW846 8260B
Toluene-d8	104			%Recov	4/23/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-4

Report Date : 4/28/98

Lab Sample Number : 882240-004

Collection Date : 4/21/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead - Dissolved	< 1.6	1.6	5.1		ug/L		4/23/98	SW846 7421	SW846 7421	MSB

Organic Results

EPA 8260 VOLATILE LIST- WATER — Prep Method: SW846 5030 — Prep Date: 4/27/98 — Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	2400	5.4	17		ug/L		4/27/98	SW846 8260B
Bromobenzene	< 17	17	54		ug/L		4/27/98	SW846 8260B
Bromochloromethane	< 8.4	8.4	27		ug/L		4/27/98	SW846 8260B
Bromodichloromethane	< 6.0	6.0	19		ug/L		4/27/98	SW846 8260B
Bromoform	< 8.8	8.8	28		ug/L		4/27/98	SW846 8260B
Bromomethane	< 14	14	45		ug/L		4/27/98	SW846 8260B
s-Butylbenzene	11	5.8	18		ug/L	Q	4/27/98	SW846 8260B
t-Butylbenzene	< 6.4	6.4	20		ug/L		4/27/98	SW846 8260B
n-Butylbenzene	23	5.8	18		ug/L		4/27/98	SW846 8260B
Carbon tetrachloride	< 6.8	6.8	22		ug/L		4/27/98	SW846 8260B
Chloroform	< 7.0	7.0	22		ug/L		4/27/98	SW846 8260B
Chlorobenzene	< 4.6	4.6	15		ug/L		4/27/98	SW846 8260B
Chlorodibromomethane	< 8.4	8.4	27		ug/L		4/27/98	SW846 8260B
Chloroethane	< 11	11	35		ug/L		4/27/98	SW846 8260B
Chloromethane	< 12	12	38		ug/L		4/27/98	SW846 8260B
2-Chlorotoluene	< 6.2	6.2	20		ug/L		4/27/98	SW846 8260B
4-Chlorotoluene	< 6.4	6.4	20		ug/L		4/27/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 8.2	8.2	26		ug/L		4/27/98	SW846 8260B
1,2-Dibromoethane	< 7.8	7.8	25		ug/L		4/27/98	SW846 8260B
Dibromomethane	< 11	11	35		ug/L		4/27/98	SW846 8260B
1,3-Dichlorobenzene	< 6.8	6.8	22		ug/L		4/27/98	SW846 8260B
1,4-Dichlorobenzene	< 6.0	6.0	19		ug/L		4/27/98	SW846 8260B
1,2-Dichloroethane	< 7.4	7.4	24		ug/L		4/27/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-4 **Report Date :** 4/28/98

Lab Sample Number : 882240-004 **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

1,2-Dichlorobenzene	< 5.0	5.0	16	ug/L		4/27/98	SW846 8260B
1,1-Dichloroethene	< 8.6	8.6	27	ug/L		4/27/98	SW846 8260B
cis-1,2-Dichloroethene	< 5.6	5.6	18	ug/L		4/27/98	SW846 8260B
Dichlorodifluoromethane	< 9.4	9.4	30	ug/L		4/27/98	SW846 8260B
trans-1,2-Dichloroethene	< 16	16	51	ug/L		4/27/98	SW846 8260B
1,2-Dichloropropane	< 7.0	7.0	22	ug/L		4/27/98	SW846 8260B
1,1-Dichloroethane	< 7.0	7.0	22	ug/L		4/27/98	SW846 8260B
1,3-Dichloropropane	< 8.4	8.4	27	ug/L		4/27/98	SW846 8260B
2,2-Dichloropropane	< 7.2	7.2	23	ug/L		4/27/98	SW846 8260B
1,1-Dichloropropene	< 16	16	51	ug/L		4/27/98	SW846 8260B
cis-1,3-Dichloropropene	< 6.4	6.4	20	ug/L		4/27/98	SW846 8260B
trans-1,3-Dichloropropene	< 8.6	8.6	27	ug/L		4/27/98	SW846 8260B
Diisopropyl ether	< 11	11	35	ug/L		4/27/98	SW846 8260B
Ethylbenzene	560	6.4	20	ug/L		4/27/98	SW846 8260B
Fluorotrichloromethane	< 5.6	5.6	18	ug/L		4/27/98	SW846 8260B
Hexachlorobutadiene	< 12	12	38	ug/L		4/27/98	SW846 8260B
Isopropylbenzene	43	5.2	17	ug/L		4/27/98	SW846 8260B
p-Isopropyltoluene	7.0	4.8	15	ug/L	Q	4/27/98	SW846 8260B
Methylene chloride	< 7.2	7.2	23	ug/L		4/27/98	SW846 8260B
Methyl-tert-butyl-ether	15	6.4	20	ug/L	Q	4/27/98	SW846 8260B
Naphthalene	130	7.0	22	ug/L		4/27/98	SW846 8260B
n-Propylbenzene	110	15	48	ug/L		4/27/98	SW846 8260B
Styrene	< 3.4	3.4	11	ug/L		4/27/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 14	14	45	ug/L		4/27/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 14	14	45	ug/L		4/27/98	SW846 8260B
Tetrachloroethene	< 8.6	8.6	27	ug/L		4/27/98	SW846 8260B
Toluene	67	5.4	17	ug/L		4/27/98	SW846 8260B
1,2,3-Trichlorobenzene	< 9.4	9.4	30	ug/L		4/27/98	SW846 8260B
1,2,4-Trichlorobenzene	< 5.4	5.4	17	ug/L		4/27/98	SW846 8260B
1,1,1-Trichloroethane	< 6.0	6.0	19	ug/L		4/27/98	SW846 8260B
1,1,2-Trichloroethane	< 12	12	38	ug/L		4/27/98	SW846 8260B
1,2,4-Trimethylbenzene	660	4.4	14	ug/L		4/27/98	SW846 8260B
Trichloroethene	< 7.4	7.4	24	ug/L		4/27/98	SW846 8260B
1,2,3-Trichloropropane	< 15	15	48	ug/L		4/27/98	SW846 8260B
1,3,5-Trimethylbenzene	160	5.4	17	ug/L		4/27/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-4 **Report Date :** 4/28/98

Lab Sample Number : 882240-004 **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

Vinyl chloride	< 4.0	4.0	13	ug/L	4/27/98	SW846 8260B
Xylenes, -m, -p	1700	8.6	27	ug/L	4/27/98	SW846 8260B
Xylene, -o	41	4.8	15	ug/L	4/27/98	SW846 8260B
4-Bromofluorobenzene	98			%Recov	4/27/98	SW846 8260B
Dibromofluoromethane	99			%Recov	4/27/98	SW846 8260B
Toluene-d8	103			%Recov	4/27/98	SW846 8260B

Organic Results

PAH (HPLC) LIST - SEMIVOLATILES Prep Method: SW846 3510 Prep Date: 4/23/98 Analyst: ARO

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	< 9.4	9.4	30		ug/L		4/27/98	SW846 8310
Acenaphthylene	< 8.2	8.2	26		ug/L		4/27/98	SW846 8310
Anthracene	< 0.42	0.42	1.3		ug/L		4/27/98	SW846 8310
Benzo(a)anthracene	< 0.28	0.28	0.89		ug/L		4/27/98	SW846 8310
Benzo(a)pyrene	< 0.30	0.30	0.96		ug/L		4/27/98	SW846 8310
Benzo(b)fluoranthene	< 0.30	0.30	0.96		ug/L		4/27/98	SW846 8310
Benzo(g,h,i)perylene	< 0.42	0.42	1.3		ug/L		4/27/98	SW846 8310
Benzo(k)fluoranthene	< 0.18	0.18	0.57		ug/L		4/27/98	SW846 8310
Chrysene	< 0.32	0.32	1.0		ug/L		4/27/98	SW846 8310
Dibenzo(a,h)anthracene	< 0.40	0.40	1.3		ug/L		4/27/98	SW846 8310
Fluoranthene	< 0.30	0.30	0.96		ug/L		4/27/98	SW846 8310
Fluorene	2.0	1.2	3.8		ug/L	Q	4/27/98	SW846 8310
Indeno(1,2,3-cd)pyrene	< 0.50	0.50	1.6		ug/L		4/27/98	SW846 8310
1-Methylnaphthalene	30	7.2	23		ug/L		4/27/98	SW846 8310
2-Methylnaphthalene	41	7.2	23		ug/L		4/27/98	SW846 8310
Naphthalene	60	8.4	27		ug/L		4/27/98	SW846 8310
Phenanthrene	15	1.8	5.7		ug/L		4/27/98	SW846 8310
Pyrene	< 0.34	0.34	1.1		ug/L		4/27/98	SW846 8310
9,10-Diphenylanthracene	73.6				%Recov		4/27/98	SW846 8310

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE
Project Number : 398132.002
Field ID : DUP
Lab Sample Number : 882240-005
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 4/24/98
Collection Date : 4/21/98
Matrix Type : WATER

Organic Results

PVOC - WATER — Prep Method: SW846 5030 — Prep Date: 4/23/98 — Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	103				%Recov		4/23/98	SW846 8260B
Dibromofluoromethane	100				%Recov		4/23/98	SW846 8260B
4-Bromofluorobenzene	99				%Recov		4/23/98	SW846 8260B
Benzene	150	0.27	0.86		ug/L		4/23/98	SW846 8260B
Ethylbenzene	11	0.32	1.0		ug/L		4/23/98	SW846 8260B
Methyl-tert-butyl-ether	21	0.32	1.0		ug/L		4/23/98	SW846 8260B
Toluene	5.3	0.27	0.86		ug/L		4/23/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		4/23/98	SW846 8260B
1,2,4-Trimethylbenzene	3.7	0.22	0.70		ug/L		4/23/98	SW846 8260B
Xylenes, -m, -p	8.5	0.43	1.4		ug/L		4/23/98	SW846 8260B
Xylene, -o	0.81	0.24	0.76		ug/L		4/23/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 | **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK | **Report Date :** 4/24/98

Lab Sample Number : 882240-006 | **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 | **Matrix Type :** WATER

Organic Results

EPA 8260 VOLATILE LIST- WATER | Prep Method: SW846 5030 | Prep Date: 4/23/98 | Analyst: HW

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		4/23/98	SW846 8260B
Bromobenzene	< 0.83	0.83	2.6		ug/L		4/23/98	SW846 8260B
Bromochloromethane	< 0.42	0.42	1.3		ug/L		4/23/98	SW846 8260B
Bromodichloromethane	< 0.30	0.30	0.96		ug/L		4/23/98	SW846 8260B
Bromoform	< 0.44	0.44	1.4		ug/L		4/23/98	SW846 8260B
Bromomethane	< 0.70	0.70	2.2		ug/L		4/23/98	SW846 8260B
s-Butylbenzene	< 0.29	0.29	0.92		ug/L		4/23/98	SW846 8260B
t-Butylbenzene	< 0.32	0.32	1.0		ug/L		4/23/98	SW846 8260B
n-Butylbenzene	< 0.29	0.29	0.92		ug/L		4/23/98	SW846 8260B
Carbon tetrachloride	< 0.34	0.34	1.1		ug/L		4/23/98	SW846 8260B
Chloroform	< 0.35	0.35	1.1		ug/L		4/23/98	SW846 8260B
Chlorobenzene	< 0.23	0.23	0.73		ug/L		4/23/98	SW846 8260B
Chlorodibromomethane	< 0.42	0.42	1.3		ug/L		4/23/98	SW846 8260B
Chloroethane	< 0.54	0.54	1.7		ug/L		4/23/98	SW846 8260B
Chloromethane	< 0.61	0.61	1.9		ug/L		4/23/98	SW846 8260B
2-Chlorotoluene	< 0.31	0.31	0.99		ug/L		4/23/98	SW846 8260B
4-Chlorotoluene	< 0.32	0.32	1.0		ug/L		4/23/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 0.41	0.41	1.3		ug/L		4/23/98	SW846 8260B
1,2-Dibromoethane	< 0.39	0.39	1.2		ug/L		4/23/98	SW846 8260B
Dibromomethane	< 0.53	0.53	1.7		ug/L		4/23/98	SW846 8260B
1,3-Dichlorobenzene	< 0.34	0.34	1.1		ug/L		4/23/98	SW846 8260B
1,4-Dichlorobenzene	< 0.30	0.30	0.96		ug/L		4/23/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		4/23/98	SW846 8260B
1,2-Dichlorobenzene	< 0.25	0.25	0.80		ug/L		4/23/98	SW846 8260B
1,1-Dichloroethene	< 0.43	0.43	1.4		ug/L		4/23/98	SW846 8260B
cis-1,2-Dichloroethene	< 0.28	0.28	0.89		ug/L		4/23/98	SW846 8260B
Dichlorodifluoromethane	< 0.47	0.47	1.5		ug/L		4/23/98	SW846 8260B
trans-1,2-Dichloroethene	< 0.79	0.79	2.5		ug/L		4/23/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK **Report Date :** 4/24/98

Lab Sample Number : 882240-006 **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

1,2-Dichloropropane	< 0.35	0.35	1.1	ug/L		4/23/98	SW846 8260B
1,1-Dichloroethane	< 0.35	0.35	1.1	ug/L		4/23/98	SW846 8260B
1,3-Dichloropropane	< 0.42	0.42	1.3	ug/L		4/23/98	SW846 8260B
2,2-Dichloropropane	< 0.36	0.36	1.1	ug/L		4/23/98	SW846 8260B
1,1-Dichloropropene	< 0.81	0.81	2.6	ug/L		4/23/98	SW846 8260B
cis-1,3-Dichloropropene	< 0.32	0.32	1.0	ug/L		4/23/98	SW846 8260B
trans-1,3-Dichlcropropene	< 0.43	0.43	1.4	ug/L		4/23/98	SW846 8260B
Diisopropyl ether	< 0.55	0.55	1.8	ug/L		4/23/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0	ug/L		4/23/98	SW846 8260B
Fluorotrichloromethane	< 0.28	0.28	0.89	ug/L		4/23/98	SW846 8260B
Hexachlorobutadiene	< 0.62	0.62	2.0	ug/L		4/23/98	SW846 8260B
Isopropylbenzene	< 0.26	0.26	0.83	ug/L		4/23/98	SW846 8260B
p-Isopropyltoluene	< 0.24	0.24	0.76	ug/L		4/23/98	SW846 8260B
Methylene chloride	0.46	0.36	1.1	ug/L	Q	4/23/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0	ug/L		4/23/98	SW846 8260B
Naphthalene	< 0.35	0.35	1.1	ug/L		4/23/98	SW846 8260B
n-Propylbenzene	< 0.76	0.76	2.4	ug/L		4/23/98	SW846 8260B
Styrene	< 0.17	0.17	0.54	ug/L		4/23/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 0.69	0.69	2.2	ug/L		4/23/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 0.70	0.70	2.2	ug/L		4/23/98	SW846 8260B
Tetrachloroethene	< 0.43	0.43	1.4	ug/L		4/23/98	SW846 8260B
Toluene	< 0.27	0.27	0.86	ug/L		4/23/98	SW846 8260B
1,2,3-Trichlorobenzene	< 0.47	0.47	1.5	ug/L		4/23/98	SW846 8260B
1,2,4-Trichlorobenzene	< 0.27	0.27	0.86	ug/L		4/23/98	SW846 8260B
1,1,1-Trichloroethane	< 0.30	0.30	0.96	ug/L		4/23/98	SW846 8260B
1,1,2-Trichloroethane	< 0.61	0.61	1.9	ug/L		4/23/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70	ug/L		4/23/98	SW846 8260B
Trichloroethene	< 0.37	0.37	1.2	ug/L		4/23/98	SW846 8260B
1,2,3-Trichloropropane	< 0.75	0.75	2.4	ug/L		4/23/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86	ug/L		4/23/98	SW846 8260B
Vinyl chloride	< 0.20	0.20	0.64	ug/L		4/23/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4	ug/L		4/23/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76	ug/L		4/23/98	SW846 8260B
4-Bromofluorobenzene	77			%Recov		4/23/98	SW846 8260B
Dibromofluoromethane	77			%Recov		4/23/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK **Report Date :** 4/24/98

Lab Sample Number : 882240-006 **Collection Date :** 4/21/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

Toluene-d8	79	%Recov	4/23/98	SW846 8260B

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Page 1 of 1

P.O. # 98-0577 Quote #

Company Name: Fischer Environmental
Branch or Location: Ripon
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.002
Project Name: Kaukauna Maintenance Garage
Project Location: Kaukauna WI
Sampled By (Print): Brian V Greg R

Regulatory Program (circle): (UST) RCRA CLP SDWA
NPDES/WPDES CAA NR____
Other

NR720 Confirmation Analysis Required? (circle): (Y) N
(En Chem will not confirm unless otherwise instructed.)

Mail Report To: Karen Burkman
Company: Fischer Environmental
Address: P.O. Box 127
Kaukauna WI 54130-2404
Invoice To: Kaukauna Maintenance Garage
Company: Kaukauna Maintenance Garage
Address: C/o Fischer
Mail Invoice To: Karen Burkman

FIELD ID*	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME	FILTERED? (YES/NO)	PRESERVATION (CODE)*	ANALYSES REQUESTED: PVOC	1,2 DCA	Naphthalene	FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
	MW-1	6-5-98		N	B	✓	✓		N/A	GW		3	40ml	-001
	MW-2			N	B	✓								-002
	MW-3			N	B	✓								-003
	MW-4			N	B	✓	✓							-004
	Dup			N	B	✓								-005
	Trip Blank			N	B	✓						1	40ml	-006

SHADED AREA FOR LABORATORY USE ONLY

*Preservation Code
A=None B=HCL C=H2SO4
D=HN03 E=EnCore F=Methanol**
G=NaOH O=Other (Indicate)

**If not using En Chem's methanol, indicate volume of methanol added and mark the appropriate samples.

Relinquished By:	Date/Time:	Received By:	Date/Time:
Brian Youngquist	6/8/98 9:30 AM	B Kemper	6/8/98 1040
B Kemper	6/8/98 1215	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By (En Chem):	Date/Time: 6/8/98 12:15

En Chem Project No. 883318
Sample Receipt Temp: R-01
Sample Receipt pH (Wet/Metals)

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 6/11/98

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
883318-001	MW-1	6/5/98			
883318-002	MW-2	6/5/98			
883318-003	MW-3	6/5/98			
883318-004	MW-4	6/5/98			
883318-005	DUP	6/5/98			
883318-006	TRIP BLANK	6/5/98			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

J. Duraceau — 6/11/98

Approval Signature — **Date**

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Field ID : MW-1

Lab Sample Number : 883318-001

WI DNR LAB ID : 405132750

Client : FISCHER ENVIRONMENTAL CONSULTING

Report Date : 6/10/98

Collection Date : 6/5/98

Matrix Type : WATER

Organic Results

PVOC + 1,2-DICHLOROETHANE - WATER **Prep Method:** SW846 5030 **Prep Date:** **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,2-Dichloroethane	4.0	0.37	1.2		ug/L		6/9/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		6/9/98	SW846 8260B
Methyl-tert-butyl-ether	6.7	0.32	1.0		ug/L		6/9/98	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		6/9/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		6/9/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		6/9/98	SW846 8260B
Dibromofluoromethane	120				%Recov		6/9/98	SW846 8260B
Toluene-d8	115				%Recov		6/9/98	SW846 8260B
4-Bromofluorobenzene	103				%Recov		6/9/98	SW846 8260B

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Project Name : KAUKAUNA MAINTENANCE GARAGE
Project Number : 398132.002
Client : FISCHER ENVIRONMENTAL CONSULTING
Field ID : MW-2
Report Date : 6/10/98
Lab Sample Number : 883318-002
Collection Date : 6/5/98
WI DNR LAB ID : 405132750
Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030 **Prep Date:** **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	115				%Recov		6/9/98	SW846 8260B
Dibromofluoromethane	116				%Recov		6/9/98	SW846 8260B
4-Bromofluorobenzene	107				%Recov		6/9/98	SW846 8260B
Benzene	170	0.27	0.86		ug/L		6/9/98	SW846 8260B
Ethylbenzene	38	0.32	1.0		ug/L		6/9/98	SW846 8260B
Methyl-tert-butyl-ether	17	0.32	1.0		ug/L		6/9/98	SW846 8260B
Toluene	1.9	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,3,5-Trimethylbenzene	0.32	0.27	0.86		ug/L	Q	6/9/98	SW846 8260B
1,2,4-Trimethylbenzene	15	0.22	0.70		ug/L		6/9/98	SW846 8260B
Xylenes, -m, -p	26	0.43	1.4		ug/L		6/9/98	SW846 8260B
Xylene, -o	0.37	0.24	0.76		ug/L	Q	6/9/98	SW846 8260B

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Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-3 **Report Date :** 6/10/98

Lab Sample Number : 883318-003 **Collection Date :** 6/5/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030 **Prep Date:** **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	115				%Recov		6/9/98	SW846 8260B
Dibromofluoromethane	118				%Recov		6/9/98	SW846 8260B
4-Bromofluorobenzene	104				%Recov		6/9/98	SW846 8260B
Benzene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		6/9/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0		ug/L		6/9/98	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		6/9/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		6/9/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		6/9/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-4

Report Date : 6/10/98

Lab Sample Number : 883318-004

Collection Date : 6/5/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC + NAPHT - WATER **Prep Method:** SW846 5030 **Prep Date:** 6/9/98 **Analyst:** EGS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	101				%Recov		6/10/98	MOD 8021B
Benzene	2300	6.5	21		ug/l		6/10/98	MOD 8021B
Ethylbenzene	470	6.0	19		ug/l		6/10/98	MOD 8021B
Methyl-tert-butyl-ether	20	5.5	18		ug/l		6/10/98	MOD 8021B
Naphthalene	110	22	70		ug/l		6/10/98	MOD 8021B
Toluene	58	5.2	17		ug/l		6/10/98	MOD 8021B
1,3,5-Trimethylbenzene	110	14	45		ug/l		6/10/98	MOD 8021B
1,2,4-Trimethylbenzene	480	22	70		ug/l		6/10/98	MOD 8021B
Xylenes, -m, -p	1300	24	76		ug/l		6/10/98	MOD 8021B
Xylene, -o	40	9.2	29		ug/l		6/10/98	MOD 8021B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : DUP

Report Date : 6/10/98

Lab Sample Number : 883318-005

Collection Date : 6/5/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC - WATER **Prep Method:** SW846 5030 **Prep Date:** **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	115				%Recov		6/9/98	SW846 8260B
Dibromofluoromethane	112				%Recov		6/9/98	SW846 8260B
4-Bromofluorobenzene	105				%Recov		6/9/98	SW846 8260B
Benzene	2200	6.8	22		ug/L		6/9/98	SW846 8260B
Ethylbenzene	420	8.0	25		ug/L		6/9/98	SW846 8260B
Methyl-tert-butyl-ether	< 8.0	8.0	25		ug/L		6/9/98	SW846 8260B
Toluene	49	6.8	22		ug/L		6/9/98	SW846 8260B
1,3,5-Trimethylbenzene	92	6.8	22		ug/L		6/9/98	SW846 8260B
1,2,4-Trimethylbenzene	410	5.5	18		ug/L		6/9/98	SW846 8260B
Xylenes, -m, -p	1100	11	35		ug/L		6/9/98	SW846 8260B
Xylene, -o	25	6.0	19		ug/L		6/9/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK

Report Date : 6/10/98

Lab Sample Number : 883318-006

Collection Date : 6/5/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

PVOC + NAPHTHALENE - WATER **Prep Method:** SW846 5030 **Prep Date:** **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Toluene-d8	116				%Recov		6/9/98	SW846 8260B
Dibromofluoromethane	116				%Recov		6/9/98	SW846 8260B
4-Bromofluorobenzene	105				%Recov		6/9/98	SW846 8260B
Benzene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0		ug/L		6/9/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0		ug/L		6/9/98	SW846 8260B
Toluene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		6/9/98	SW846 8260B
Naphthalene	< 0.35	0.35	1.1		ug/L		6/9/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70		ug/L		6/9/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86		ug/L		6/9/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4		ug/L		6/9/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76		ug/L		6/9/98	SW846 8260B

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525 Science Drive, Madison, WI 53711, 608-232-3300 • 1-888-536-2436, FAX: 608-233-0502
1423 N. 8th Street, Suite 122, Superior, WI 54880, 715-392-5844 • 1-800-837-8238, FAX 715-392-5843

CHAIN OF CUSTODY

29956

Page 1 of 1

Company Name: Fischer Environmental
Branch or Location: Kaukauna
Project Contact: Karen Burkman
Telephone: (920) 766-2069
Project Number: 398132.002
Project Name: Kaukauna Maintenance Garage
Project Location: Kaukauna, WI.
Sampled By (Print): Shad W. / Brian Y.
Regulatory Program (circle): UST RCRA CLP SDWA NPDES/WPDES CAA NR
Other
R720 Confirmation Analysis Required? (circle) Y N
(En Chem will not confirm unless otherwise instructed.)

P.O. # Quote #
Mail Report To: Karen Burkman
Company: Fischer Env. Con.
Address: P.O. Box 127, Kaukauna, WI. 54130-2064
Invoice To: Karen Burkman
Company: Fischer Env. Con.
Address: Same
Mail Invoice To: Karen Burkman

FILTERED? (YES/NO) N Y
PRESERVATION (CODE)* B O
ANALYSES REQUESTED: VOC, Lead

FIELD ID	SAMPLE DESCRIPTION	COLLECTION DATE	COLLECTION TIME			FIELD SCREEN	MATRIX	GOOD COND.	TOTAL BOTTLES	COMMENTS	LABORATORY NUMBER
MW-5	Monitoring Well #5	8/31/98	1pm	X	X	NA	GW	X	3-40mL 1-250mL		001
MW-6	↓ #6	↓	↓	↓	↓	↓	↓	↓	↓		002
Trip Bl.	Trip Blank	↓	↓	↓	↓	↓	↓	↓	1-40mL		003

SHADED AREA FOR LABORATORY USE ONLY

*Preservation Code: A=None, B=HCL, C=H2SO4, D=HNO3, E=EnCore, F=Methanol**, G=NaOH, O=Other (indicate)
**If not using En Chem's methanol, indicate volume of methanol added and

Relinquished By:	Date/Time:	Received By:	Date/Time:
Brian Youngbauer	9/2/98	Ken Wachsmuth for	9/2/98 10:30
Ken Wachsmuth	9/2/98 1600		
		Received By (En Chem):	

En Chem Project No.: 885215
Sample Receipt Temp.: Not
Sample Receipt pH (Wet/Metals):

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800-7-ENCH
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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client: FISCHER ENVIRONMENTAL CONSU

WI DNR LAB ID : 405132750

Report Date : 9/10/98

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
885215-001	MW-5	8/31/98			
885215-002	MW-6	8/31/98			
885215-003	TRIP BLANK	8/31/98			

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample narrative. Release of this final report is authorized by Laboratory management, as is verified by the following signature.

J. Duraceau — 9/10/98

Approval Signature — Date

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-5

Report Date : 9/8/98

Lab Sample Number : 885215-001

Collection Date : 8/31/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead - Dissolved	< 1.6	1.6	5.1		ug/L		9/3/98	SW846 7421	SW846 7421	MSB

Organic Results

EPA 8260 VOLATILE LIST- WATER Prep Method: SW846 5030 Prep Date: 9/4/98 Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	5.5	0.27	0.86		ug/L		9/4/98	SW846 8260B
Bromobenzene	< 0.83	0.83	2.6		ug/L		9/4/98	SW846 8260B
Bromochloromethane	< 0.42	0.42	1.3		ug/L		9/4/98	SW846 8260B
Bromodichloromethane	< 0.30	0.30	0.96		ug/L		9/4/98	SW846 8260B
Bromoform	< 0.44	0.44	1.4		ug/L		9/4/98	SW846 8260B
Bromomethane	< 0.70	0.70	2.2		ug/L		9/4/98	SW846 8260B
s-Butylbenzene	0.53	0.29	0.92		ug/L	Q	9/4/98	SW846 8260B
t-Butylbenzene	< 0.32	0.32	1.0		ug/L		9/4/98	SW846 8260B
n-Butylbenzene	1.4	0.29	0.92		ug/L		9/4/98	SW846 8260B
Carbon tetrachloride	< 0.34	0.34	1.1		ug/L		9/4/98	SW846 8260B
Chloroform	0.68	0.35	1.1		ug/L	Q	9/4/98	SW846 8260B
Chlorobenzene	< 0.23	0.23	0.73		ug/L		9/4/98	SW846 8260B
Chlorodibromomethane	< 0.42	0.42	1.3		ug/L		9/4/98	SW846 8260B
Chloroethane	< 0.54	0.54	1.7		ug/L		9/4/98	SW846 8260B
Chloromethane	< 0.61	0.61	1.9		ug/L		9/4/98	SW846 8260B
2-Chlorotoluene	< 0.31	0.31	0.99		ug/L		9/4/98	SW846 8260B
4-Chlorotoluene	< 0.32	0.32	1.0		ug/L		9/4/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 0.41	0.41	1.3		ug/L		9/4/98	SW846 8260B
1,2-Dibromoethane	< 0.39	0.39	1.2		ug/L		9/4/98	SW846 8260B
Dibromomethane	< 0.53	0.53	1.7		ug/L		9/4/98	SW846 8260B
1,3-Dichlorobenzene	< 0.34	0.34	1.1		ug/L		9/4/98	SW846 8260B
1,4-Dichlorobenzene	< 0.30	0.30	0.96		ug/L		9/4/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		9/4/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-5 **Report Date :** 9/8/98

Lab Sample Number : 885215-001 **Collection Date :** 8/31/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

1,2-Dichlorobenzene	< 0.25	0.25	0.80	ug/L		9/4/98	SW846 8260B
1,1-Dichloroethene	< 0.43	0.43	1.4	ug/L		9/4/98	SW846 8260B
cis-1,2-Dichloroethene	< 0.28	0.28	0.89	ug/L		9/4/98	SW846 8260B
Dichlorodifluoromethane	< 0.47	0.47	1.5	ug/L		9/4/98	SW846 8260B
trans-1,2-Dichloroethene	< 0.79	0.79	2.5	ug/L		9/4/98	SW846 8260B
1,2-Dichloropropane	< 0.35	0.35	1.1	ug/L		9/4/98	SW846 8260B
1,1-Dichloroethane	< 0.35	0.35	1.1	ug/L		9/4/98	SW846 8260B
1,3-Dichloropropane	< 0.42	0.42	1.3	ug/L		9/4/98	SW846 8260B
2,2-Dichloropropane	< 0.36	0.36	1.1	ug/L		9/4/98	SW846 8260B
1,1-Dichloropropene	< 0.81	0.81	2.6	ug/L		9/4/98	SW846 8260B
cis-1,3-Dichloropropene	< 0.32	0.32	1.0	ug/L		9/4/98	SW846 8260B
trans-1,3-Dichloropropene	< 0.43	0.43	1.4	ug/L		9/4/98	SW846 8260B
Diisopropyl ether	< 0.55	0.55	1.8	ug/L		9/4/98	SW846 8260B
Ethylbenzene	8.2	0.32	1.0	ug/L		9/4/98	SW846 8260B
Fluorotrichloromethane	< 0.28	0.28	0.89	ug/L		9/4/98	SW846 8260B
Hexachlorobutadiene	< 0.62	0.62	2.0	ug/L		9/4/98	SW846 8260B
Isopropylbenzene	0.90	0.26	0.83	ug/L		9/4/98	SW846 8260B
p-Isopropyltoluene	< 0.24	0.24	0.76	ug/L		9/4/98	SW846 8260B
Methylene chloride	< 0.36	0.36	1.1	ug/L		9/4/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0	ug/L		9/4/98	SW846 8260B
Naphthalene	3.2	0.35	1.1	ug/L		9/4/98	SW846 8260B
n-Propylbenzene	2.8	0.76	2.4	ug/L		9/4/98	SW846 8260B
Styrene	< 0.17	0.17	0.54	ug/L		9/4/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 0.69	0.69	2.2	ug/L		9/4/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 0.70	0.70	2.2	ug/L		9/4/98	SW846 8260B
Tetrachloroethene	< 0.43	0.43	1.4	ug/L		9/4/98	SW846 8260B
Toluene	0.63	0.27	0.86	ug/L	Q	9/4/98	SW846 8260B
1,2,3-Trichlorobenzene	< 0.47	0.47	1.5	ug/L		9/4/98	SW846 8260B
1,2,4-Trichlorobenzene	< 0.27	0.27	0.86	ug/L		9/4/98	SW846 8260B
1,1,1-Trichloroethane	< 0.30	0.30	0.96	ug/L		9/4/98	SW846 8260B
1,1,2-Trichloroethane	< 0.61	0.61	1.9	ug/L		9/4/98	SW846 8260B
1,2,4-Trimethylbenzene	14	0.22	0.70	ug/L		9/4/98	SW846 8260B
Trichloroethene	< 0.37	0.37	1.2	ug/L		9/4/98	SW846 8260B
1,2,3-Trichloropropane	< 0.75	0.75	2.4	ug/L		9/4/98	SW846 8260B
1,3,5-Trimethylbenzene	5.0	0.27	0.86	ug/L		9/4/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-5

Report Date : 9/8/98

Lab Sample Number : 885215-001

Collection Date : 8/31/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Vinyl chloride	< 0.20	0.20	0.64	ug/L	9/4/98	SW846 8260B
Xylenes, -m, -p	23	0.43	1.4	ug/L	9/4/98	SW846 8260B
Xylene, -o	1.3	0.24	0.76	ug/L	9/4/98	SW846 8260B
4-Bromofluorobenzene	88			%Recov	9/4/98	SW846 8260B
Dibromofluoromethane	91			%Recov	9/4/98	SW846 8260B
Toluene-d8	91			%Recov	9/4/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE
Project Number : 398132.002
Field ID : MW-6
Lab Sample Number : 885215-002
WI DNR LAB ID : 405132750
Client : FISCHER ENVIRONMENTAL CONSULTING
Report Date : 9/8/98
Collection Date : 8/31/98
Matrix Type : WATER

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Lead - Dissolved	< 1.6	1.6	5.1		ug/L		9/3/98	SW846 7421	SW846 7421	MSB

Organic Results

EPA 8260 VOLATILE LIST- WATER — Prep Method: SW846 5030 — Prep Date: 9/4/98 — Analyst: JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		9/4/98	SW846 8260B
Bromobenzene	< 0.83	0.83	2.6		ug/L		9/4/98	SW846 8260B
Bromochloromethane	< 0.42	0.42	1.3		ug/L		9/4/98	SW846 8260B
Bromodichloromethane	< 0.30	0.30	0.96		ug/L		9/4/98	SW846 8260B
Bromoform	< 0.44	0.44	1.4		ug/L		9/4/98	SW846 8260B
Bromomethane	< 0.70	0.70	2.2		ug/L		9/4/98	SW846 8260B
s-Butylbenzene	< 0.29	0.29	0.92		ug/L		9/4/98	SW846 8260B
t-Butylbenzene	< 0.32	0.32	1.0		ug/L		9/4/98	SW846 8260B
n-Butylbenzene	< 0.29	0.29	0.92		ug/L		9/4/98	SW846 8260B
Carbon tetrachloride	< 0.34	0.34	1.1		ug/L		9/4/98	SW846 8260B
Chloroform	< 0.35	0.35	1.1		ug/L		9/4/98	SW846 8260B
Chlorobenzene	< 0.23	0.23	0.73		ug/L		9/4/98	SW846 8260B
Chlorodibromomethane	< 0.42	0.42	1.3		ug/L		9/4/98	SW846 8260B
Chloroethane	< 0.54	0.54	1.7		ug/L		9/4/98	SW846 8260B
Chloromethane	< 0.61	0.61	1.9		ug/L		9/4/98	SW846 8260B
2-Chlorotoluene	< 0.31	0.31	0.99		ug/L		9/4/98	SW846 8260B
4-Chlorotoluene	< 0.32	0.32	1.0		ug/L		9/4/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 0.41	0.41	1.3		ug/L		9/4/98	SW846 8260B
1,2-Dibromoethane	< 0.39	0.39	1.2		ug/L		9/4/98	SW846 8260B
Dibromomethane	< 0.53	0.53	1.7		ug/L		9/4/98	SW846 8260B
1,3-Dichlorobenzene	< 0.34	0.34	1.1		ug/L		9/4/98	SW846 8260B
1,4-Dichlorobenzene	< 0.30	0.30	0.96		ug/L		9/4/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		9/4/98	SW846 8260B

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- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-6 **Report Date :** 9/8/98

Lab Sample Number : 885215-002 **Collection Date :** 8/31/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

1,2-Dichlorobenzene	< 0.25	0.25	0.80	ug/L	9/4/98	SW846 8260B
1,1-Dichloroethene	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
cis-1,2-Dichloroethene	< 0.28	0.28	0.89	ug/L	9/4/98	SW846 8260B
Dichlorodifluoromethane	< 0.47	0.47	1.5	ug/L	9/4/98	SW846 8260B
trans-1,2-Dichloroethene	< 0.79	0.79	2.5	ug/L	9/4/98	SW846 8260B
1,2-Dichloropropane	< 0.35	0.35	1.1	ug/L	9/4/98	SW846 8260B
1,1-Dichloroethane	< 0.35	0.35	1.1	ug/L	9/4/98	SW846 8260B
1,3-Dichloropropane	< 0.42	0.42	1.3	ug/L	9/4/98	SW846 8260B
2,2-Dichloropropane	< 0.36	0.36	1.1	ug/L	9/4/98	SW846 8260B
1,1-Dichloropropene	< 0.81	0.81	2.6	ug/L	9/4/98	SW846 8260B
cis-1,3-Dichloropropene	< 0.32	0.32	1.0	ug/L	9/4/98	SW846 8260B
trans-1,3-Dichloropropene	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
Diisopropyl ether	< 0.55	0.55	1.8	ug/L	9/4/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0	ug/L	9/4/98	SW846 8260B
Fluorotrichloromethane	< 0.28	0.28	0.89	ug/L	9/4/98	SW846 8260B
Hexachlorobutadiene	< 0.62	0.62	2.0	ug/L	9/4/98	SW846 8260B
Isopropylbenzene	< 0.26	0.26	0.83	ug/L	9/4/98	SW846 8260B
p-Isopropyltoluene	< 0.24	0.24	0.76	ug/L	9/4/98	SW846 8260B
Methylene chloride	< 0.36	0.36	1.1	ug/L	9/4/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0	ug/L	9/4/98	SW846 8260B
Naphthalene	< 0.35	0.35	1.1	ug/L	9/4/98	SW846 8260B
n-Propylbenzene	< 0.76	0.76	2.4	ug/L	9/4/98	SW846 8260B
Styrene	< 0.17	0.17	0.54	ug/L	9/4/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 0.69	0.69	2.2	ug/L	9/4/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 0.70	0.70	2.2	ug/L	9/4/98	SW846 8260B
Tetrachloroethene	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
Toluene	< 0.27	0.27	0.86	ug/L	9/4/98	SW846 8260B
1,2,3-Trichlorobenzene	< 0.47	0.47	1.5	ug/L	9/4/98	SW846 8260B
1,2,4-Trichlorobenzene	< 0.27	0.27	0.86	ug/L	9/4/98	SW846 8260B
1,1,1-Trichloroethane	< 0.30	0.30	0.96	ug/L	9/4/98	SW846 8260B
1,1,2-Trichloroethane	< 0.61	0.61	1.9	ug/L	9/4/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70	ug/L	9/4/98	SW846 8260B
Trichloroethene	< 0.37	0.37	1.2	ug/L	9/4/98	SW846 8260B
1,2,3-Trichloropropane	< 0.75	0.75	2.4	ug/L	9/4/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86	ug/L	9/4/98	SW846 8260B

EN CHEM INC.

1795 Industrial Dr
Green Bay, WI 54
920-469-2
800-7-ENCHL
FAX: 920-469-88

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : MW-6

Report Date : 9/8/98

Lab Sample Number : 885215-002

Collection Date : 8/31/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Vinyl chloride	< 0.20	0.20	0.64	ug/L	9/4/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76	ug/L	9/4/98	SW846 8260B
4-Bromofluorobenzene	86			%Recov	9/4/98	SW846 8260B
Dibromofluoromethane	88			%Recov	9/4/98	SW846 8260B
Toluene-d8	91			%Recov	9/4/98	SW846 8260B

ENCHEM INC.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002

Client : FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK

Report Date : 9/8/98

Lab Sample Number : 885215-003

Collection Date : 8/31/98

WI DNR LAB ID : 405132750

Matrix Type : WATER

Organic Results

EPA 8260 VOLATILE LIST- WATER **Prep Method:** SW846 5030 **Prep Date:** 9/4/98 **Analyst:** JJB

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 0.27	0.27	0.86		ug/L		9/4/98	SW846 8260B
Bromobenzene	< 0.83	0.83	2.6		ug/L		9/4/98	SW846 8260B
Bromochloromethane	< 0.42	0.42	1.3		ug/L		9/4/98	SW846 8260B
Bromodichloromethane	< 0.30	0.30	0.96		ug/L		9/4/98	SW846 8260B
Bromoform	< 0.44	0.44	1.4		ug/L		9/4/98	SW846 8260B
Bromomethane	< 0.70	0.70	2.2		ug/L		9/4/98	SW846 8260B
s-Butylbenzene	< 0.29	0.29	0.92		ug/L		9/4/98	SW846 8260B
t-Butylbenzene	< 0.32	0.32	1.0		ug/L		9/4/98	SW846 8260B
n-Butylbenzene	< 0.29	0.29	0.92		ug/L		9/4/98	SW846 8260B
Carbon tetrachloride	< 0.34	0.34	1.1		ug/L		9/4/98	SW846 8260B
Chloroform	< 0.35	0.35	1.1		ug/L		9/4/98	SW846 8260B
Chlorobenzene	< 0.23	0.23	0.73		ug/L		9/4/98	SW846 8260B
Chlorodibromomethane	< 0.42	0.42	1.3		ug/L		9/4/98	SW846 8260B
Chloroethane	< 0.54	0.54	1.7		ug/L		9/4/98	SW846 8260B
Chloromethane	< 0.61	0.61	1.9		ug/L		9/4/98	SW846 8260B
2-Chlorotoluene	< 0.31	0.31	0.99		ug/L		9/4/98	SW846 8260B
4-Chlorotoluene	< 0.32	0.32	1.0		ug/L		9/4/98	SW846 8260B
1,2-Dibromo-3-chloropropane	< 0.41	0.41	1.3		ug/L		9/4/98	SW846 8260B
1,2-Dibromoethane	< 0.39	0.39	1.2		ug/L		9/4/98	SW846 8260B
Dibromomethane	< 0.53	0.53	1.7		ug/L		9/4/98	SW846 8260B
1,3-Dichlorobenzene	< 0.34	0.34	1.1		ug/L		9/4/98	SW846 8260B
1,4-Dichlorobenzene	< 0.30	0.30	0.96		ug/L		9/4/98	SW846 8260B
1,2-Dichloroethane	< 0.37	0.37	1.2		ug/L		9/4/98	SW846 8260B
1,2-Dichlorobenzene	< 0.25	0.25	0.80		ug/L		9/4/98	SW846 8260B
1,1-Dichloroethene	< 0.43	0.43	1.4		ug/L		9/4/98	SW846 8260B
cis-1,2-Dichloroethene	< 0.28	0.28	0.89		ug/L		9/4/98	SW846 8260B
Dichlorodifluoromethane	< 0.47	0.47	1.5		ug/L		9/4/98	SW846 8260B
trans-1,2-Dichloroethene	< 0.79	0.79	2.5		ug/L		9/4/98	SW846 8260B

ENCHEM INC.
1795 Industrial Dr
Green Bay, WI 54
920-469-2
800-7-ENCH
FAX: 920-469-88

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK **Report Date :** 9/8/98

Lab Sample Number : 885215-003 **Collection Date :** 8/31/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

1,2-Dichloropropane	< 0.35	0.35	1.1	ug/L	9/4/98	SW846 8260B
1,1-Dichloroethane	< 0.35	0.35	1.1	ug/L	9/4/98	SW846 8260B
1,3-Dichloropropane	< 0.42	0.42	1.3	ug/L	9/4/98	SW846 8260B
2,2-Dichloropropane	< 0.36	0.36	1.1	ug/L	9/4/98	SW846 8260B
1,1-Dichloropropene	< 0.81	0.81	2.6	ug/L	9/4/98	SW846 8260B
cis-1,3-Dichloropropene	< 0.32	0.32	1.0	ug/L	9/4/98	SW846 8260B
trans-1,3-Dichloropropene	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
Diisopropyl ether	< 0.55	0.55	1.8	ug/L	9/4/98	SW846 8260B
Ethylbenzene	< 0.32	0.32	1.0	ug/L	9/4/98	SW846 8260B
Fluorotrichloromethane	< 0.28	0.28	0.89	ug/L	9/4/98	SW846 8260B
Hexachlorobutadiene	< 0.62	0.62	2.0	ug/L	9/4/98	SW846 8260B
Isopropylbenzene	< 0.26	0.26	0.83	ug/L	9/4/98	SW846 8260B
p-Isopropyltoluene	< 0.24	0.24	0.76	ug/L	9/4/98	SW846 8260B
Methylene chloride	< 0.36	0.36	1.1	ug/L	9/4/98	SW846 8260B
Methyl-tert-butyl-ether	< 0.32	0.32	1.0	ug/L	9/4/98	SW846 8260B
Naphthalene	< 0.35	0.35	1.1	ug/L	9/4/98	SW846 8260B
n-Propylbenzene	< 0.76	0.76	2.4	ug/L	9/4/98	SW846 8260B
Styrene	< 0.17	0.17	0.54	ug/L	9/4/98	SW846 8260B
1,1,2,2-Tetrachloroethane	< 0.69	0.69	2.2	ug/L	9/4/98	SW846 8260B
1,1,1,2-Tetrachloroethane	< 0.70	0.70	2.2	ug/L	9/4/98	SW846 8260B
Tetrachloroethene	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
Toluene	< 0.27	0.27	0.86	ug/L	9/4/98	SW846 8260B
1,2,3-Trichlorobenzene	< 0.47	0.47	1.5	ug/L	9/4/98	SW846 8260B
1,2,4-Trichlorobenzene	< 0.27	0.27	0.86	ug/L	9/4/98	SW846 8260B
1,1,1-Trichloroethane	< 0.30	0.30	0.96	ug/L	9/4/98	SW846 8260B
1,1,2-Trichloroethane	< 0.61	0.61	1.9	ug/L	9/4/98	SW846 8260B
1,2,4-Trimethylbenzene	< 0.22	0.22	0.70	ug/L	9/4/98	SW846 8260B
Trichloroethene	< 0.37	0.37	1.2	ug/L	9/4/98	SW846 8260B
1,2,3-Trichloropropane	< 0.75	0.75	2.4	ug/L	9/4/98	SW846 8260B
1,3,5-Trimethylbenzene	< 0.27	0.27	0.86	ug/L	9/4/98	SW846 8260B
Vinyl chloride	< 0.20	0.20	0.64	ug/L	9/4/98	SW846 8260B
Xylenes, -m, -p	< 0.43	0.43	1.4	ug/L	9/4/98	SW846 8260B
Xylene, -o	< 0.24	0.24	0.76	ug/L	9/4/98	SW846 8260B
4-Bromofluorobenzene	86			%Recov	9/4/98	SW846 8260B
Dibromofluoromethane	90			%Recov	9/4/98	SW846 8260B

ENCHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name : KAUKAUNA MAINTENANCE GARAGE

Project Number : 398132.002 **Client :** FISCHER ENVIRONMENTAL CONSULTING

Field ID : TRIP BLANK **Report Date :** 9/8/98

Lab Sample Number : 885215-003 **Collection Date :** 8/31/98

WI DNR LAB ID : 405132750 **Matrix Type :** WATER

Toluene-d8	92	%Recov	9/4/98	SW846 8260B

FISCHER
ENVIRONMENTAL, INC.
P.O. Box 127, KAUKAUNA, WI 54130
Phone: 920-766-2069 ▯ FAX: 920-759-2669
E-mail: madkauk@ethernet.com

FAX COVER SHEET

TO: Dan Tsoris

COMPANY: WDNR

FAX: (920) 424-4404

DATE: 8-14-98

FROM: Karen Burkman

MESSAGE: Jeff Fischer should be calling you about the Kaukauna maint. Garage site today

8/17/98 - Gave Notice to Proceed For Location (proposed on page 9) of Piezometer. I stated that Drilling should use Double CASING or other method to prevent downward Migration of Contaminants during drilling activities. cst 8/17/98

NO. of PAGES (Including cover sheet): 9

Corporate Office: P.O. Box 552, Ripon, Wisconsin 54971
Phone: (920) 745-2200 • FAX: (920) 745-2222 • E-mail: kfischer@fdldotnet.com

Wausau Office
Phone: (715) 848-0093

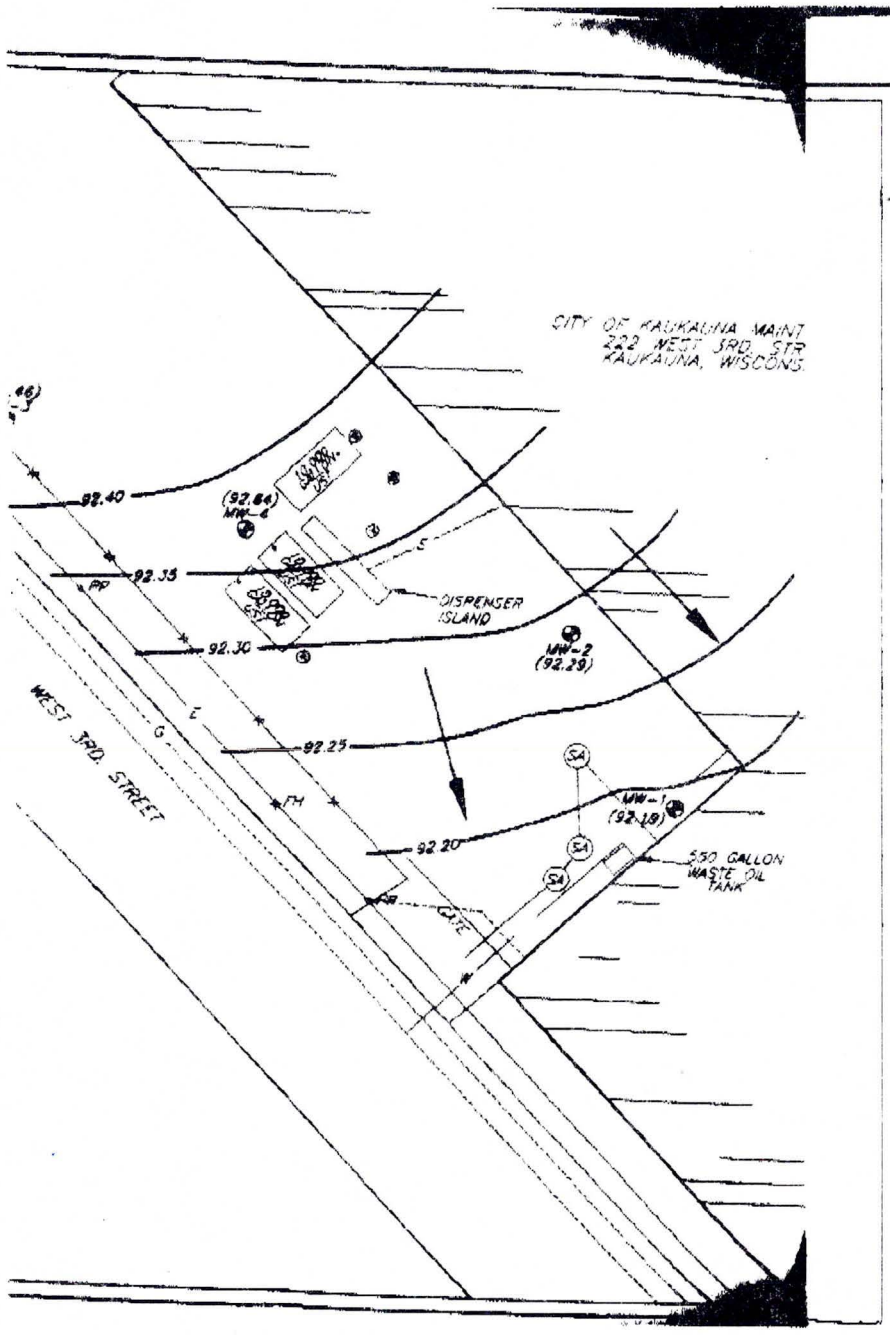


FIGURE 5: GROUND-WATER FLOW DIRECTION - APRIL 21, 1998

GW = 3.5 to 4.5 feet

Bedrock = $\bar{x}$ 10 ft. So if pet. are floaters, do I have to assess bedrock-GW contam? WDNR = yes

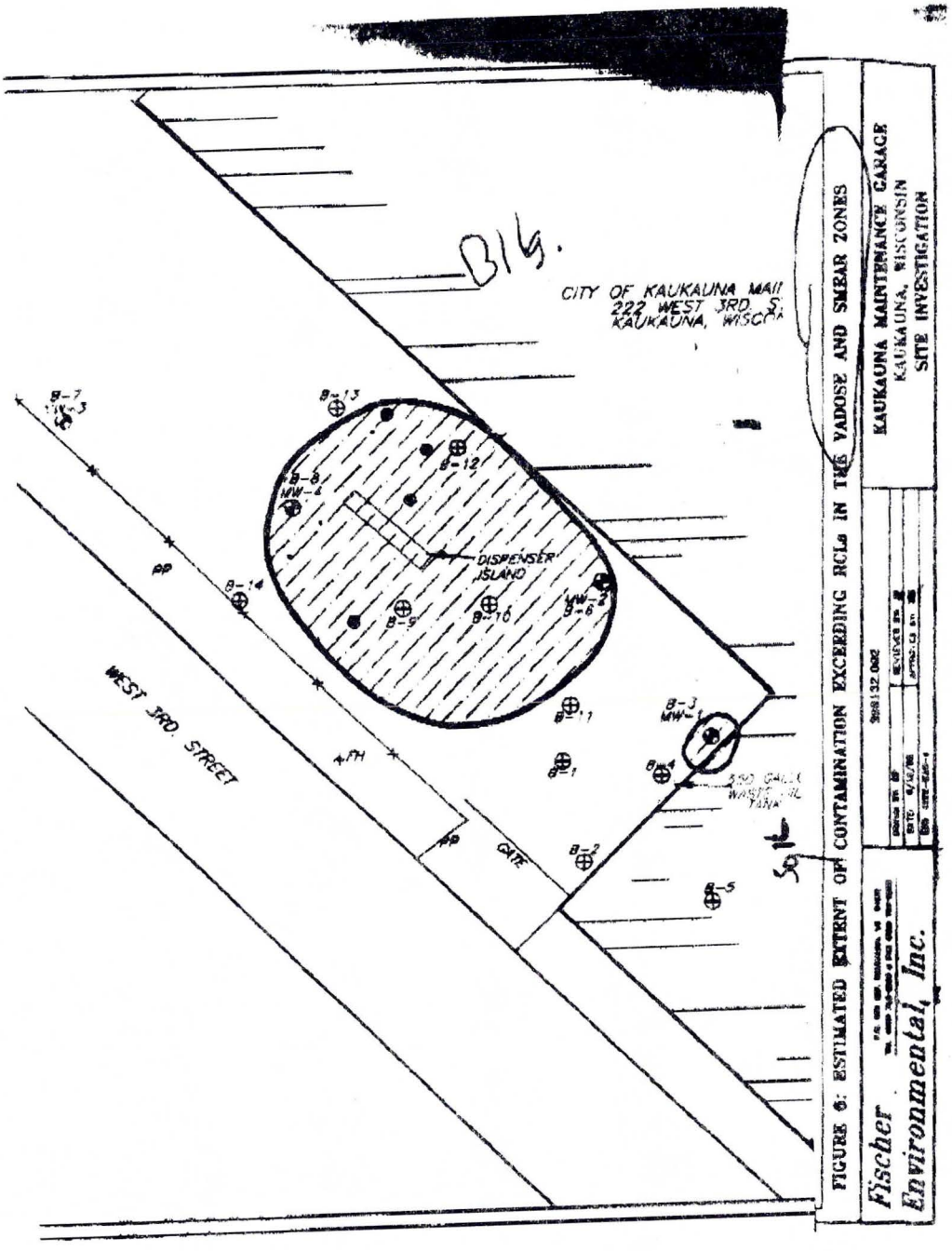

CITY OF KAUKAUNA MAIL
222 WEST 3RD. S.
KAUKAUNA, WISCO
B-13
B-12
B-8
MW-2
DISPENSER
ISLAND
B-14
B-9
B-16
MW-3
B-6
B-11
B-3
MW-1
B-1
B-4
B-2
B-5
WEST 3RD. STREET
ALLEY
GATE
KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION
FIGURE 6: ESTIMATED EXTENT OF CONTAMINATION EXCEEDING RCLs IN THE VADOSE AND SMEAR ZONES
Fischer Environmental, Inc.

FIGURE 7: ESTIMATED EXTENT OF GROUND WATER CONTAMINATION EXCEEDING THE ENFORCEMENT STANDARDS

Fischer Environmental, Inc.

KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
SITE INVESTIGATION

08/14/1998 08:41 759-2569 FISCHER ENV INC PAGE 05

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-1

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date						
Parameter	**4/12/94**	**1/23/95**	**9/26/95**	**4/21/96**	**9/3/96**	**ES**	**PAL**
Cadmium	0.1					5	0.5
Volatile Organic Compounds (VOCs)							
Benzene	1.2	<0.6	<0.6	<0.27	<0.27	5	0.5
1,2-Dichloroethane						5	0.5
Ethylbenzene	3.6	<1.0	<1.0	<0.32	<0.32	700	140
Methyl-Tert-Butyl-Ether		5.2	9.6	6.4	6.7	60	12
Xylenes, Total	23	<1.0	<1.0	<0.43	<0.43	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established
Note: April 12, 1994, Jan 23, 1995, Sept 26, 1995, sampling events by OMNNI Associates

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-2

Kaukaune Maintenance Garage - FISCHER Project #398132.002

	Sampling Date			
Parameter	**4/21/98**	**6/5/98**	**ES**	**PAL**
Lead	<1.6		15	1.5
Volatile Organic Compounds (VOCs)		170		
Benzene	18		5	0.5
Ethylbenzene	11	38	700	140
Isopropylbenzene	1.4		NE	NE
Methyl-Tert-Butyl-Ether			60	12
n-Propylbenzene	1.2		NE	NE
Toluene	5.5	1.9	343	68.6
Trimethylbenzenes	3.7	15.32	NE	NE
Xylenes, Total	9.38	26.37	620	124

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established

08/14/1998 08:41 759-2569 FISCHER ENV INC PAGE 03

TABLE 3

Summary of Ground-Water Analytical Results (compounds detected) - MW-3

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date			
Parameter	**4/21/98**	**8/5/98**	**ES**	**PAL**
Lead	<1.6		15	1.5
Volatile Organic Compounds (VOCs)				
	<varies	<varies	varies	varies

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)
Blank - not analyzed for parameter
NE - not established

08/14/1998 08:41 759-2569 FISCHER ENV INC PAGE 07

TABLE 3

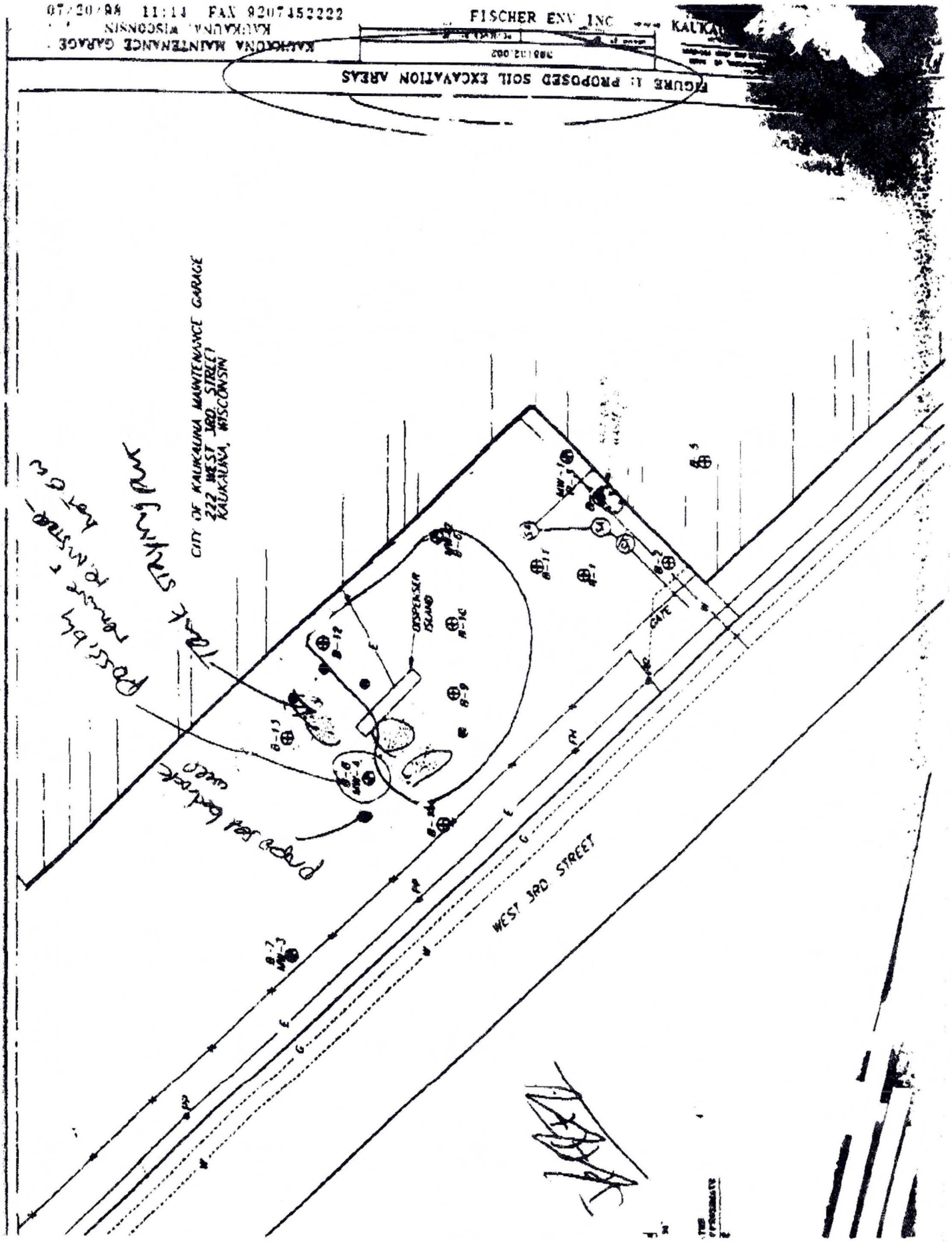
Summary of Ground-Water Analytical Results (compounds detected) - MW-4

Kaukauna Maintenance Garage - FISCHER Project #398132.002

	Sampling Date			
Parameter	**4/21/98**	**6/5/98**	**ES**	**PAL**
Lead	<1.6		15	1.5
Volatile Organic Compounds (VOCs)	2800	2800		
Benzene			5	0.5
s-Butylbenzene	11		NE	NE
n-Butylbenzene	23		NE	NE
Ethylbenzene			700	140
Isopropylbenzene	43		NE	NE
p-Isopropyltoluene	7.0		NE	NE
Methyl-Tert-Butyl-Ether			60	12
Naphthalene			40	8
n-Propylbenzene	110		NE	NE
Toluene	67	58	343	68.6
Trimethylbenzenes	820	590	NE	NE
Xylenes, Total			620	124
Polynuclear Aromatic Hydrocarbons (PAH)				
Flourene	2.0		400	80
1-methylnaphthalene	30		NE	NE
2-methylnaphthalene	41		NE	NE
Naphthalene			40	8
Phenanthrene	15		NE	NE

All concentrations in ug/l - micrograms per liter
ES - Enforcement Standard (exceedances shaded red)
PAL - Preventive Action Limit (exceedances shaded yellow)

Blank - not analyzed for parameter
NE - not established


KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
FIGURE 1: PROPOSED SOIL EXCAVATION AREAS
CITY OF KAUKAUNA MAINTENANCE GARAGE
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN
DISPENSER ISLAND
GATE
WEST 3RD STREET
Possibly remove & restore hot on
Tank staging pit
Proposed bedrock weep

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: July 23, 1998

FILE REF: 03-45-001729

TO: File

FROM: Dino Tsoris

SUBJECT: Site Investigation City of Kaukauna Garage

Karen Burkman of Fischer Environmental contacted me to discuss the potential for installing a piezometer at the site. Bedrock is at a depth of ~ 10 BGL, groundwater is reportedly at a depth of 2-3 BGL and soil and groundwater contamination has been detected in the shallow zone. A piezometer located in proximity of the hot zone should be installed to determine the extent of contamination. The city of Kaukauna is upgrading the site and soil remediation, by excavation, is expected to be conducted within 60 days. I told Karen that it would be appropriate to install the piezometer after the site upgrades and soil remediation; the delay would prevent the potential of having to remove or damage the well during soil remediation activites.

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Fischer Environmental Consulting, LLC.

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Tele. (715) 848-0093 - FAX (920) 759-2669

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WDNR OSH
LUST PROGRAM

NR 716.09 SITE INVESTIGATION WORK PLAN

Prepared For:

KAUKAUNA MAINTENANCE GARAGE

222 West 3rd Street
Kaukauna, WI

LUST ID#03-45-1729

March 4, 1998

Fischer Environmental Consulting, LLC.

Professional Environmental and Geotechnical Engineers and Hydrogeologists

KAUKAUNA OFFICE
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Telephone (920) 766-2069 - FAX (920) 759-2669

WAUSAU OFFICE
P.O. Box 1601, Wausau, WI 54402
Telephone (715) 848-0093 - FAX (920) 759-2669

March 4, 1998

Mr. Dino Tsoris
Wisconsin Department of Natural Resources
P.O. Box 2565
Oshkosh, WI 54903

Re: **NR 716.09 SITE INVESTIGATION WORK PLAN for Kaukauna Maintenance Garage**
222 West 3rd Street, Kaukauna, WI (Outagamie County)
FISCHER Project # 398132.002
LUST ID # 03-45-1729

Dear Mr. Tsoris:

On behalf of Mr. John Sundelius, Street Superintendent for the City of Kaukauna, Fischer Environmental Consulting, LLC. (FISCHER) is pleased to submit this Site Investigation Work Plan, which has been designed to investigate the extent of petroleum-affected soils and/or ground water at the above referenced site. In following Wisconsin Department of Natural Resources (WDNR) Guidance for Conducting Environmental Response Actions, a phased approach is being recommended to reduce costs.

If you have any questions, or wish to discuss any part of this plan, we would be pleased to do so at your earliest convenience.

Respectfully submitted,

FISCHER ENVIRONMENTAL CONSULTING, LLC.

Karen A. Burkman
Senior Project Manager

JAD/kab/drm
cc: Mr. John Sundelius
City of Kaukauna – Street Superintendent

TABLE OF CONTENTS
NR 716.09 SITE INVESTIGATION WORK PLAN
KAUKAUNA MAINTENANCE GARAGE
03/04/98

SECTION

1.0 INTRODUCTION 1

1.1 PURPOSE 1
1.2 BACKGROUND 1

2.0 SITE LOCATION AND CONTACTS 3

3.0 PHYSIOGRAPHICAL AND GEOLOGICAL INFORMATION 4

3.1 TOPOGRAPHY AND SURFACE HYDROLOGY 4
3.2 SOILS 4
3.3 GEOLOGY 4
3.4 HYDROGEOLOGY AND POTABLE WELLS 5
3.5 POTENTIAL MIGRATION PATHWAYS AND IMPACTS TO RECEPTORS 5

4.0 SAMPLING AND ANALYSIS STRATEGY - SOIL 6

4.1 BORING LOCATIONS, CONSTRUCTION AND SAMPLING METHODS 6
4.2 ANALYSIS 6
4.3 QUALITY CONTROL AND ASSURANCE, DECONTAMINATION AND WASTE MANAGEMENT 7

5.0 SAMPLING AND ANALYSIS STRATEGY - GROUND WATER 8

5.1 GROUND-WATER MONITORING WELL LOCATIONS, CONSTRUCTION AND SAMPLING METHODS 8
5.2 ANALYSIS 8
5.3 QUALITY CONTROL AND ASSURANCE, DECONTAMINATION AND WASTE MANAGEMENT 8

6.0 SCHEDULE OF EVENTS 10

7.0 REFERENCES 11

TABLES

Table 1	Tank Descriptions
Table 2	Soil Sampling Parameters and Frequency
Table 3	Ground-water Monitoring Well Sampling Parameters and Frequency

FIGURES

Figure 1	Site Location Map
Figure 2	Site Plan
Figure 3	Proposed Soil Boring Locations
Figure 4	Proposed Ground-water Monitoring Well Locations

APPENDIX

Appendix A	Acronyms

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to inform the WDNR of the proposed Site Investigation activities, and to fulfill WDNR and Wisconsin Department of Commerce (COMM) requirements pertaining to the release at the Kaukauna Maintenance Garage site. This Site Investigation Work Plan outlines FISCHER's initial proposed investigative phase for this project. In addition, this work plan will provide the philosophy for continued investigation and possible remediation. This Site Investigation Work Plan has been prepared in general accordance with NR 716.09, Wisconsin Administrative Code.

The purpose of the Site Investigation is to determine the degree and type of contamination and to define the horizontal and vertical extent of impacted soil and/or ground water. After data has been collected and results have been reviewed, FISCHER will compare the soil analytical results to WDNR's generic Residual Contaminants Levels and the ground-water analytical results to WDNR's Enforcement Standards and Preventive Action Limits in order to define the extent of petroleum contamination. FISCHER will also make the necessary recommendations for remediation or closure. Upon completion of the Site Investigation, a Site Investigation Report and Remedial Action Plan (RAP) will be prepared and submitted to the WDNR. The Site Investigation will be performed, and the subsequent report will be prepared, in general accordance with WDNR and COMM guidelines and regulations, such as NR 141 and NR 700's, Wisconsin Administrative Code.

1.2 BACKGROUND

Kaukauna Maintenance Garage is located within the N ¼ of Government Lot 22, Township 21N, Range 18E in Outagamie County (Figure 1 - Site Location Map and Figure 2 - Site Plan). Specifically, the site is located at 222 West 3rd Street in Kaukauna, Wisconsin (WI). The site is utilized as a maintenance garage and is currently owned by the City of Kaukauna. Four (4) underground storage tanks (USTs) are located on the subject property. The USTs are in use, with the exception of the UST containing leaded gasoline (Table 1 - Tank Descriptions).

OMNNI Associates has been conducting a Site Investigation with regards to the waste oil UST, since contamination was discovered in December of 1993 [Leaking Underground Storage Tank (LUST) ID #45-1729]. Based on preliminary review of OMNNI Associates' Site Investigation report, the extent of contamination from the waste oil UST has not yet been defined. Reportedly, OMNNI collected a ground water sample from a sump located near the remaining USTs and the analytical result indicated contamination from the other USTs.

FISCHER was retained by Mr. John Sundelius, Street Superintendent for the City of Kaukauna, on February 18, 1998 to review all pertinent information pertaining to the subject site, prepare a Site Investigation Work Plan to be submitted to the WDNR, perform a Site Investigation to determine the extent of petroleum affected soils and/or ground water, prepare and submit a Site Investigation Report and RAP, and to oversee the remediation of soils and/or ground water requiring remediation per WDNR guidelines and regulations.

Mr. Dino Tsoris, with the WDNR, indicated the same LUST ID number could be used at this time. However, if two (2) separate plumes are detected during FISCHER's Site Investigation activities, a separate LUST ID number will be obtained at that time.

2.0 SITE LOCATION AND CONTACTS

Site Name and Location:	Kaukauna Maintenance Garage 222 West 3rd Street Kaukauna, WI 54130 N ¼ of Government Lot 22, Township 21N, Range 18E in Outagamie County (Figure 1 – Site Location Map)
Site Operations:	The site is used as a municipal maintenance garage.
Responsible Party:	City of Kaukauna Department of Public Works P.O. Box 890 Kaukauna, WI 54130-0890 Contact: Mr. John Sundelius – Street Superintendent Phone: (920) 766-337
Consultant:	Fischer Environmental Consulting, LLC. P.O. Box 127 Kaukauna, WI 54130 Phone: (920) 766-2069
Project Manager:	Ms. Karen A. Burkman Fischer Environmental Consulting, LLC. P.O. Box 127 Kaukauna, WI 54130 Phone: (920) 766-2069
Project Hydrogeologist:	Mr. Jeffrey L. Fischer Fischer Environmental Consulting, LLC. P.O. Box 552 Ripon, WI 54971 Phone: (920) 745-2200
Contractors:	Analytical and drilling contractors to be selected.

3.0 PHYSIOGRAPHICAL AND GEOLOGIC INFORMATION

3.1 TOPOGRAPHY AND SURFACE HYDROLOGY

A 1974, photorevised 1984, United States Geological Survey (USGS) topographic map (Kaukauna Quadrangle) was reviewed. Based on this review, the site is nearly level with an elevation of approximately 655 +/- 5 feet above mean sea level. The Fox River is located approximately 600 feet northeast of the site. The Fox River and Kankapot Creek confluence is located approximately 2,000 feet southeast of the site.

3.2 SOILS

According to the "Soil Survey of Outagamie County, WI", the soil in the subject site area typically consists of Udorthents. This is well drained, mainly level and gently sloping soil in filled areas, where the fill is mainly loamy and clayey. The permeability varies but is mostly slow or very slow.

Local potable well construction reports and geologic logs were requested from the Geological Natural History Survey (GNHS) office located in Madison, Wisconsin. Based on three (3) well construction reports for wells located in the site vicinity, the following formations were encountered during well installation.

- Clay 0-10 feet (ft) below ground surface (BGS); till 10-55 ft BGS; Dolomite 55-240 ft BGS; Sandstone 240-245 ft BGS; Dolomite 245-250 ft BGS; Sandstone 250-260 ft BGS; Dolomite 260-440 ft BGS; Siltstone 440-450 ft BGS; Dolomite 450-459 ft BGS; Shale 459-460 ft BGS; Dolomite 460-465 ft BGS; Sandstone 465-550 ft BGS; Siltstone 550-557 ft BGS
- Drift 0-8 ft BGS; Dolomite 8-172 ft BGS; Sandstone 172-228 ft BGS; Dolomite 228-403 ft BGS; Sandstone 403-733½ ft BGS
- Clay 0-26 ft BGS; Limestone 26-353 ft BGS; Shale 353-355 ft BGS; Limestone 355-395 ft BGS; Sandstone 395-795 ft BGS; "Broken" Granite 795-806 ft BGS

Based on review of OMNNI's Soil Boring Logs previously submitted to the WDNR, in general, silt, sand and fill overlay clay on the site. Site specific soil information will be obtained by visual classification of soil samples collected during the Site Investigation and preparation of Soil Boring Logs.

3.3 GEOLOGY

Glacial geology in the site vicinity consists of glacial lake basins. The bedrock in the site area is comprised of Ordivician Formation, Sinnipee Group dolomite with some limestone and shale.

Local potable well construction reports and geologic logs were requested from the GNHS office located in Madison, Wisconsin. Based on review of the aforementioned well construction reports, bedrock was first encountered between eight (8) and ten (10) ft BGS in three (3) wells. According to OMNNI's Soil Boring Logs, bedrock was encountered at approximately ten (10) ft BGS on the site.

3.4 HYDROGEOLOGY AND POTABLE WELLS

Based on review of a topographic map, the general ground-water flow direction in the site vicinity is to the north or northeast, towards the Fox River. Precipitation, location of roads etc. and the elevation of nearby river levels may affect ground-water flow direction. At least three (3) ground-water monitoring wells would be needed to obtain a site specific ground-water flow direction.

Based on the three (3) aforementioned well construction reports, the depth to ground water ranged from 48 to 72 ft BGS. OMNNI stated in its previously submitted Site Investigation report the "depth to ground water at this site is approximately four (4) feet."

A review of the well construction reports supplied by the GNHS office indicated four (4) potable wells may be present with a ¼-mile radius of the site. The wells were installed prior to 1946, with the exception of one (1) well installed in 1974. Therefore, there is the possibility that not all of these four (4) wells are still present or in use. There did not appear to be any well construction reports for potable wells located on, or adjacent to, the subject site.

Additional information regarding the depth to ground water, flow direction of ground water and presence of on-site or nearby potable wells may be obtained during the Site Investigation.

3.5 POTENTIAL MIGRATION PATHWAYS AND IMPACTS TO RECEPTORS

During the Site Investigation, FISCHER will attempt to identify potential migration pathways, such as subsurface utility trenches. At this time, FISCHER is not aware of any receptors, such as potable wells, sensitive species/habitats/ecosystems, wetlands, surface waters, outstanding/exceptional resource waters, and significant historical/archaeological sites. There is known petroleum-impacted soil and ground water present on the site. Impacts to potential receptors will be evaluated during the Site Investigation.

4.0 SAMPLING AND ANALYSIS STRATEGY – SOIL

4.1 BORING LOCATIONS, CONSTRUCTION AND SAMPLING METHODS

Based on the presence of the UST system at the site, FISCHER proposes to advance approximately eight (8) soil borings, approximately 8-inches in diameter, to an approximate depth of ten (10) feet each. The initial soil borings will be located in the vicinity of the UST system. Additional borings will be performed radially outward from the UST system as necessary to determine the extent of petroleum-affected soil and ground water (Figure 3 - Proposed Soil Boring Locations). It should be noted that additional soil probes or borings may be required if the extent of petroleum contamination is not defined within the number of borings estimated above.

Soil samples, for field screening and chemical analysis, will be obtained continuously during the advancement of the soil borings and will be visually observed for classification, staining and other apparent petroleum signs. Each soil sample will be screened in the field for the presence of volatile vapors with a photoionization detector using headspace screening procedures.

One (1) to three (3) soil samples will be collected from each soil probe/boring. At least one (1) of those samples will be collected from above the apparent water table, in each probe/boring. The purpose of the sampling strategy is to define the horizontal and vertical extent of petroleum-impacted soil. However, analysis of soil samples collected at and below the water table can be useful in determining the extent of the ground-water contaminant plume. Sample collection and preservation procedures will be described in the Site Investigation Report and Remedial Action Plan.

Probes and borings not converted into monitoring wells will be properly abandoned in accordance with NR 141, Wisconsin Administrative Code.

Soil probes/borings will be performed on the subject property. If the field screenings, observations and laboratory analysis indicate petroleum-affected soils may have migrated off-site, FISCHER will coordinate with adjacent property owners and the WDNR. Proper authorization and permits (if necessary) for continued off-site investigation will be obtained before the investigation is continued off-site.

4.2 ANALYSIS

Soil samples will be subject to chain-of-custody procedures and will be transported to a Wisconsin certified laboratory for chemical analysis. Soil samples will be analyzed for Gasoline Range Organics (GRO), Diesel Range Organics (DRO), Polynuclear Aromatic Hydrocarbons (PAH), Petroleum Volatile Organic Compounds (PVOC), Volatile Organic Compound (VOC), Lead and geologic parameters, depending on location, in general compliance with current WDNR guidelines for petroleum-related investigations (Table 2 - Soil Sampling Parameters and Frequency). The parameters analyzed by the laboratory will be in accordance with WDNR and Environmental Protection Agency (EPA) approved methods.

4.3 QUALITY CONTROL AND ASSURANCE, DECONTAMINATION AND WASTE MANAGEMENT

There is the potential for the laboratory to detect volatile compounds in soil samples field preserved with methanol, as a result of adsorption of contaminants in the air. Therefore, as required, one (1) methanol trip blank per day will be prepared and submitted to the laboratory with the soil samples.

Soil sampling devices will either be decontaminated between samples in the field with soap solutions and water rinses or will be disposed of after each use. Augers will be steam cleaned prior to each soil boring. Clean latex gloves will be donned between samples. These methods will be implemented to eliminate cross-contamination between samples and the introduction of contaminants to the samples.

Soil cuttings appearing to be impacted, based on field observations and screening, will be placed in Department of Transportation (DOT) approved 55-gallon drums for future disposal. The drums will be properly labeled, closed and left on-site. It will be the responsibility of the consultant (FISCHER) to oversee the removal of the drums from the site for treatment and/or disposal. However, the drum(s) and contents will be left on-site in the care, custody, and control of the property owner until the drums are removed from the site under FISCHER personnel supervision.

The state certified laboratory will follow quality control and assurance procedures in accordance with WDNR and EPA protocol for the approved analytical methods utilized.

5.0 SAMPLING AND ANALYSIS STRATEGY – GROUND WATER

5.1 GROUND-WATER MONITORING WELL LOCATIONS, CONSTRUCTION AND SAMPLING METHODS

Ground-water monitoring wells will be installed at the site in approximately three (3) borings. The ground-water monitoring wells will be installed in accordance with the standards set forth in NR 141, Wisconsin Administrative Code. The ground-water monitoring well construction will generally consist of a five (5) or ten (10) foot length of 2-inch diameter Polyvinyl Chloride (PVC) 0.010-inch slotted screen, and solid schedule 40 PVC riser pipe. The ground-water wells will be constructed such that the well screen will intersect the water table to permit the detection of free-petroleum product on the water surface. A flush-mounted or aboveground protective casing will be installed over the riser.

Ground-water monitoring wells will be developed, purged and sampled. Portable pumps will be used to develop and purge the wells. Disposable bailers will be used to collect ground-water samples. Samples for metals analysis will be field filtered with disposable 45 micron filters. Sample collection and preservation procedures will be described in the Site Investigation Report and RAP.

Ground-water monitoring wells will be installed on the subject property. If the laboratory analysis indicates petroleum-affected ground water may have migrated off-site, FISCHER will coordinate with adjacent property owners and the WDNR. Proper authorization and permits (if necessary) will be obtained before the investigation is continued off-site.

5.2 ANALYSIS

Ground-water samples will be subject to chain-of-custody procedures and will be transported to a Wisconsin certified laboratory for chemical analysis. The ground-water samples will be analyzed for parameters in general compliance with current WDNR guidelines for petroleum related investigations (Table 3 – Ground-water Sampling Parameters and Frequency). The parameters analyzed by the laboratory will be in accordance with WDNR and EPA approved methods. Ground-water samples collected from the monitoring wells may be field analyzed for Dissolved Oxygen (DO), conductivity, pH, temperature, Oxygen-Reduction potential and Ferrous Iron. Ground-water samples collected from the monitoring wells will be initially analyzed for VOC and Lead and subsequent samples will be analyzed for VOC or PVOC and Lead, depending on the initial round of analytical results. Subsequent sampling events may include collection of ground-water samples to be analyzed for Natural Attenuation (NA) parameters (Sulfate, Nitrate, Alkalinity, dissolved Manganese and Methane). The parameters analyzed by the laboratory will be in accordance with WDNR and EPA approved methods.

5.3 QUALITY CONTROL AND ASSURANCE, DECONTAMINATION AND WASTE MANAGEMENT

There is the potential for the laboratory to detect volatile compounds in ground-water samples as a result of absorption of contaminants from materials encountered during shipping. Therefore, as required, one (1) trip blank per sampling event will be prepared and submitted to the laboratory with the ground-water samples.

There is the potential for the laboratory to detect volatile compounds in the samples as a result of cross-contamination. However, since FISCHER will utilize disposable sampling equipment, this potential should be eliminated.

Since poor field sampling techniques may result in analytical results that are non-reproducible, one (1) field duplicate sample per sampling event will be prepared and submitted to the laboratory with the other ground-water samples. Comparison of the analytical result for the field duplicate will give an indication of the reliability of the quantified result for the sample.

Portable pumps will be decontaminated between wells with water rinses. Sampling bailers, rope, tubing and filters will be disposed of after each use. Clean latex gloves will be donned between samples. These methods will be implemented to eliminate cross-contamination between samples and the introduction of contaminants to the samples.

Purge water will be placed in DOT approved 55-gallon drums for future disposal. The drums will be properly labeled, closed and left on-site. If analytical results indicate the absence of contaminants, the purge water will be allowed to infiltrate into the ground surface. It will be the responsibility of FISCHER to oversee the removal of the drums from the site for treatment and/or disposal. However, the drum(s) and contents will be left on-site in the care, custody, and control of the property owner until the drums are removed from the site under FISCHER personnel supervision.

The state certified laboratory will follow quality control and assurance procedures in accordance with WDNR and EPA protocol for the approved analytical methods utilized.

6.0 SCHEDULE OF EVENTS

The field investigation is anticipated to begin within approximately 15 days after the submittal of this work plan, depending upon commodity service scheduling and utility clearance. After well installation and boring, a site survey, including determination of well elevations, will be completed. A report will be written, summarizing the analytical and field results obtained during the field investigation, and submitted to the WDNR, as required.

7.0 REFERENCES

- NR 141 Wisconsin Administrative Code, September 1995 update
- NR 700s Wisconsin Administrative Code, February 1997 update
- "Glacial Deposits of Wisconsin", GNHS, 1985
- GNHS well constructor's reports
- "Soil Survey of Outagamie County, WI"
- "Bedrock Geology of Wisconsin", GNHS, 1982
- 7.5 minute series topographic map (Kaukauna Quadrangle), USGS, 1974, photorevised 1984

Table 1
Tank Descriptions

Tank Size (gallons)	**Content**
10,000	Diesel Fuel
10,000	Leaded Gasoline
10,000	Unleaded Gasoline
500 or 550	Waste Oil

TABLE 2

SOIL SAMPLING PARAMETERS AND FREQUENCY

PARAMETER	ESTIMATED SAMPLE FREQUENCY
Petroleum Volatile Organic Compounds (PVOC)	One to three samples per soil boring
Gasoline Range Organics (GRO)	One to three samples per soil boring
Diesel Range Organics (DRO)	One to three samples per soil boring
Polynuclear Aromatic Hydrocarbons (PAH)	One to two samples in impacted area
Lead	One to two samples
BIO-1 Landfill Waste characterization (GRO, DRO, Benzene, Lead)	One to two samples
Methanol Blank	One per sampling period
Grain Size Analysis/ Permeability	One to three samples, if necessary

TABLE 3
GROUND-WATER MONITORING WELL SAMPLING PARAMETERS AND FREQUENCY

PARAMETER	ESTIMATED SAMPLE FREQUENCY
Volatile Organic Compounds (VOCs)	First round of sampling. If VOCs are detected in the first round, the subsequent samplings will include VOCs.
Petroleum Volatile Organic Compounds (PVOCs)	Each sampling event after the first round, if only petroleum volatiles are detected
Polynuclear Aromatic Hydrocarbons (PAH)	First round of sampling. If PAH are detected, in the first round the subsequent samplings will include PAH.
Soluble Lead	First round of sampling. If soluble lead is detected in the first round, subsequent sampling will include lead.
Natural Attenuation parameters	One test per well, per sampling event, if applicable
Dissolved Oxygen	Minimum of one test per well, per sampling event
Conductivity	Minimum of one test per well, per sampling event
pH	Minimum of one test per well, per sampling event
Temperature	Minimum of one test per well, per sampling event
Oxygen-Reduction Potential	Minimum of one test per well, per sampling event
Trip Blank	One per sampling event
Replicate Sample	One per sampling event
Field Blank	One per sampling event; if applicable

LEGEND

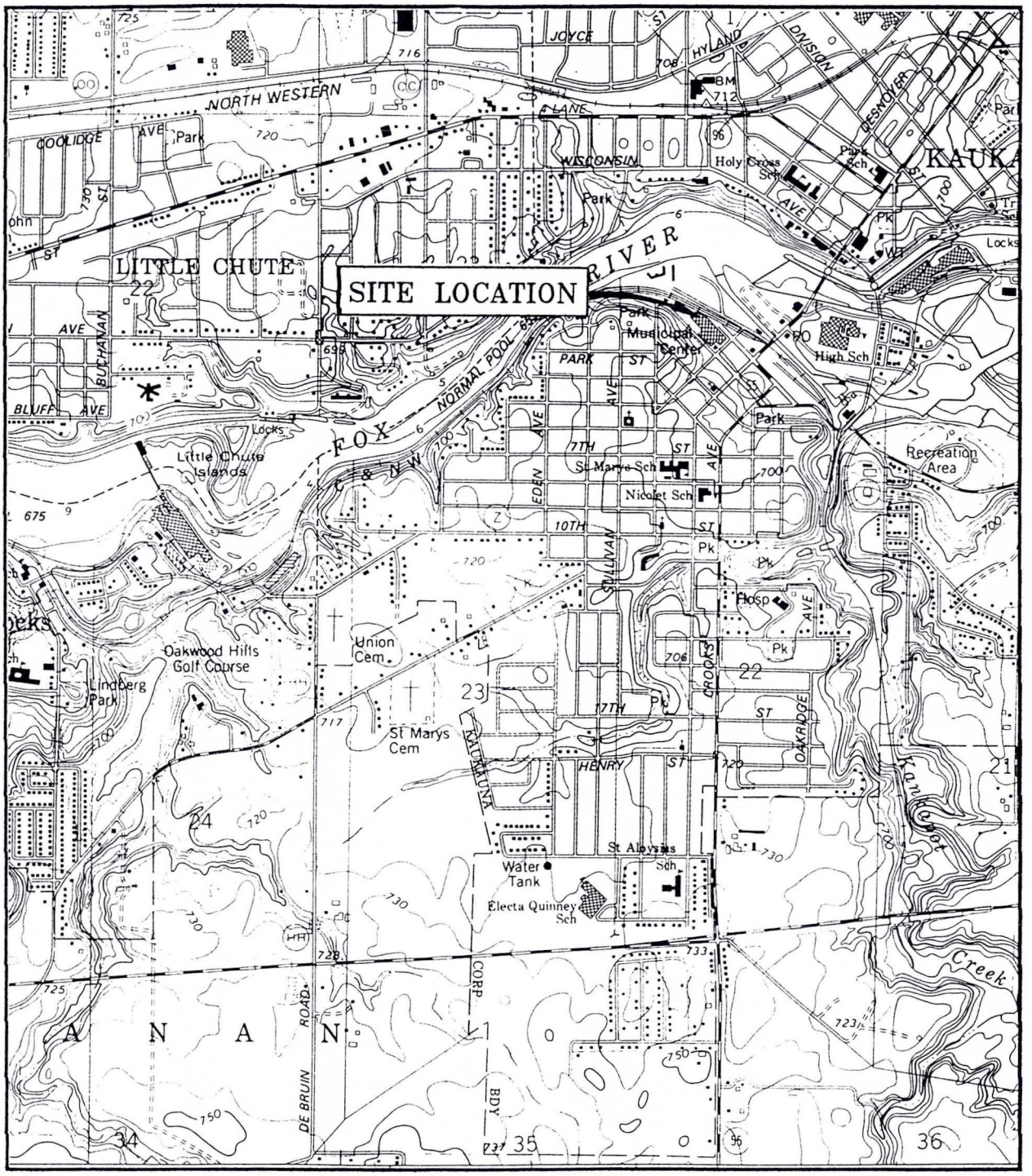
- Property Line
- Centerline
- SA — Sanitary Sewer Line
- ST — Storm Sewer Line
- W — Water Line
- G — Gas Line
- E — Electric Lines
- E — Underground Electric Lines
- C — Communication Lines
- C — Underground Communication Lines
- 1015.17 — Ground-water Contour Line and Elevation
- 1015.17 — Surface Contour Line and Elevation
- GW Extraction Piping
- SVE Extraction Piping
- Air Sparging Piping
- MH — Manhole
- PP — Utility Power Pole
- FH — Fire Hydrant
- Stop Sign
- Light Pole
- Traffic Signal
- 000 — Lab Analysis
- 000 — Pid Reading
- Site Assessment / Closure Sample

- or — Estimated Lateral Area of Ground-water Contamination Exceeding NR140 Enforcement Standards
- or — Estimated Lateral Area of Soil Contaminant Concentrations Exceeding NR720 Residual Contaminant Levels
- Building
- UST/AST — Existing UST or AST
- UST/AST — Removed UST or AST
- Limits of Excavation
- MW-# — Monitoring Well
- Proposed Monitoring Well
- B-# — Soil Boring
- Proposed Soil Boring/Soil Geoprobe
- PW — Private Well
- Abandoned Well
- Extraction/Recovery Sump
- Soil Geoprobe Sample
- Soil & Water Geoprobe Sample
- Backhoe Test Pit

REVISED 11/21/97

Fischer Environmental Consulting, LLC

P.O. BOX 127
KAUKAUNA, WI 54130-2404
TEL. (920) 766-2069
FAX (920) 759-2669



KAUKAUNA QUADRANGLE
U.S.G.S. 7.5 MINUTE SERIES
(TOPOGRAPHIC) OUTAGAMIE COUNTY
WISCONSIN

N

SCALE: 1:24,000

FIGURE 1: SITE LOCATION MAP

Fischer Environmental Consulting, LLC P.O. BOX 127, KAUKAUNA, WI 54130 TEL (920) 766-2069 ■ FAX (920) 759-2669	398132.002	CITY OF KAUKAUNA MAINTENANCE GARAGE
	DATE: 3298	KAUKAUNA, WISCONSIN
	ID#: FIG1	WORK PLAN

CITY OF KAUKAUNA MAINTENANCE GARAGE
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

PP
W
E
G
PP
W
E
G
FH
PP
GATE
W
WEST 3RD. STREET

FILL PIPES
10,000 GALLON UST
10,000 GALLON UST
10,000 GALLON UST
E
DISPENSER ISLAND

SA
SA
SA
B-1
B-2
B-3
MW-1
B-4
B-5
550 GALLON WASTE OIL TANK

N

1'5' 0 15' 30'

SCALE: 1" = 30'

NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

- SUMP WELLS BY OTHERS
- MONITORING WELL BY OMNNI
- SOIL BORING BY OMNNI

FIGURE 2: SITE PLAN

CITY OF KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
WORK PLAN

398132.002
DRAWN BY: KP | REVIEWED BY: JF
DATE: 2/28/98 | APPROVED BY: KB
ID#: CITY-KAU-1

Fischer Environmental Consulting, LLC
P.O. BOX 127, KAUKAUNA, WI 54130
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CITY OF KAUKAUNA MAINTENANCE GARAGE
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

PP
W
E
G
B-6
B-13
B-12
B-8
B-11
B-9
B-10
FILL PIPES
B-7
10,000 GALLON UST
10,000 GALLON UST
10,000 GALLON UST
DISPENSER ISLAND
WEST 3RD. STREET
FH
PP
GATE
SA
B-1
B-3
MW-1
B-4
550 GALLON WASTE OIL TANK
B-2
B-5

N

1'5' 0 15' 30'

SCALE: 1" = 30'

NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

FIGURE 3: PROPOSED SOIL BORING LOCATIONS

CITY OF KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
WORK PLAN

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 2/28/98	APPROVED BY: KB
ID#: CITY-KAU-1	

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CITY OF KAUKAUNA MAINTENANCE GARAGE
222 WEST 3RD. STREET
KAUKAUNA, WISCONSIN

WEST 3RD. STREET

PP
W
E
G
MW-2
PP
W
E
G
FH
PP
GATE
W

FILL PIPES
MW-3
10,000 GALLON UST
10,000 GALLON UST
10,000 GALLON UST
E
MW-4
DISPENSER ISLAND

SA
SA
SA
B-1
B-2
B-3
MW-1
B-4
550 GALLON WASTE OIL TANK
B-5

N

1'5' 0 15' 30'

SCALE: 1" = 30'

NOT ALL UTILITIES ARE LOCATED
ALL UTILITIES AND LOCATIONS ARE APPROXIMATE
REFER TO LEGEND PAGE

FIGURE 4: PROPOSED MONITORING WELL LOCATIONS

CITY OF KAUKAUNA MAINTENANCE GARAGE
KAUKAUNA, WISCONSIN
WORK PLAN

398132.002

DRAWN BY: KP	REVIEWED BY: JF
DATE: 2/25/98	APPROVED BY: KB
ID#: CITY-KAU-1	

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APPENDIX A

ACRONYMS

ACRONYMS

1,2 – DCA	1,2 - Dichloroethane
AST	Aboveground Storage Tank
BGS	Below the Ground Surface
COMM	Department of Commerce (formerly DILHR)
DILHR	Department of Industry, Labor and Human Relations
DO	Dissolved Oxygen
DOT	Department of Transportation
DRO	Diesel Range Organics
ES	Enforcement Standards
EPA	Environmental Protection Agency
NA	Natural Attenuation
ND	No Analyte Detected Above the Method Detection Limit
NE	No Established Compound Regulations
NS	Not Sampled for the Particular Parameter(s)
PAH	Polynuclear Aromatic Hydrocarbons
PAL	Preventive Action Limit
PID	Photoionization Detector
PVC	Polyvinyl Chloride
PVOC	Petroleum Volatile Organic Compounds
ppb	Parts Per Billion
ppm	Parts Per Million
RAP	Remedial Action Plan
ERP	Environmental Repair Program
ft	Feet
FISCHER	Fischer Environmental Consulting, LLC
GNHS	Geological and Natural History Survey
GRO	Gasoline Range Organics
LSA	Limited Site Assessment
LUST	Leaking Underground Storage Tank
MDL	Method Detection Limit
mg/kg	Milligram per Kilogram (ppm)
mg/l	Milligram per Liter (ppm)
MTBE	Methyl-Tert-Butyl Ether
RCL	Residual Contaminant Levels
RNA	Remediation by Natural Attenuation
SPT	Standard Penetration Test
TOC	Total Organic Carbon as NPOC
TKN	Total Kjeldahl Nitrogen
ug/kg	Microgram per Kilogram (ppb)
ug/l	Microgram per Liter (ppm)
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
UST	Underground Storage Tank
WI	Wisconsin

Fischer Environmental Consulting, LLC.
Professional Environmental and Geotechnical Engineers and Hydrogeologists
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March 2, 1998

RECEIVED
MAR 0 5 1998
WDNR OSH
LUST PROGRAM

Mr. Dino Tsoris
Wisconsin Department of Natural Resources
P.O. Box 2565
Oshkosh, WI 54903

RE: **SITE INVESTIGATION for Kaukauna Maintenance Garage**
222 West 3rd Street, Kaukauna, WI (Outagamie County)
WDNR LUST ID #03-45-1729
FISCHER Project #398132.002

Dear Mr. Tsoris:

This letter is to inform you that Fischer Environmental Consulting, LLC. (FISCHER), was retained on February 18, 1998 by Mr. John Sundelius, Street Superintendent for the City of Kaukauna, to conduct a Site Investigation at the above referenced site. The purpose of the Site Investigation will be to determine the extent of petroleum-affected soils and/or ground water, prepare and submit a Site Investigation Report and Remedial Action Plan, and to oversee the remediation of soils and/or ground water requiring remediation per Wisconsin Department of Natural Resources (WDNR) guidelines and regulations.

OMNNI Associates has been conducting a Site Investigation with regards to the waste oil underground storage tank (UST) located at the site, since contamination was discovered in December of 1993. Reportedly, OMNNI detected contamination in a ground-water sample collected from a sump located near the other USTs. FISCHER's Site Investigation will be in regards to the three (3) other USTs.

Per our telephone conversation on February 23, FISCHER will continue to use the WDNR ID number currently assigned to site. However, if two (2) separate plumes are detected during FISCHER's Site Investigation activities, a separate WDNR ID number will be obtained at that time.

Please send a copy of all future correspondences concerning this project to our office. If you have any questions or need additional information, please contact us at your earliest convenience.

Sincerely,

FISCHER ENVIRONMENTAL CONSULTING, LLC.

Karen A. Burkman
Senior Project Manager

cc: Mr. John Sundelius

ENGINEERING
ARCHITECTURE
ENVIRONMENTAL

OMNNI ASSOCIATES

OMNNI ASSOCIATES, INC.
ONE SYSTEMS DRIVE
APPLETON, WI 54914-1654
414-735-6900
FAX 414-830-6100

October 25, 1995

RECEIVED
OCT 26 1995
WDNR OSH
LUST PROGRAM

Mr. Tom Verstegen
DNR - Oshkosh Area Office
905 Bayshore Drive
P.O. Box 2564
Oshkosh, WI 54903

RE: Quarterly sampling report for the City of Kaukauna Municipal Garage, 201 W. Second Street, Kaukauna, WI (LUST ID #45-1729).

Dear Tom:

This letter details the third round of groundwater sampling at the above site.

In March 1994, OMNNI completed a subsurface investigation at the City of Kaukauna Municipal Garage. As part of the investigation, five soil borings were performed. One was converted to a groundwater monitoring well to determine the impact of the petroleum contamination on the groundwater. (See Figure 1 - Site Detail Map, attached.) The initial sampling round revealed detections of benzene, 1,2-dichloroethane, and MTBE above the DNR preventive action limits. (See Table 1 - Summary of Laboratory Analysis, Groundwater - Historical, attached.) The investigation activities are documented in a report prepared by OMNNI dated June 27, 1994.

The groundwater monitoring well was sampled for the third time on September 26, 1995. All field data was recorded on a well specific field sheet. (See Well Specific Field Sheet, attached.)

The sample collected from the monitoring well was analyzed for petroleum volatile organic compounds (PVOCs) and 1,2-dichloroethane.

The laboratory analysis indicated an enforcement standard (ES) exceedance for 1,2-dichloroethane at 7.8 µg/l. (See Table 1 - Summary of Laboratory Analysis, Groundwater - Historical, and Laboratory Analysis and Chain of Custody Documentation, attached.) Benzene was not detected. The MTBE level was below the preventive action limit.

With the limited amount of historical data available, the ES exceedance in 1,2-dichloroethane is insufficient to trigger additional remedial action at ths time. OMNNI recommends the monitoring well continue to be sampled quarterly for PVOCs and 1,2-dichloroethane.

According to City officials, a spring 1996 waste oil tank removal is anticipated.

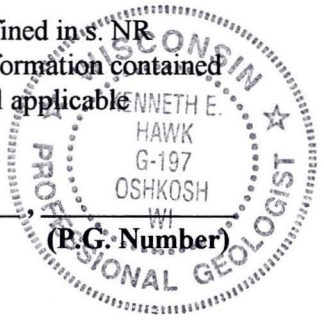
Please feel free to contact OMNNI if you have any questions regarding the City of Kaukauna Municipal Garage project.

Sincerely,

Kenneth E. Hawk
Hydrogeologist

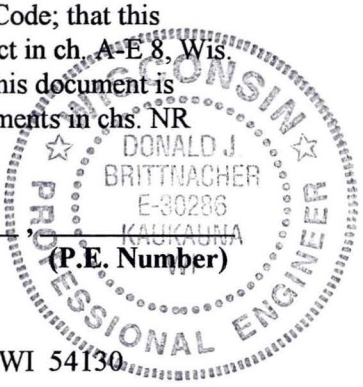
Enclosures

"I, Kenneth E. Hawk, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."



_____, _____
(Professional Geologist) **(P.G. Number)**

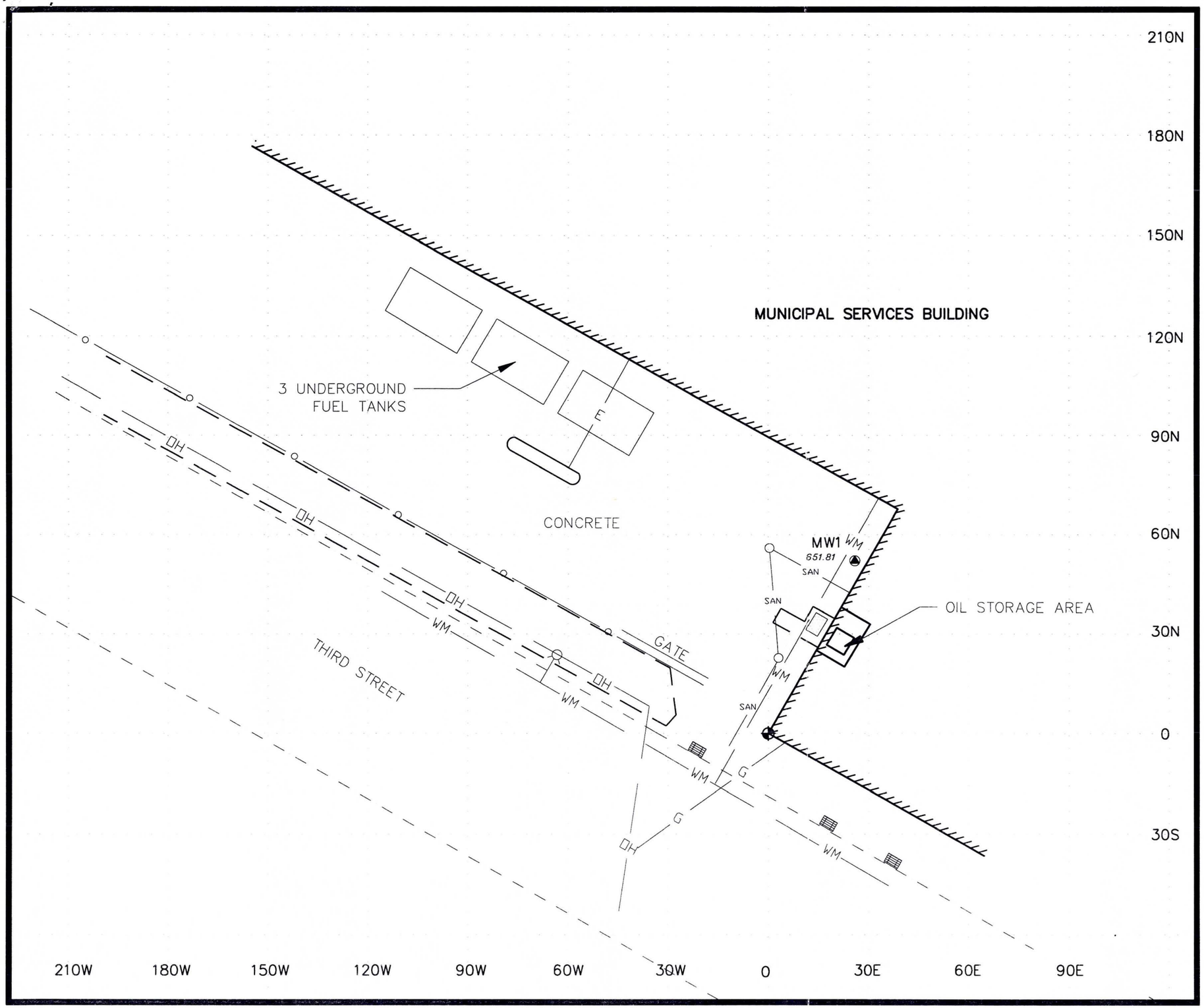
"I, Don Brittnacher, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."



Don Brittnacher, _____
(Professional Engineer) **(P.E. Number)**

cc: Mr. John Sundelius, City of Kaukauna, 201 W. Second Street, Kaukauna, WI 54130

DILHR - Safety and Buildings Division, P.O. Box 7969, Madison, WI 53707



LOCAL GRID NORTH
N

0' 6' 15' 30'
SCALE: 1" = 30'

LEGEND:

MW1 ▲	WELL LOCATION AND I.D. No.
MW1 ▲ 651.81	GROUNDWATER ELEVATION AT WELL
◇	EXISTING WASTE OIL TANK LOCATION
⬭	PUMP ISLAND
—— SAN ——○	SANITARY SEWER AND MANHOLE
—— G ——	NATURAL GAS
—— WM ——	WATERMAIN
—— OH ——	OVERHEAD UTILITIES
—— E ——	ELECTRICAL LINE
○	HYDRANT
—— ——	EDGE OF ASPHALT
— — —	EDGE OF STREET
—— o ——	FENCE
//////////	BUILDING FACE
30N	GRID LINE (30' INTERVAL)
⊕	REFERENCE POINT

FIGURE 1
SITE DETAIL MAP
(9/26/95)

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

PROJECT :	N1019B
CAD FILE:	N1019B3.DWG
DRAWN :	DLD
DATE :	10/19/95
REVIEWED :	

ONE SYSTEMS DRIVE APPLETON, WISCONSIN 54914-1654
PHONE : (414) 735-6900 FAX : (414) 830-6100

TABLE 1
SUMMARY OF LABORATORY ANALYSIS
GROUNDWATER - HISTORICAL

PARAMETER	ES	PAL	MW1		
SAMPLE DATE	-	-	4/12/94	1/23/95	9/26/95
DETECTED VOCs / PVOCs (µg/L)					
BENZENE	5	0.5	1.2	ND	ND
1,2-DICHLOROETHANE	5	0.5	4.9	4.7	7.8
ETHYLBENZENE	700	140	3.6	ND	ND
MTBE	65	12	17	5.2	9.6
m,p-XYLENE	620	124	23	ND	ND
DIESEL RANGE ORGANICS (µg/L)	-	-	690	NA	NA
DISSOLVED CADMIUM (µg/L)	5	0.5	0.1	NA	NA

ES = enforcement standard
PAL = preventive action limit
ND = not detected
NA = not analyzed
= sample concentrations detected over the preventive action limit

WELL SPECIFIC FIELD SHEET (WSFS) - Monitoring Wells

Fill out one column of this form for each monitoring well which is sampled on each sampling date.

Facility Name: N1019B94; City of Kaukauna Date: September 26, 1995

License or Permit#: Weather Conditions: Sunny, 60°F

Persons Sampling: Bill Endter

Sampling Equipment (for measuring water level, purging, sampling and filtering. Include model if appropriate.)
Hydac pH/Conductivity meter, Voss disposable bailers, Solonist water level meter

*Well Name	MW1
*DNR ID No.	
Pipe top elevation (MSL) Reference elevation if different	656.87
Measured depth to water (ft)	5.06
Correction	-
Total depth to water (ft)	-
**Water elevation (MSL)	651.81
Depth to bottom of well (ft)	9.59
Volume H_2O in well (gal)	0.74
Volume to be purged (4x vol. in well)	2.95
Time purging begun	3:32
Time purging completed	3:39
Purged dry? (Y/N)	No
Time sample with drawn	3:40
Field temperature (°C)	18.17
Field conductivity (uncorrected)	2660
**Field conductivity (at 25°C)	-
Time conductivity measured	3:43
Field pH (std. units)	7.91
Time pH measured	3:43
Color (Y/N)	Slight amber
Odor (Y/N)	Slight

*Well Name	MW1
Turbidity (Y/N)	No
Sample field filtered? (Y/N)	No
Time filtered	-
Well cap and lock replaced? (Y/N)	Yes

Comments (discuss condition of well, casing, seal, etc. and problems, including any deviations from the sampling plan):

The monitoring well is in good condition.

The water had a slight amber tint.

Purged water was volatilized on 3rd Street.

* Fill out before going into field
** Can be calculated later

State of Wisconsin
Department of Natural Resources

EN CHEM INC.

CHAIN OF CUSTODY RECORD
LUST PROGRAM
Based on Form 4400-151 Rev. 4-93

MKE

Note: Use of this form is voluntary but is requested by the Department pursuant to ch. NR 149, NR 500-540, NR 158 and NR 419, Wis.Adm.Code. Personally identifiable information will be used for no other purpose.

Sample Collector(s)	Title/Work Station/Company	Telephone Number (include area code)
Bill Endter	Omni Associates	(414) 735-6900
Property Owner	**Property Address**	**Telephone Number (include area code)**
City of Kaukauna	N1019A94	

I hereby certify that I received, properly handled and disposed of these samples as noted below:

Relinquished By (Signature)	Date/Time	Received By (Signature)
W.P. Endter	9/29/95 8:00	
Relinquished By (Signature)	Date/Time	Received By (Signature)
	9/29/95 11:55	
Relinquished By (Signature)	Date/Time	Received for EN CHEM by (Signature)
	9/29/95 14:50	Gloria DeSutter

LABORATORY USE ONLY

Temperature of temperature blank REC

If samples were received on ice and there was ice remaining, you may report the temperature as 'received on ice'. If all of the ice was melted, the temperature of the melt may be substituted for a temperature blank

Field ID Number	Date Collected	Time Collected	Sample Type 1	Sample Device	Preserv. Type	Field Screening	Location/Description (see footnote 2)	Analysis Type	Lab ID Number	Sample Condition: no/Type of Containers	Cracked /broken	Improp. Sealed	Good Cond.	Other Comments
Trip	9-26-95	10:00 am	QC	—	HCl		Trip blank	2+1,2-DCA	157218	3 40ml			X	
MW1	↓	3:40 pm	GW	Grab	↓		Monitoring Well 1	2+1,2-DCA	157220	↓			↓	

FOOTNOTES
1. specify groundwater, surface water, soil, leachate, sludge, etc.
2. sample description must clearly correlate the sample ID to the sampling location.

ANALYSIS CODES

1. GRO	5. DRO	9. Free Liquids	13. BETX
2. PVOC	6. PAH	10. pH	14. Protocol D1-GRO
3. Lead	7. Flashpoint	11. TCLP-Benzene	15. Protocol D1-DRO
4. 8021	8. Percent Solids	12. TCLP-Lead	16. 8260

QTA# _____ En Chem Project# 9509558

BILLING ADDRESS:

Job Name/Number: _____

Job Description: _____

EN CHEM INC.

. . . chemistry for the environment

1795 Industrial Drive
Green Bay, WI 54302
414-469-2436
800-7-ENCHEM
FAX:414-469-8827

Lab Certification No. 405132750
Location : CITY OF KAUKAUNA
Your Sample ID: TRIP
Sample Desc. : TRIP BLANK
Sample Matrix : WATER Date Collected: 09/26/1995
En Chem Proj# : 9509558 Date Received : 09/29/1995
En Chem Lab # : 157219 Date Reported : 10/05/1995

Report to: OMNNI ASSOCIATES
ONE SYSTEMS DRIVE
APPLETON, WI 54914

Bill to: OMNNI ASSOCIATES

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
PVOC+	Benzene	ND	ug/l	0.6	SW846 5030	10/04/1995	SW846 8260	10/04/1995	HW
	Ethyl Benzene	ND	ug/l	1.0					
	Methyl-tert-Butyl Ether	ND	ug/l	1.0					
	Toluene	ND	ug/l	1.0					
	1,2,4-Trimethylbenzene	ND	ug/l	1.0					
	1,3,5-Trimethylbenzene	ND	ug/l	1.0					
	Xylenes, m + p	ND	ug/l	1.0					
	Xylene, o	ND	ug/l	1.0					
	1,2-Dichloroethane	ND	ug/l	1.0					

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

M. Suha

Printed on Recycled Paper

EN CHEM INC.

. . . chemistry for the environment

1795 Industrial Drive
Green Bay, WI 54302
414-469-2436
800-7-ENCHEM
FAX: 414-469-8827

Lab Certification No. 405132750
Location : CITY OF KAUKAUNA
Your Sample ID: MW1
Sample Desc. : MONITORING WELL 1
Sample Matrix : WATER Date Collected: 09/26/1995
En Chem Proj# : 9509558 Date Received : 09/29/1995
En Chem Lab # : 157220 Date Reported : 10/05/1995

Report to: OMNNI ASSOCIATES
ONE SYSTEMS DRIVE
APPLETON, WI 54914

Bill to: OMNNI ASSOCIATES

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
PVOC+	Benzene	ND	ug/l	0.6	SW846 5030	10/04/1995	SW846 8260	10/04/1995	HW
	Ethyl Benzene	ND	ug/l	1.0					
	Methyl-tert-Butyl Ether	9.6	ug/l	1.0					
	Toluene	ND	ug/l	1.0					
	1,2,4-Trimethylbenzene	ND	ug/l	1.0					
	1,3,5-Trimethylbenzene	ND	ug/l	1.0					
	Xylenes, m + p	ND	ug/l	1.0					
	Xylene, o	ND	ug/l	1.0					
	1,2-Dichloroethane	7.8	ug/l	1.0					

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

M. Suha

Printed on Recycled Paper

ENGINEERING
ARCHITECTURE
ENVIRONMENTAL

OMNNI
ASSOCIATES

OMNNI ASSOCIATES, INC.
303 S. BLUEMOUND DR.
APPLETON, WI 54914
414-739-7814
FAX 414-739-7765

March 17, 1995

RECEIVED
MAR 21 1995
WDNR OSH
LUST PROGRAM

Mr. Tom Verstegen
DNR - Oshkosh Area Office
905 Bayshore Drive
P.O. Box 2564
Oshkosh, WI 54903

RE: Quarterly sampling report for the City of Kaukauna Municipal Garage, 201 W. Second Street, Kaukauna, WI (LUST ID #45-1729).

Dear Tom:

This letter details the second round of groundwater sampling at the above site.

In March 1994, OMNNI completed a subsurface investigation at the City of Kaukauna Municipal Garage. As part of the investigation, five soil borings were performed. One was converted to a groundwater monitoring well to determine the impact of the petroleum contamination on the groundwater. (See Figure 1 - Site Detail Map, attached.) The initial sampling round revealed detections of benzene, 1,2-dichloroethane, and MTBE above the DNR preventive action limits. (See Table 1 - Summary of Laboratory Analysis, Groundwater - Historical, attached.) The investigation activities are documented in a report prepared by OMNNI dated June 27, 1994.

The groundwater monitoring well was sampled for the second time on January 23, 1995. All field data was recorded on a well specific field sheet. (See Well Specific Field Sheet, attached.)

The sample collected from the monitoring well was analyzed for petroleum volatile organic compounds (PVOCs) and 1,2-dichloroethane.

The laboratory analysis revealed a preventive action limit exceedance for 1,2-dichloroethane at 4.7 μg/l. (See Table 1 - Summary of Laboratory Analysis, Groundwater - Historical, and Laboratory Analysis and Chain of Custody Documentation, attached.)

The laboratory analysis during this round are consistent with the previous results for 1,2-dichloroethane. Unlike the initial round of sampling, benzene was not detected. The MTBE level was below the preventive action limit.

OMNNI recommends the monitoring well continue to be sampled quarterly for PVOCs and 1,2-dichloroethane.

According to City officials, the waste oil tank is being removed during spring/summer of 1995.

Please feel free to contact OMNNI if you have any questions regarding the City of Kaukauna Municipal Garage project.

Sincerely,

Dave Fries
Hydrogeologist

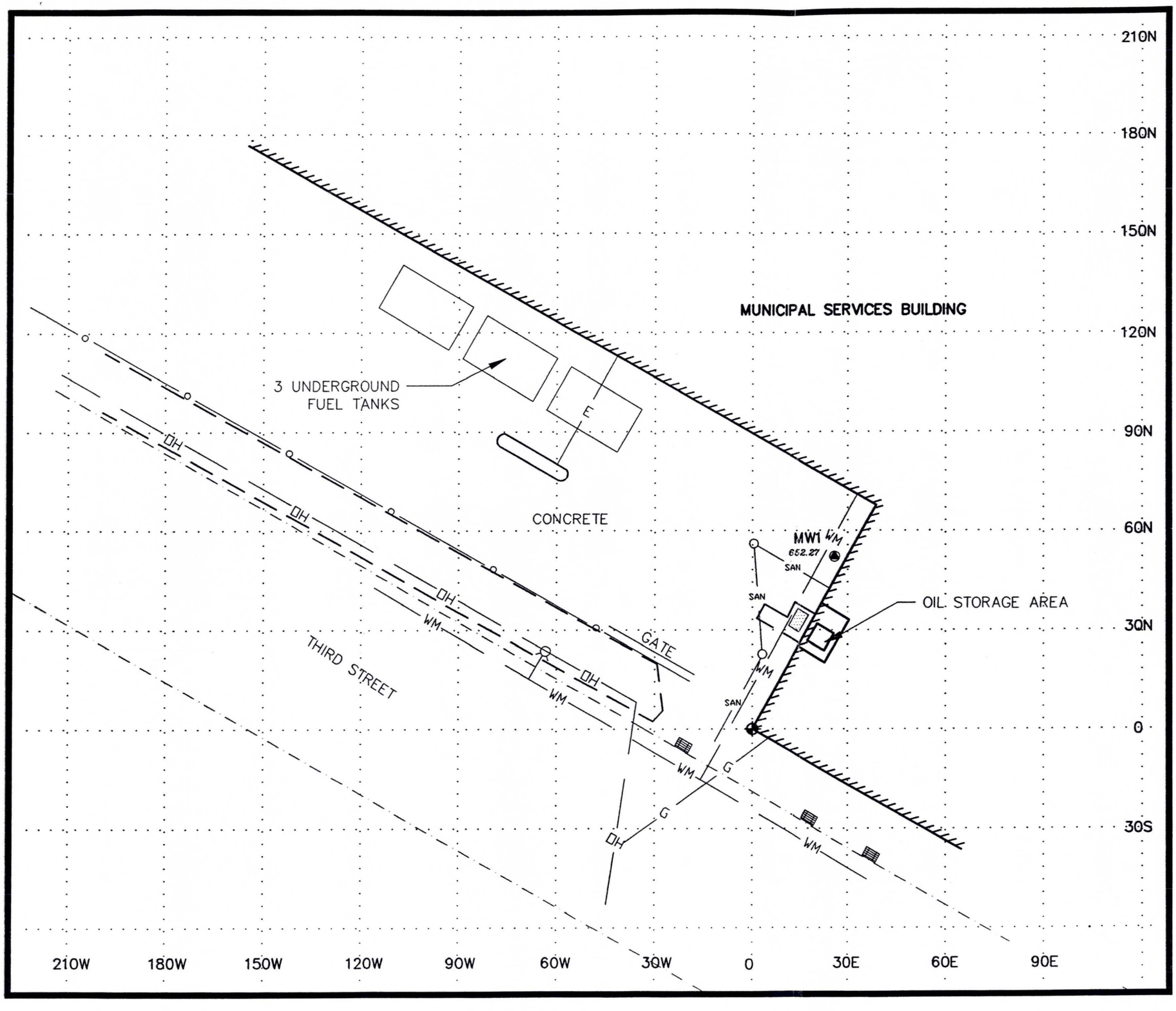
Enclosures

"I, Dave Fries, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

_____, 3/17/95
(Hydrogeologist) **(Date)**

cc: Mr. John Sundelius, City of Kaukauna, 201 W. Second Street, Kaukauna, WI 54130

DILHR - Safety and Buildings Division, P.O. Box 7969, Madison, WI 53707



LOCAL GRID NORTH
N

0' 6' 15' 30'
SCALE: 1" = 30'

LEGEND:

- MW1 — WELL LOCATION AND I.D. No.
- MW1 652.27 — GROUNDWATER ELEVATION AT WELL
- EXISTING WASTE OIL TANK LOCATION
- PUMP ISLAND
- SAN — SANITARY SEWER AND MANHOLE
- G — NATURAL GAS
- WM — WATERMAIN
- OH — OVERHEAD UTILITIES
- E — ELECTRICAL LINE
- HYDRANT
- EDGE OF ASPHALT
- EDGE OF STREET
- FENCE
- BUILDING FACE
- 30N — GRID LINE (30' INTERVAL)
- REFERENCE POINT

FIGURE 1
SITE DETAIL MAP

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

PROJECT :	N1019B
CAD FILE:	N1019B3.DWG
DRAWN :	DLD
DATE :	3/1/94
REVIEWED :	

303 SOUTH BLUEMOUND DRIVE APPLETON, WI 54914
PHONE : (414) 739-7814 FAX : (414) 739-7765

TABLE 1
SUMMARY OF LABORATORY ANALYSIS
GROUNDWATER - HISTORICAL

PARAMETER	ES	PAL	MW1	
SAMPLE DATE	-	-	4/12/94	1/23/95
DETECTED VOCs / PVOCs (µg/L)				
BENZENE	5	0.5	1.2	ND
1,2-DICHLOROETHANE	5	0.5	4.9	4.7
ETHYLBENZENE	700	140	3.6	ND
MTBE	65	12	17	5.2
m,p-XYLENE	620	124	23	ND
DIESEL RANGE ORGANICS (µg/L)	-	-	690	NA
DISSOLVED CADMIUM (µg/L)	5	0.5	0.1	NA

ES = enforcement standard
PAL = preventive action limit
ND = not detected over the practical quantitative limit
NA = not analyzed
[ ] = sample concentrations detected over the preventive action limit

WELL SPECIFIC FIELD SHEET (WSFS) - Monitoring Wells

Fill out one column of this form for each monitoring well which is sampled on each sampling date.

Facility Name: City of Kaukauna Date: January 23, 1995

License or Permit#: Weather Conditions: Overcast 22°F

Persons Sampling: Bill Endter

Sampling Equipment (for measuring water level, purging, sampling and filtering. Include model if appropriate.) Hydac pH/Conductivity meter, Voss Disposable Bailers, Solonist Water Level Meter

*Well Name	MW1
*DNR ID No.	-
Pipe top elevation (MSL) Reference elevation if different	656.87
Measured depth to water (ft)	4.60
Correction	-
Total depth to water (ft)	-
**Water elevation (MSL)	652.27
Depth to bottom of well (ft)	9.5
Volume H_2O in well (gal)	0.80
Volume to be purged (4x vol. in well)	3.19
Time purging begun	12:45
Time purging completed	12:52
Purged dry? (Y/N)	No
Time sample with drawn	12:55
Field temperature (°C)	10.50
Field conductivity (uncorrected)	1609
**Field conductivity (at 25°C)	-
Time conductivity measured	12:59
Field pH (std. units)	8.09

*Well Name	MW1
Time pH measured	12:59
Color (Y/N)	Yes
Odor (Y/N)	No
Turbidity (Y/N)	No
Sample field filtered? (Y/N)	No
Time filtered	-
Well cap and lock replaced? (Y/N)	Yes

Comments (discuss condition of well, casing, seal, etc. and problems, including any deviations from the sampling plan):

- **Well is in good condition.**
- **Purged water was volatilized on 3rd Street.**
- **Water had a slight yellowish color.**

* Fill out before going into field
** Can be calculated later

EN CHEM INC.

. . . chemistry for the environment

1795 Industrial Drive
Green Bay, WI 54302
414-469-2436
800-7-ENCHEM
FAX: 414-469-8827

Lab Certification No. 405132750
Location : CITY OF KAUKAUNA #N1019B94
Your Sample ID: TRIP
Sample Desc. : TRIP BLANK
Sample Matrix : WATER Date Collected: 01/23/1995
En Chem Proj# : 9501277 Date Received : 01/25/1995
En Chem Lab # : 133385 Date Reported : 01/31/1995

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: OMNNI ASSOCIATES

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
PVOC	Benzene	ND	ug/l	0.6	SW846 5030	01/30/1995	SW846 8020	01/30/1995	CAR2
	Ethyl Benzene	ND	ug/l	1.0					
	Methyl-tert-Butyl Ether	ND	ug/l	1.0					
	Toluene	ND	ug/l	1.0					
	1,2,4-Trimethylbenzene	ND	ug/l	1.0					
	1,3,5-Trimethylbenzene	ND	ug/l	1.0					
	Xylenes, m + p	ND	ug/l	1.0					
	Xylene, o	ND	ug/l	1.0					

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

Nitric Mulberg

Printed on Recycled Paper

EN CHEM INC.

. . . chemistry for the environment

1795 Industrial Drive
Green Bay, WI 54302
414-469-2436
800-7-ENCHEM
FAX:414-469-8827

Lab Certification No. 405132750
Location : CITY OF KAUKAUNA #N1019894
Your Sample ID: MW1
Sample Desc. : MONITORING WELL 1
Sample Matrix : WATER Date Collected: 01/23/1995
En Chem Proj# : 9501277 Date Received : 01/25/1995
En Chem Lab # : 133386 Date Reported : 02/01/1995

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: OMNNI ASSOCIATES

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
PVOC	Benzene	ND	ug/l	0.6	SW846 5030	01/31/1995	SW846 8260	01/31/1995	RJN
	Ethyl Benzene	ND	ug/l	1.0					
	Methyl-tert-Butyl Ether	5.2	ug/l	1.0					
	Toluene	ND	ug/l	1.0					
	1,2,4-Trimethylbenzene	ND	ug/l	1.0					
	1,3,5-Trimethylbenzene	ND	ug/l	1.0					
	Xylenes, m + p	ND	ug/l	1.0					
	Xylene, o	ND	ug/l	1.0					
12DCA	1,2-Dichloroethane	4.7	ug/l	1.0		01/31/1995	SW846 8260	01/31/1995	RJN

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

Printed on Recycled Paper

State of Wisconsin
Department of Natural Resources

EN CHEM INC.

CHAIN OF CUSTODY RECORD
LUST PROGRAM
Based on Form 4400-151 (11-91)

pro# N1019B94

NESV...

Note: This form is required by the Department of Natural Resources for leaking underground storage tank sites in compliance with ch NR 500-540, NR 158 and NR 419, Wis.Adm.Code

Sample Collector(s) Bill Endter	Title/Work Station/Company OMNNI	Telephone Number (include area code) (414) 735-6900
Property Owner City of Kaukauna	Property Address N1019B94	Telephone Number (include area code)

I hereby certify that I received, properly handled and disposed of these samples as noted below:

Relinquished By (Signature)	Date/Time	Received By (Signature)
W.R. Endter	1/24/95 4:00	Mark Robinson
Relinquished By (Signature)	Date/Time	Received By (Signature)
Relinquished By (Signature)	Date/Time	Received for EN CHEM by (Signature)
Mark Robinson	1/25/95 7:28AM.	[signature]

Temperature of temperature blank on ice

If samples were received on ice and there was ice remaining, you may report the temperature as 'received on ice'. If all of the ice was melted, the temperature of the melt may be substituted for a temperature blank.

Field ID Number	Date Collected	Time Collected	Sample Type1	Sample Device	Preserv. Type	Location/Description (see footnote 2)	Analysis Code(s)	Lab ID Number	no/Type of Containers	Sample Condition: Cracked /broken	Improperly sealed	Good Condition	Other Comments
Trip	1/23/95	11:30	QC	-	HCl	Trip blank	2	133385	3.40ml			✓	
MW1	↓	12:55	GW	Grab	HCl	Monitoring Well 1	2+12.00	133386	↓			✓	

FOOTNOTES:
1. specify groundwater, surface water, soil, leachate, sludge, etc.
2. sample description must clearly correlate the sample ID to the sampling location.

ANALYSIS CODES

1. GRO
2. PVOC
3. LEAD
4. 8021
5. DRO
6. PAH
7. Flashpoint
8. Percent Solids
9. Free Liquids
10. pH
11. TCLP-Benzene
12. TCLP-Lead

DEPARTMENT USE/OPTIONAL FOR SOIL SAMPLERS

Disposition of unused portion of sample, Laboratory should:

__ Dispose __ Retain for ____ days

__ Return __ Other

pro# 9501277

DEPARTMENT USE ONLY

Split samples: Offered? __ yes __ no (Check one)

Accepted? __ yes __ no (Check one)

Accepted By: _____

IMPORTANT MESSAGE

FOR Pat

DATE 1-18 TIME 9:32 A.M. P.M.

M Dave

OF Omni Assoc.

PHONE 735-6900
AREA CODE NUMBER EXTENSION

☐ FAX

☐ MOBILE
AREA CODE NUMBER TIME TO CALL

TELEPHONED		PLEASE CALL	
CAME TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		RUSH	
RETURNED YOUR CALL		SPECIAL ATTENTION	

MESSAGE GARAGE

RE: City of Kaukauna

- tank still there

- monitor till tank removal.

SIGNED

TOPS FORM 3002S
LITHO IN U.S.A.

WISCONSIN
DEPT. OF NATURAL RESOURCES
George E. Meyer, Secretary
William R. Selbig, District Director

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Oshkosh Area Office
905 Bayshore Drive
Box 2565
Oshkosh, Wisconsin 54903
Telephone #: (414)424-3050
Telefax #: (414)424-4404

January 11, 1995

Mr. John Sundelius
City of Kaukauna
201 West Second St.
Kaukauna, WI 54130

RE: Information on Site Investigation/Remediation
Waste Collection Site, Kaukauna, WI
WDNR LUST ID # 45-1729

Dear Mr. Sundelius:

On July 15, 1994, our office sent you a "Notice to Proceed" letter. In this letter, the WDNR requested that you or your consultant provide us with status reports providing an update of site activities. Since July 15, 1994, we have not received any updates concerning investigation/remediation activities at this site.

By February 13, 1995, please provide this office with an update of activities that have occurred since July 15, 1994. We request that you continue to submit status reports on a quarterly basis. You should submit correspondence and reports to:

Wisconsin Department of Natural Resources
Attn: Thomas Verstegen
905 Bayshore Drive, Box 2565
Oshkosh, WI 54903
414-424-7887

All submittals should be identified with the WDNR LUST ID number listed above.

In order to assist both you and your consultant in understanding what is required by the Department, please refer to the "Site Investigation Checklist" that was provided to you earlier; it was prepared by the Department as a summary of what needs to be done, the rules that need to be followed, and the standards which need to be met for a complete assessment and ultimate closeout of a LUST site.

Investigative groundwater and soil samples should be analyzed according to the parameters listed in the LUST Analytical Guidance publication. It is very important that your consultant understands and meets the minimum standards established by the Department.

Your failure to proceed with the investigation and remediation at this site could result in enforcement action.

Printed on Recycled Paper

If I can be of further assistance or answer any questions concerning this letter, please feel free to contact me at (414) 424-7891. Thank you for your cooperation.

Sincerely,

Patrick Grogan, Hydrogeologist
Leaking Underground Storage Tank Unit

cc: case file
Mr. Dave Fries, Omnni Associates, 303 S. Bluemound Dr., Appleton, WI 54914

WISCONSIN
DEPT. OF NATURAL RESOURCES
George E. Meyer, Secretary
William R. Selbig, District Director

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Oshkosh Area Office
905 Bayshore Drive
Box 2565
Oshkosh, Wisconsin 54903
Telephone #: (414)424-3050
Telefax #: (414)424-4404

July 15, 1994

Mr. John Sundelius
City of Kaukauna
201 W. Second Street
Kaukauna, WI 54130

SUBJECT: Acknowledgement of Receipt - Soil and Groundwater Investigation Report, Kaukauna Municipal Garage, LUST Unique ID #45-1729

Dear Mr. Sundelius:

My office received the above mentioned report on July 7, 1994. The report has not been reviewed nor approved by the Department; however, you should proceed with your consultant's recommendations.

Once the work is completed, your consultant should certify to you that the work is in compliance with the Department's standards for investigation and soil and/or groundwater cleanup. Adequate documentation in the form of formal reports, i.e. Site Investigation, Remedial Action Report, and/or Closure Report, should be submitted to the Department. The major goals of any environmental cleanup action are to define the extent of contamination, choose appropriate remedial options and remediate soils/groundwater to state standards. All applicable State of Wisconsin regulations must be followed for these projects.

Effective this date, every 90 days, you or your consultant should provide the Department with a status report providing an update of site activities. Because the Department is experiencing a backlog of emergency and high priority sites (your site is currently ranked as "Low" priority), workload and staffing levels do not allow us to provide you with review and oversight at this time. However, as workload and staff levels are adjusted, we will review your consultant's work for completeness at the time you request a PECFA review or closeout of your site. You should continue to submit correspondence to the following address:

Wisconsin Department of Natural Resources
Attn: Tom Verstegen
905 Bayshore Drive
Box 2565
Oshkosh,WI 54903

Printed on Recycled Paper

All correspondence and reports should be identified with the assigned WDNR LUST ID number. Unless otherwise requested, please send only one copy of all submittals.

If you are interested in obtaining the protection of limited liability undert s. 144.765, Stats., please contact Mark Giesfeldt at (608) 267-7562 or Darsi Foss at (608) 267-6713, in the Department of Natural Resources' Madison office for more information. The liability exemption under s. 144.765, Stats., is available to persons who meet the definition of "purchaser" in s. 144.765 (1) (c) and receive Department approval for the response actions taken at the property undergoing cleanup. The Department will determine eligibility for this program on a case-by-case basis, prior to the "purchaser" developing a scope of work for conducting a ch. NR 716 site investigation at the property.

If I can be of further assistance, please feel free to contact me at (414) 424-7887.

Sincerely,

Thomas Verstegen

Thomas Verstegen
Hydrogeologist
Leaking Underground Storage Tank Program

cc: Case File - OSH
Dave Fries, Omnni Associates, 303 S. Bluemound Road, Appleton, WI 54914

OMNI ASSOCIATES

Soil and Groundwater Investigation

at

Kaukauna Municipal Garage
201 W. Second St.
Kaukauna, WI

LMD #45-1729

June 27, 1994

Project N-1019A

TABLE OF CONTENTS

	Page
Executive Summary	1
Introduction/Background	1
Geology and Hydrogeology	2
Field Activities	2
Soil Borings	2
Well Installation	2
Field and Analytical Results	3
Soil	3
Groundwater	3
Analysis of Degree and Extent of Contamination	3
Conclusions/Recommendations	4
Standard Of Care	4
Distribution	5

LIST OF APPENDICES

	Appendix
Figures	A
Figure 1 - Site Location Map	
Figure 2 - Site Detail Map	
Tables	B
Table I - Summary of Field Headspace Analysis - Soil Boring Samples	
Table II - Summary of Laboratory Analysis - Soil Boring Samples	
Table III - Summary of Laboratory Analysis - Groundwater	
DNR Forms	C
Soil Boring Log Information Forms 4400-122	
DNR Monitoring Well Construction Forms 4400-113A	
Monitoring Well Development Forms 4400-113B	
Borehole Abandonment Forms 3300-5B	
Groundwater Monitoring Well Information Form 4400-89 and Well Specific Field Sheets	
Handbook of Field Procedures	D
Laboratory Analysis Results And Chain Of Custody Documentation	E

EXECUTIVE SUMMARY

OMNNI has completed the subsurface investigation at the City of Kaukauna Municipal Garage, 201 W. Second Street, Kaukauna, WI. The investigation was performed at the request of the Wisconsin Department of Natural Resources (DNR) following the report of petroleum contamination discovered during maintenance of piping for an underground waste oil storage tank (UST) in December, 1993. The waste oil tank remains in use.

In order to determine the extent of the contamination, five soil borings were completed at the site on March 21, 1994. A groundwater monitoring well was constructed in one of the borings.

The soil samples collected from each boring were tested for diesel range organics (DRO) and petroleum volatile organic compounds (PVOCs). The sample collected from boring B4 was also tested for polynuclear aromatic hydrocarbons (PAHs), lead, cadmium, and PCBs. The groundwater sample was tested for DRO, lead, cadmium, and volatile organic compounds (VOCs).

Analytical test results indicated that the soil has been impacted in the tank bed area. Soil samples collected from borings located away from the tank bed indicate that the contamination is not extensive. The groundwater has not been impacted downgradient of the waste oil tank.

OMNNI recommends that a remedial action plan be developed to address the soil contamination associated with the waste oil tank system. The remedial action should occur during the tank removal. OMNNI also recommends that the monitoring well on-site be sampled quarterly for PVOCs to continue to monitor the groundwater quality at the site.

INTRODUCTION/BACKGROUND

In December, 1993, petroleum contamination was discovered during maintenance of piping for an underground storage tank containing waste oil. Laboratory analysis results indicated a diesel range organics (DRO) concentration of 1,200 ppm in a sample collected at this time. The tank remains in use. The piping maintenance work was performed by U.S. Petroleum Equipment and Environmental Services.

OMNNI was contracted by the City of Kaukauna to perform the investigation at the site. The site is located in the N 1/4 of Government Lot 22, T21N, R18E, Outagamie County, Wisconsin. (See Figure 1 - Site Location Map, Appendix A.)

The following are the primary contacts for the project:

Owner: City of Kaukauna, 201 W. Second Street, Kaukauna, WI 54130; (414) 766-6337.
Contact: Mr. John Sundelius.

Consultant: OMNNI Associates, 303 S. Bluemound Dr., Appleton, WI 54914; (414) 739-7814.
Contact: Mr. Dave Fries.

Driller: GCME Inc., 3471 Packerland Drive, De Pere, WI 54115; (414) 337-9077.
Contact: Mr. Mike Greil.

Laboratory: EN CHEM Inc., 1795 Industrial Drive, Green Bay, WI 54302; (800) 736-2436.
Contact: Mr. Dave Turiff.

GEOLOGY AND HYDROGEOLOGY

Surficial deposits in the vicinity of the site consist of sediment deposited during the Wisconsin Glaciation. According to United States Geological Survey maps (Water Resources of Wisconsin - Fox-Wolf River Basin, by Perry G. Alcott, 1968), these deposits are composed of glacial lake deposits consisting of mainly silt and clay. The silt and clay overlie the undifferentiated Platteville Formation, Decorah Formation, and Galena Dolomite of Ordovician age.

Subsurface materials encountered during drilling activities consisted of silty sands (SM) and sandy clay (CL) throughout each boring. Bedrock was encountered at a depth of approximately 10.5 feet on-site. Topography on-site is generally flat. Immediately off-site it slopes more steeply upward to the west. The Fox River is located approximately 1/6 mile to the northeast of the site, and Kankapot Creek is located to the east - southeast of the site.

The local groundwater movement is expected to be east - northeast. The depth to the shallow groundwater is approximately four feet.

Variations in groundwater depth and flow direction typically occur due to seasonal variations, and underground structures (e.g., sewers).

Surface water drainage in the general vicinity of the site is controlled by an engineered storm sewer system located on Third Street.

FIELD ACTIVITIES

SOIL BORINGS

Soil boring activities were performed on March 21, 1994. A total of five soil borings were installed to identify the extent of soil contamination. (See Figure 2 - Site Detail Map, Appendix A.) A groundwater monitoring well was installed in one of the soil borings to determine the impact of the contamination on the groundwater.

The borings were installed to depths of between 8.0 and 10.0 feet. (See DNR Forms, Appendix C, for specific information on boring and well construction.) The soil borings that were not converted to groundwater monitoring wells were properly abandoned per NR 141. (See DNR Forms, Appendix C for Borehole Abandonment Forms.)

Soil samples were obtained at two-foot intervals for field screening. At each sampling interval, a representative portion of the soil was also collected for possible laboratory analysis. (See Handbook of Field Procedures, Appendix D.) Soil samples were chosen from each boring for laboratory analysis based on headspace PID screening data, the location of the water table, and visual and olfactory observations.

WELL INSTALLATION

The monitoring well was installed and developed according to NR 141 groundwater monitoring well requirements. A seven-foot screen was placed in the well at a depth of approximately 10.5 feet, to intersect the water table at the site.

OMNNI surveyed the well. Elevations are based on a local reference point. Ground elevation was surveyed to the nearest 0.1 foot, and the top of the well casing to the nearest 0.01 foot.

The groundwater monitoring well was developed on March 31, 1994 and a sample was obtained from the well on April 12, 1994. (See Well Specific Field Sheets, Appendix C). Water level readings obtained by OMNNI indicated that the depth to the shallow groundwater table is approximately four feet from the ground surface.

FIELD AND ANALYTICAL RESULTS

SOIL

Results of field headspace screening of soils showed readings of between 0.0 ppm and 1,000 ppm (isobutylene equivalents) for all soil samples screened. (See Table 1 - Summary of Field Headspace Analysis, Soil Boring Samples, Appendix B.) The sample that exhibited the 1,000 ppm headspace had an odor characteristic of solvents and not waste oil. Field screening results and field observations showed waste oil contamination in boring location B4 only. Background readings of the ambient air prior to sampling were 0.0 ppm.

All samples collected for laboratory analysis from the area surrounding the waste oil tank system were tested for DRO and PVOCs. The sample collected from boring B4, located next to the tank bed, was also tested for PAHs, lead, cadmium, and PCBs.

Results of analytical testing on soil samples collected during drilling activities showed a DNR interim soil cleanup guideline exceedance (250 ppm) for DRO in the sample collected from B4. (See Table 2 - Summary of Laboratory Analysis, Soil Boring Samples, Appendix B, and Laboratory Results and Chain of Custody Documentation, Appendix F.) The DRO concentration in the sample collected from boring B5 was 12 ppm. DRO were not detected above the method detection limit in the samples collected from B1 - B3. Some low level PVOCs were detected in three of the borings. The interim guidelines for PVOCs were not exceeded. PCBs and PAHs were not detected above their method detection limits in sample B4-3. Lead was detected at a concentration of 4.4 ppm and cadmium was detected at a level of 0.03 ppm.

GROUNDWATER

The monitoring well was sampled on April 12, 1994. The groundwater sample was analyzed for VOCs, DRO, lead and cadmium during the first round.

Laboratory analysis results showed that the groundwater on-site has been slightly impacted. (See Table 3 - Summary of Laboratory Analysis, Groundwater, Appendix B.) Several VOCs were detected in the well. Benzene, 1,2-dichloroethane, and MTBE were detected above their preventive action limits (PALs). Lead was not detected above the method detection limit. Cadmium was detected at a level of 0.1 ppb.

ANALYSIS OF DEGREE AND EXTENT OF CONTAMINATION

The investigation carried out at the City of Kaukauna Municipal Garage has identified the extent of soil and groundwater contamination on-site.

The soil contamination on-site appears to be limited to the tank bed area. The samples collected from this area during the piping maintenance activities and during the investigation contained DRO levels above the interim soil guidelines (>250 ppm). Samples collected from the other soil borings during the investigation contained DRO concentrations at or below 12 ppm.

Vertical definition of the contamination in this area was determined during the investigation. Headspace screening of samples collected from B4 at this time showed contamination to be up to eight feet deep.

The groundwater sample collected from MW1, located downgradient from the tank bed, is slightly contaminated. The source of this contamination appears to be related to the waste oil tank. A DRO concentration of 690 ppb was detected in the water sample. The solvent odor observed in the soil sample collected from MW1 at a depth of 2 - 4 feet is indicative of another possible source of contamination in the well.

Depth to groundwater at this site is approximately four feet. The groundwater flow direction is expected to be to the north-northeast towards the Fox River.

CONCLUSIONS/RECOMMENDATIONS

OMNNI recommends that a remedial action plan be developed to address the soil and groundwater contamination at the site. The underground waste oil storage tank has not been removed from the site. Remediation of contaminated soil should occur in conjunction with the tank removal if cost effective. OMNNI also recommends that a monitoring program be developed to characterize trends in groundwater quality at the site. The program should provide for quarterly sampling of the wells to determine seasonal fluctuation in water table elevation and contaminant concentration. The well should be sampled for PVOCs.

STANDARD OF CARE

The conclusions presented in this investigation were arrived at using generally accepted hydrogeologic and engineering practices. The conclusions presented herein represent our professional opinions, based on the data collected at the time of the investigation, at the specific boring and sampling locations discussed in this report. Conditions at other locations on the property may be different than described in this investigation. Other than this, no warranty is expressed, implied or intended. The scope of this report is limited to the specific project and location described herein.

Prepared By: Dave Fries
Hydrogeologist

Reviewed By: Don Brittnacher
Director of Environmental Services

"I, David L. Fries, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Dave Fries / Hydrogeologist , 7/5/99
(Signature and Title) (Date)

DISTRIBUTION:

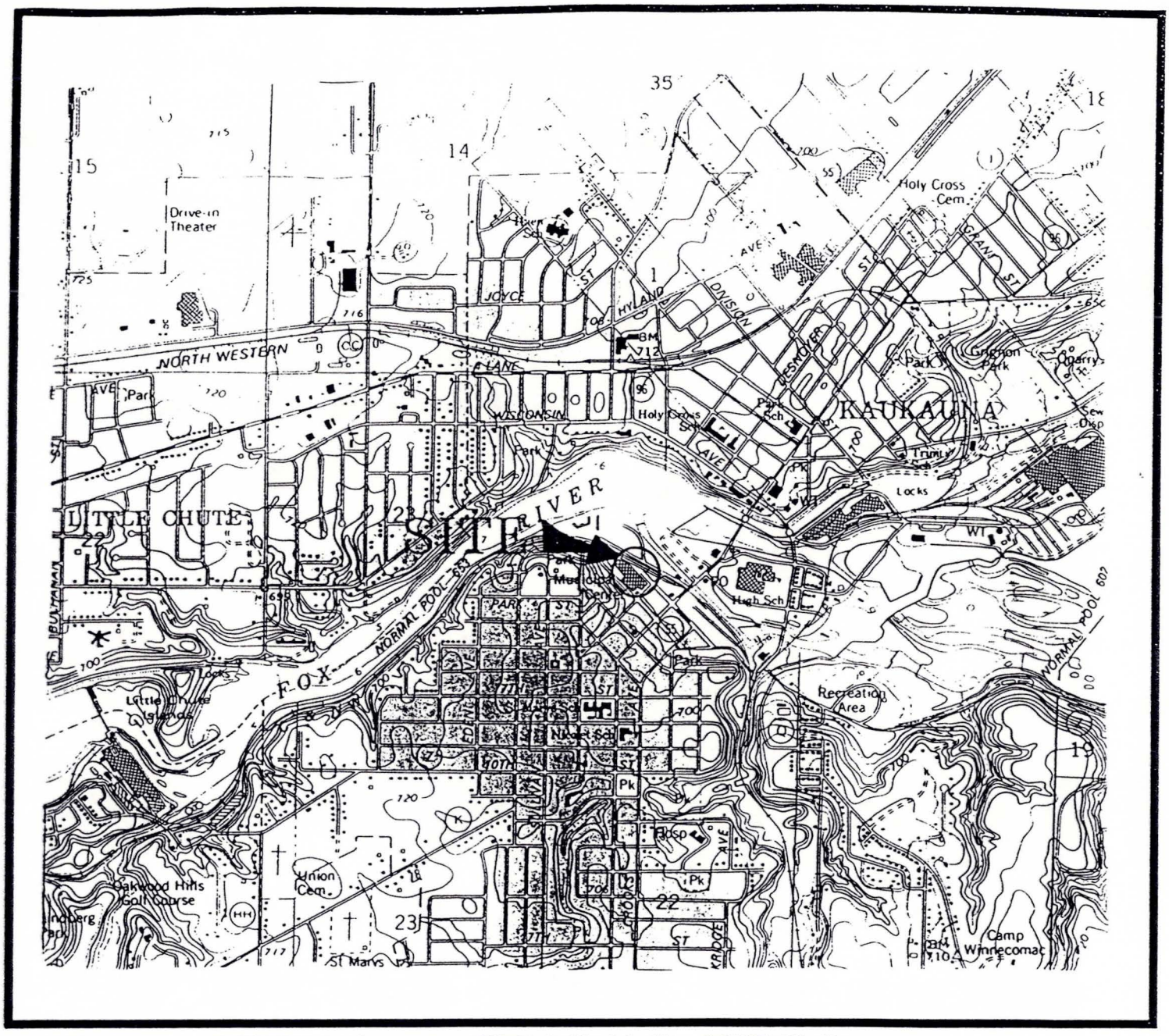
Mr. John Sundelius
City of Kaukauna Street Superintendent
201 W. Second Street
Kaukauna, WI 54130

Mr. Tom Verstegen
DNR - Oshkosh Area
905 Bayshore Drive
Oshkosh, WI 54903

DILHR - Safety & Buildings Division
P.O. Box 7969
Madison, WI 53707

APPENDIX A

FIGURES



SOURCE: USGS 7 5 MINUTE TOPOGRAPHIC MAP, KAUKAUNA, WISCONSIN QUADRANGLE, 1974 - PHOTOREVISED 1984

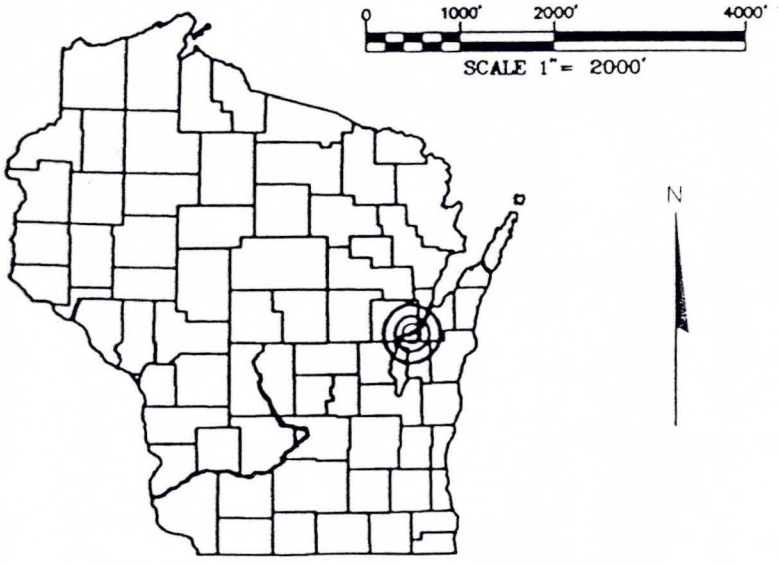


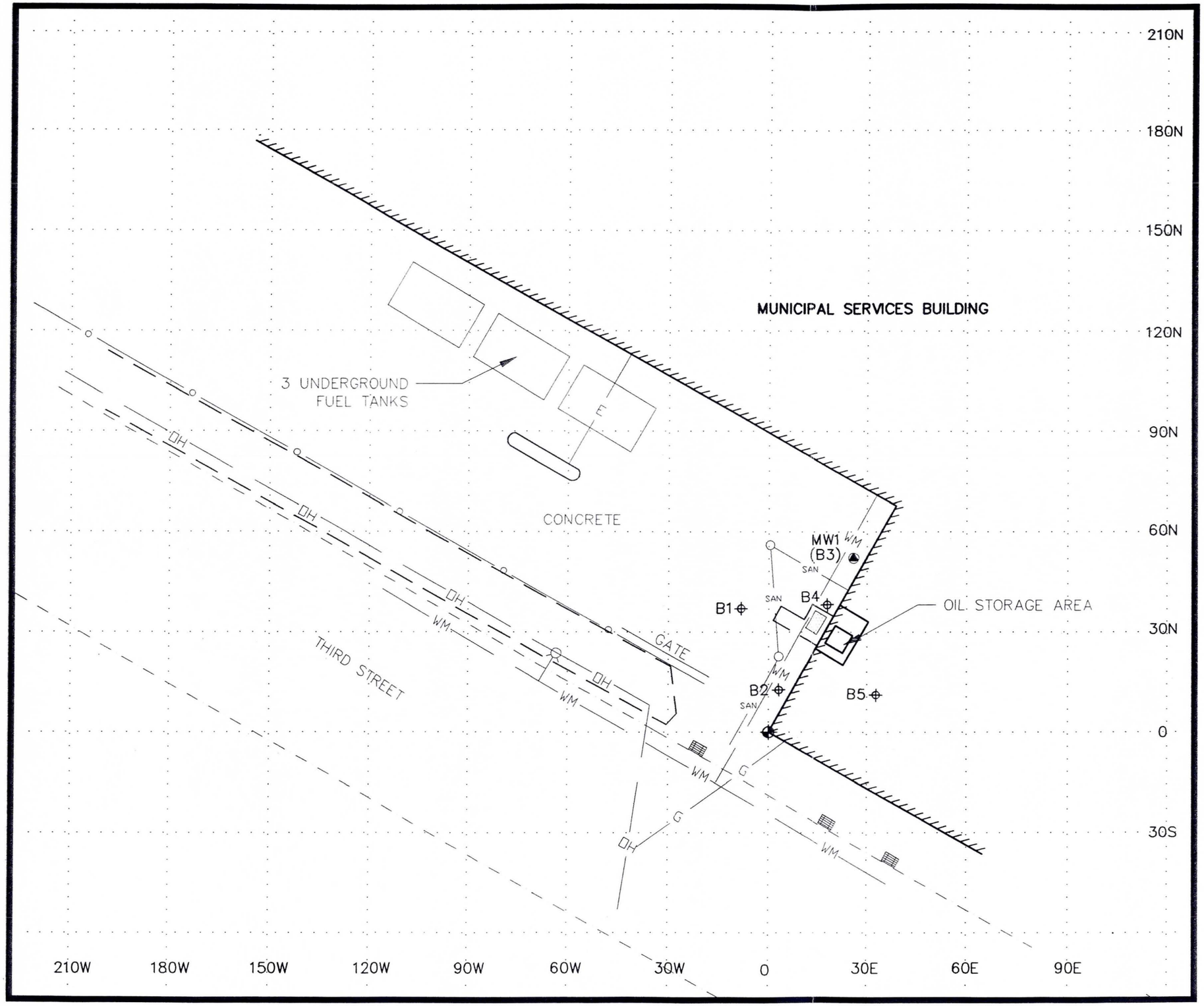
FIGURE 1
SITE LOCATION MAP

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

PROJECT	N1019B
CAD FILE	N1019B1.DWG
DRAWN	DLD
REVIEWED	
DATE	3/1/94

303 SOUTH BLUEMOUND DRIVE APPLETON, WI 54914
PHONE (414) 739-7814 FAX (414) 739-7765



LOCAL GRID NORTH
N

0' 6' 15' 30'
SCALE: 1" = 30'

LEGEND:

- MW1 — WELL LOCATION AND I.D. No.
- B1 — SOIL BORING LOCATION AND I.D. No.
- APPROXIMATE LOCATION OF 550 GALLON WASTE OIL TANK
- PUMP ISLAND
- SAN — SANITARY SEWER AND MANHOLE
- G — NATURAL GAS
- WM — WATERMAIN
- OH — OVERHEAD UTILITIES
- E — ELECTRICAL LINE
- HYDRANT
- EDGE OF ASPHALT
- EDGE OF STREET
- FENCE
- BUILDING FACE
- 30N — GRID LINE (30' INTERVAL)
- REFERENCE POINT

FIGURE 2
SITE DETAIL MAP

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

PROJECT :	N1019B
CAD FILE:	N1019B3.DWG
DRAWN :	DLD
DATE :	3/1/94
REVIEWED :	

303 SOUTH BLUEMOUND DRIVE APPLETON, WI 54914
PHONE : (414) 739-7814 FAX : (414) 739-7765

APPENDIX B

TABLES

TABLE 1
SUMMARY OF FIELD HEADSPACE ANALYSIS
SOIL BORING SAMPLES
CONCENTRATION IN PPM (ISOBUTYLENE EQUIVALENTS)
MARCH 21, 1994, SAMPLING EVENT

SAMPLE ID	SAMPLE LOCATION	DEPTH (FEET)	PID	SOIL CHARACTERISTICS
B1–1	Boring B1	2.0 – 4.0	4.0	Black silt with gravel fill. Slight odor?
* B1–2		4.0 – 6.0	10.0	Brown sand with silt and gravel. No odor.
B1–3		6.0 – 8.0	10.0	Brown clay. No odor.
B1–4		8.0 – 10.0	5.0	Brown clay with gravel.
B2–1	Boring B2	2.0 – 4.0	4.0	Brown silt with some gravel and cinders. No odor.
B2–2		4.0 – 6.0	3.0	Brown clay with gravel. No odor.
* B2–3		6.0 – 8.0	3.0	Brown clay with gravel. No odor.
B2–4		8.0 – 10.0	3.0	Tight red brown clay with no gravel. No odor.
B3–1	Monitoring Well MW1	2.0 – 4.0	1000	Black silt (fill) with cinders and gravel. Solvent/paint odor
* B3–2		4.0 – 6.0	93.0	Brown clay with some tan sand and gravel. No odor.
B3–3		6.0 – 8.0	3.0	Brown clay with gravel. No odor.
B3–4		8.0 – 10.0	1.0	Brown clay with gravel. No odor.
B4–1	Boring B4	2.0 – 4.0	0.0	Black silt with cinders (fill) and gravel. No odor.
B4–2		4.0 – 6.0	111	Clay with gravel and sand. Waste oil odor at tip.
* B4–3		6.0 – 8.0	15.0	Clay with gravel and sand. Some waste oil odor to 7 feet.
B4–4		8.0 – 10.0	0.0	Red brown clay. No odor.
B5–1	Boring B5	1	0.0	Silt with sand. No odor.
* B5–2		2.0 – 4.0	0.0	Silt with some gravel. No odor.
B5–3		4.0 – 6.0	0.0	Silt with wood organics. No odor.
B5–4		6.0 – 8.0	0.0	Silt. No odor.

* = sample sent in for laboratory analysis

TABLE 2
SUMMARY OF LABORATORY ANALYSIS
SOIL BORING SAMPLES
MARCH 21, 1994 SAMPLING EVENT

PARAMETER	GUIDE	B1-2	B2-3	B3-2	B4-3	B5-2
SAMPLE DEPTH (feet)	-	4.0 - 6.0	6.0 - 8.0	4.0 - 6.0	6.0 - 8.0	2.0 - 4.0
DIESEL RANGE ORGANICS (mg/kg)	250	ND	ND	ND	280	12
DETECTED PCBs (µg/kg)	-	NA	NA	NA	ND	NA
CADMIUM (mg/kg)	-	NA	NA	NA	0.03	NA
LEAD (mg/kg)	50	NA	NA	NA	4.4	NA
DETECTED PAHs (µg/kg)	-	NA	NA	NA	ND	NA
DETECTED PVOCs (µg/kg)						
BENZENE	5.5	1.7	ND	ND	ND	ND
ETHYLBENZENE	2900	ND	ND	ND	2.4	ND
MTBE	-	3.1	ND	ND	ND	ND
m,p-XYLENE	4100	ND	ND	380	12	ND
o-XYLENE	4100	ND	ND	ND	1.1	ND

NA = not analyzed
ND = not detected
= sample concentrations detected over the DNR guideline

TABLE 3
SUMMARY OF LABORATORY ANALYSIS
GROUNDWATER
APRIL 12, 1994, SAMPLING EVENT

PARAMETER (µg/L)	ES	PAL	MW1
DETECTED VOCs			
BENZENE	5	0.5	1.2
1,2-DICHLOROETHANE	5	0.5	4.9
ETHYLBENZENE	700	140	3.6
MTBE	65	12	17
m,p-XYLENE	620	124	23
DIESEL RANGE ORGANICS	-	-	690
CADMIUM	5	0.5	0.1

ES = enforcement standard
PAL = preventive action limit
= sample concentrations detected over the preventive action limit

APPENDIX C

DNR FORMS

WELL SPECIFIC FIELD SHEET (WSFS) - Monitoring Wells

Fill out one column of this form for each monitoring well which is sampled on each sampling date.

Facility Name: City of Kaukauna N-1019B Date: 04/12/94

License or Permit#: _____ Weather Conditions: Overcast 40°

Persons Sampling: Karl Breuer

Sampling Equipment (for measuring water level, purging, sampling and filtering. Include model if appropriate.) Hydac pH/Conductivity meter, Voss Disposable Bailers, Keck Water / Product Interface Meter

*Well Name	MW1
*DNR ID No.	
Pipe top elevation (MSL) Reference elevation if different	
Measured depth to water (ft)	4.17
Correction	
Total depth to water (ft)	
**Water elevation (MSL)	
Depth to bottom of well (ft)	9.5
Volume H_2O in well (gal)	0.87
Volume to be purged (4x vol. in well)	3.48
Time purging begun	9:51
Time purging completed	9:57
Purged dry? (Y/N)	N
Time sample with drawn	10:03
Field temperature (°C)	8.7
Field conductivity (uncorrected)	2990
**Field conductivity (at 25°C)	
Time conductivity measured	10:10
Field pH (std. units)	7.19
Time pH measured	10:09
Color (Y/N)	N
Odor (Y/N)	N
Turbidity (Y/N)	Y

*Well Name	MW1
Sample field filtered? (Y/N)	Y
Time filtered	10:20
Well cap and lock replaced? (Y/N)	Y

Comments (discuss condition of well, casing, seal, etc. and problems, including any deviations from the sampling plan): Well in good condition. Water purged from well was volatilized on blacktop. Samples sent to Enchem.

* Fill out before going into field
** Can be calculated later

State of Wisconsin
Department of Natural Resources

GROUNDWATER MONITORING WELL INFORMATION FORM

Chapter 144, Wis. Stats.
Form 4400-89

Rev. 1-90

Facility Name	Facility ID Number	Date	Completed By (Name and Firm)
City of Kaukauna Municipal Bldg.		05/18/94	Dave Fries - OMNNI, Environmental Division

Well Name	DNR Well ID Number	Well Location	N	S	E	W	Date Established	Well Casing Diam.	Well Casing Type	Elevations Top of Well Casing	Elevations Ground Surface	Reference MSL (✓)	Reference Site Datum (✓)	Screen Length	Well Depth	Type of Well (✓) PIEZ	OW	PW	LYS	Other	Abandoned	Enf. Stds Apply	Gradient U, S, D, or N
MW1		52	X				03/21/94	2"	PVC	656.87	657.4	✓		7'	9.6'		X					Y	D
		26			X																		

Location Coordinates Are:

☐ Local Grid System (preferred)
☐ State Plane Coordinate
☐ Northern
☐ Central

Remarks:

PSS Use:

File Maint. Completed: _____

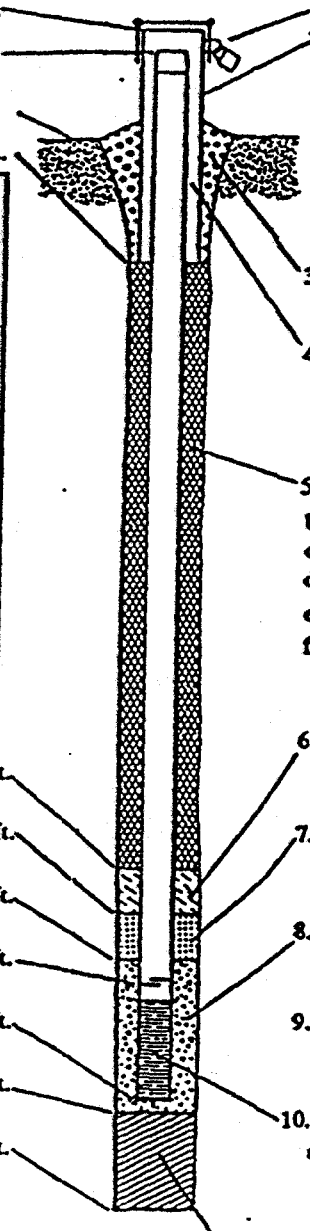
Other: _____

ate of Wisconsin
epartment of Natural Resources

Route to: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4-90

cility/Project Name: City of Kaukauna Municipal Bldg
Local Grid Location of Well: 52 ft. ■ N. ☐ S. 26 ft. ■ E. ☐ W.
Well Name: MW1
cility License, Permit or Monitoring Number:
Grid Origin Location: Lat. _____ Long. _____ or
St. Plane _____ ft. N, _____ ft. E.
Wis. Unique Well Number: DNR Well Number:
pe of Well: Water Table Observation Well ■ 11; Piezometer ☐ 12
Date Well Installed: 03/21/94 (m m / d d / y y)
Section Location of Waste/Source: GOV. Lot 22, 1/4 of N 1/4 of Sec. 22, T. 21 N, R. 18 ☐ E. ■ W.
stance Well Is From Waste/Source Boundary: Approximately 20 ft.
Well Installed By: (Person's Name and Firm) GCME/Mike Griel
Well A Point of Enforcement Std. Application? ■ Yes ☐ No
Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ■ Downgradient n ☐ Not Known



Protective pipe, top elevation 657.45 ft. MSL
Well casing, top elevation 656.87 ft. MSL
Land surface elevation 657.4 ft. MSL
Surface seal, bottom 656.4 ft. MSL or 1.0 ft.

USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

Sieve analysis attached? ☐ Yes ☐ No

Drilling method used: Rotary ☐ 50; Hollow Stem Auger ■ 41; Other ☐ _____

Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

Drilling additives used? ☐ Yes ☐ No

Describe _____

Source of water (attach analysis): _____

Bentonite seal, top 656.4 ft. MSL or 1.0 ft.
Fine sand, top _____ ft. MSL or _____ ft.
Filter pack, top 654.9 ft. MSL or 2.5 ft.
Screen joint, top 654.4 ft. MSL or 3.0 ft.
Well bottom 647.4 ft. MSL or 10.0 ft.
Filter pack, bottom 646.9 ft. MSL or 10.5 ft.
Borehole, bottom 646.9 ft. MSL or 10.5 ft.
Borehole, diameter 8.3 in.
O.D. well casing 2.07 in.
I.D. well casing 1.9 in.

1. Cap and lock? ■ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 9.0 in.
   b. Length: 10 ft.
   c. Material: Steel ■ 04; Other ☐ _____
   d. Additional protection? ☐ Yes ■ No
   If yes, describe: _____
3. Surface seal: Bentonite ☐ 30; Concrete ■ 01; Other ☐ _____
4. Material between well casing and protective pipe: Bentonite ☐ 30; Annular space seal ☐ _____; Other ☐ _____
5. Annular space seal: a. Granular Bentonite ■ 33
   b. _____ Lbs/gal mud weight ... Bentonite-sand slurry ☐ 35
   c. _____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
   d. _____ % Bentonite ..... Bentonite-cement grout ☐ 50
   e. .5 Ft³ volume added for any of the above
   f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ■ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
   b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
   c. _____ Other ☐ _____
7. Fine sand material: Manufacturer, product name & mesh size
   a. _____
   b. Volume added _____ ft³
8. Filter pack material: Manufacturer, product name and mesh size
   a. 35-45 Badger Mining Corp. Silica
   b. Volume added 2.5 ft³
9. Well casing: Flush threaded PVC schedule 40 ■ 23; Flush threaded PVC schedule 80 ☐ 24; Other ☐ _____
10. Screen material: PVC
    a. Screen type: Factory cut ■ 11; Continuous slot ☐ 01; Other ☐ _____
    b. Manufacturer Johnson Filtration
    c. Slot size: 0.01 in.
    d. Slotted length: 7.0 ft.
11. Backfill material (below filter pack): None ■ 14; Other ☐ _____

hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Dave Jr
Firm: OMNNI Associates

ease complete both sides of this form and return to the appropriate DNR office listed at the top of this form as required by chs. 144, 147 and 160, Wis. Stats., d ch. NR 141, Wis. Ad. Code. In accordance with ch.144, Wis Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than 000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each y of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT

Form 3300-5B Rev. 7-89

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: B1

County: Outagamie

Gov. Lot ___ 1/4 of N 1/4 of Sec. 22 ; T. 21 N; R. 18 ■ E ☐ W

(If applicable) ___ Gov't Lot ___ Grid Number

Grid Location: 37 ft. ■ N. ☐ S., 8 ft. ☐ E. ■ W.

Civil Town Name:

Street Address of Well: 201 W. Second Street

City, Village: Kaukauna, WI

(2) FACILITY NAME

Original Well Owner (If Known):

Present Well Owner: City of Kaukauna

Street or Route: 201 W. Second Street

City, State, Zip Code: Kaukauna, WI 54130

Facility Well No. and/or Name (If Applicable):

WI Unique Well No.: _ _ _ _ _ _

Reason For Abandonment: For Soil Sampling Only

Date of Abandonment: 03/21/94

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On (Date): 03/21/94

☐ Monitoring Well
☐ Water Well
☐ Drillhole
■ Borehole

Construction Report Available? ☐ Yes ■ No

Construction Type:
Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) 10.5 (From groundsurface) Casing Diameter (ins.)

Casing Depth (ft.)

Was Well Annular Space Grouted? ☐ Yes ☐ No ☐ Unknown
If Yes, To What Depth? Feet

(4) Depth to Water (Feet): Approximately 4 feet

Pump & Piping Removed?	☐ Yes	☐ No	■ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	■ Not Applicable
Screen Removed?	☐ Yes	☐ No	■ Not Applicable
Casing Left in Place?	☐ Yes	■ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☐ No	N/A
Did Sealing Material Rise to Surface?	■ Yes	☐ No	
Did Material Settle After 24 Hours?	☐ Yes	■ No	
If Yes, Was Hole Retopped?	☐ Yes	☐ No	

(5) Required Method of Placing Sealing Material
■ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☐ Other (Explain)

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete) Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
■ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt/Concrete	Surface	1	-	
3/8" Bentonite Pellets	1	10.5	~2 Ft^3	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: GCME/OMNNI

Signature of Person Doing Work: Dan [illegible] Date Signed: 6/7/94

Street or Route: 303 S. Bluemound Drive Telephone Number: (414) 739-7814

City, State, Zip Code: Appleton, WI 54914

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected | District/County

Reviewer/Inspector

Follow-up Necessary

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT

Form 3300-5B Rev. 7-89

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: B2

County: Outagamie

Gov. Lot ___ 1/4 of N 1/4 of Sec. 22 ; T. 21 N; R. 18 ■ E ☐ W

(If applicable) ___ Gov't Lot ___ Grid Number

Grid Location: 13 ft. ■ N. ☐ S., 3 ft. ■ E. ☐ W.

Civil Town Name:

Street Address of Well: 201 W. Second Street

City, Village: Kaukauna, WI

(2) FACILITY NAME

Original Well Owner (If Known):

Present Well Owner: City of Kaukauna

Street or Route: 201 W. Second Street

City, State, Zip Code: Kaukauna, WI 54130

Facility Well No. and/or Name (If Applicable):

WI Unique Well No.: _ _ _ _ _ _

Reason For Abandonment: For Soil Sampling Only

Date of Abandonment: 03/21/94

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On

(Date) 03/21/94

☐ Monitoring Well
☐ Water Well
☐ Drillhole
Borehole

Construction Report Available? ☐ Yes ■ No

Construction Type:
■ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) 10 Casing Diameter (ins.) ___
(From groundsurface)

Casing Depth (ft.) ___

Was Well Annular Space Grouted? ☐ Yes ☐ No ☐ Unknown
If Yes, To What Depth? ___ Feet

(4) Depth to Water (Feet) Approximately 4 feet

Pump & Piping Removed?	☐ Yes	☐ No	■ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	■ Not Applicable
Screen Removed?	☐ Yes	☐ No	■ Not Applicable
Casing Left in Place?	☐ Yes	■ No	

If No, Explain ___

Was Casing Cut Off Below Surface?	☐ Yes	☐ No	N/A
Did Sealing Material Rise to Surface?	■ Yes	☐ No	
Did Material Settle After 24 Hours?	☐ Yes	■ No	
If Yes, Was Hole Retopped?	☐ Yes	☐ No	

(5) Required Method of Placing Sealing Material
■ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☐ Other (Explain)

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete) Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
■ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt/Concrete	Surface	1		
3/8" Bentonite Pellets	1	10	~ 2 Ft^3	

(8) Comments:

(9) Name of Person or Firm Doing Sealing Work: GCME/OMNNI

Signature of Person Doing Work: Dave [illegible] Date Signed: 6/7/94

Street or Route: 303 S. Bluemound Drive Telephone Number: (414) 739-7814

City, State, Zip Code: Appleton, WI 54914

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected: District/County:

Reviewer/Inspector:

Follow-up Necessary:

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT

Form 3300-5B Rev. 7-89

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: B4

County: Outagamie

Gov. Lot ___ 1/4 of N 1/4 of Sec. 22 ; T. 21 N; R. 18 ■ E ☐ W

(If applicable) ___ Gov't Lot ___ Grid Number

Grid Location: 38 ft ■ N. ☐ S., 18 ft ■ E. ☐ W.

Civil Town Name:

Street Address of Well: 201 W. Second Street

City, Village: Kaukauna, WI

(2) FACILITY NAME

Original Well Owner (If Known):

Present Well Owner: City of Kaukauna

Street or Route: 201 W. Second Street

City, State, Zip Code: Kaukauna, WI 54130

Facility Well No. and/or Name (If Applicable):

WI Unique Well No.: _ _ _ _ _ _

Reason For Abandonment: For Soil Sampling Only

Date of Abandonment: 03/21/94

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On (Date): 03/21/94

☐ Monitoring Well
☐ Water Well
☐ Drillhole
— Borehole

Construction Report Available? ☐ Yes ■ No

Construction Type:
■ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) 10' (From groundsurface) Casing Diameter (ins.)

Casing Depth (ft.)

Was Well Annular Space Grouted? ☐ Yes ☐ No ☐ Unknown
If Yes, To What Depth? ___ Feet

(4) Depth to Water (Feet): Approximately 4 feet

Pump & Piping Removed?	☐ Yes	☐ No	■ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	■ Not Applicable
Screen Removed?	☐ Yes	☐ No	■ Not Applicable
Casing Left in Place?	☐ Yes	■ No	

If No, Explain

Was Casing Cut Off Below Surface?	☐ Yes	☐ No	N/A
Did Sealing Material Rise to Surface?	■ Yes	☐ No	
Did Material Settle After 24 Hours?	☐ Yes	■ No	
If Yes, Was Hole Retopped?	☐ Yes	☐ No	

(5) Required Method of Placing Sealing Material
■ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☐ Other (Explain)

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete) Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
■ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite

(7)

Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt/Concrete	Surface	1	-	
3/8" Bentonite Pellets	1	10	≈ 2 Ft^3	

(8) Comments:

Name of Person or Firm Doing Sealing Work: GCME/OMNNI

Signature of Person Doing Work: [signature] Date Signed: 6/7/94

Street or Route: 303 S. Bluemound Drive Telephone Number: (414) 739-7814

City, State, Zip Code: Appleton, WI 54914

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	
Follow-up Necessary	

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT

Form 3300-5B
Rev. 7-89

All abandonment work shall be performed in accordance with the provisions of Chapters NR 111, NR 112 or NR 141, Wis. Admin. Code, whichever is applicable. Also, see instructions on back.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location: B5

County: Outagamie

Gov. Lot ___ 1/4 of N 1/4 of Sec. 22 ; T. 21 N; R. 18 ■ E ☐ W

(If applicable) ___ Gov't Lot ___ Grid Number

Grid Location: 11 ft. ■ N. ☐ S., 32 ft. ■ E. ☐ W.

Civil Town Name:

Street Address of Well: 201 W. Second Street

City, Village: Kaukauna, WI

(2) FACILITY NAME

Original Well Owner (If Known):

Present Well Owner: City of Kaukauna

Street or Route: 201 W. Second Street

City, State, Zip Code: Kaukauna, WI 54130

Facility Well No. and/or Name (If Applicable):

WI Unique Well No.: _ _ _ _ _ _

Reason For Abandonment: For Soil Sampling Only

Date of Abandonment: 03/21/94

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On

(Date) 03/21/94

☐ Monitoring Well
☐ Water Well
☐ Drillhole
Borehole

Construction Report Available? ☐ Yes ■ No

Construction Type:
■ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify)

Formation Type:
Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft.) 10 Casing Diameter (ins.) ___
(From groundsurface)

Casing Depth (ft.) ___

Was Well Annular Space Grouted? ☐ Yes ☐ No ☐ Unknown
If Yes, To What Depth? ___ Feet

(4) Depth to Water (Feet) Approximately 4 feet

Pump & Piping Removed?	☐ Yes	☐ No	■ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	■ Not Applicable
Screen Removed?	☐ Yes	☐ No	■ Not Applicable
Casing Left in Place?	☐ Yes	■ No	

If No, Explain ___

Was Casing Cut Off Below Surface?	☐ Yes	☐ No	N/A
Did Sealing Material Rise to Surface?	■ Yes	☐ No	
Did Material Settle After 24 Hours?	☐ Yes	■ No	
If Yes, Was Hole Retopped?	☐ Yes	☐ No	

(5) Required Method of Placing Sealing Material
■ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Dump Bailer ☐ Other (Explain)

(6) Sealing Materials — For monitoring wells and monitoring well boreholes only
☐ Neat Cement Grout
☐ Sand-Cement (Concrete) Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
■ Chipped Bentonite
☐ Bentonite Pellets
☐ Granular Bentonite

(7) Sealing Material Used	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	Mix Ratio or Mud Weight
Asphalt/Concrete	Surface	1	-	
3/8" Bentonite Pellets	1	10	~2 Ft^3	

(8) Comments: ___

(9) Name of Person or Firm Doing Sealing Work: GCME/OMNNI

Signature of Person Doing Work: Dave [illegible] Date Signed: 6/7/94

Street or Route: 303 S. Bluemound Drive Telephone Number: (414) 739-7814

City, State, Zip Code: Appleton, WI 54914

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected | District/County

Reviewer/Inspector

Follow-up Necessary

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
■ Underground Tanks
☐ Water Resources
☐ Other _____

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
City of Kaukauna		B1

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
GCME, Mike Griel	03 / 21 / 94 (M M D D Y Y)	03 / 21 / 94 (M M D D Y Y)	6.25" SSA

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			_____ Feet MSL	_____ Feet MSL	6.25 inches

Boring Location
State Plane _____ N, _____ E S/C/N
_____ 1/4 of N 1/4 of Gov. Lot 22 _____, T 21 N, R 18 E

Lat __° __' __"
Long __° __' __"

Local Grid Location (if applicable)
37.00 Feet ☐ S 8.00 Feet ■ W ☐ N ☐ E

County	DNR County Code	Civil Town/City/ or Village
Outagamie	4 5	City of Kaukauna

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/Comments
			1											
			2											
		24												
		12												
1	24	7	3	Black SILT with GRAVEL				4.0		M				
		6												
			4											
		3												
		5												
2	12	23	5	Brown SAND with SILT and GRAVEL No odor				10.0		W				Lab sample collected
		6												
			6											
		8												
		23												
3	24	22	7	Brown CLAY No odor				10.0		W				
		21												
			8											
		10												
		24												
4	24	23	9	Brown CLAY with GRAVEL				5.0		W				
		21												
			10											
				BEDROCK @ 10.5 feet										
			11											
			12											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature _____ Firm OMNNI, Environmental Division
303 S. Bluemound Dr., Appleton, WI 54914

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number	Length Recovered (In)								Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											
			32											

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
■ Underground Tanks
☐ Water Resources
☐ Other _____

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
City of Kaukauna		B2

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
GCME, Mike Griel	03/21/94 (M M D D Y Y)	03/21/94 (M M D D Y Y)	6.25" SSA

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			_____ Feet MSL	_____ Feet MSL	6.25 inches

Boring Location
State Plane _____ N, _____ E S/C/N
_____ 1/4 of N 1/4 of Gov. Lot 22 _____, T 21 N, R 18 E

Lat __° __' __"
Long __° __' __"

Local Grid Location (if applicable)
13.00 Feet ☐ S 3.00 Feet ☐ W
■ N ■ E

County	DNR County Code	Civil Town/City/ or Village
Outagamie	4 5	City of Kaukauna

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/Comments
1	15	3 3 3 3	1 2 3 4	Brown SILT with some GRAVEL and CINDERS No odor				4.0		M/W				
2	2	2 2 3 3	5 6	Brown CLAY with GRAVEL No odor				3.0		W				
3	6	8 12 14 7	7 8	Brown CLAY with GRAVEL No odor				3.0		W				Lab sample collected
4	24	12 14 14	9 10 11 12	Tight red-brown CLAY No GRAVEL No odor E.O.B. @ 10.0 Feet				3.0		W				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Dave [illegible] Firm OMNNI, Environmental Division
303 S. Bluemound Dr., Appleton, WI 54914

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number	Length Recovered (in)								Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											
			32											

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
■ Underground Tanks
☐ Water Resources
☐ Other _____

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
City of Kaukauna		B3

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
GCME, Mike Griel	03 / 21 / 94 (M M D D Y Y)	03 / 21 / 94 (M M D D Y Y)	8.50" SSA

DNR Facility Well No.	PE Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW1	_____ Feet MSL	_____ Feet MSL	8.50 inches

Boring Location
State Plane _____ N, _____ E S/C/N
_____ 1/4 of N 1/4 of Gov. Lot 22, T 21 N, R 18 E
Lat __° __' __"
Long __° __' __"

Local Grid Location (if applicable)
■ N ☐ S 52.00 Feet
■ E ☐ W 26.00 Feet

County	DNR County Code	Civil Town/City/ or Village
Outagamie	45	City of Kaukauna

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/Comments
1	24	5 6 6 8	1 2 3 4	Black SILT (FILL) with CINDERS and GRAVEL SOLVENT/paint odor				1,000		M				
2	24	3 5 4 6	5 6	Brown CLAY with some tan SAND and GRAVEL				93.0		M/W				Lab sample collected
3	24	4 6 9 13	7 8	Brown CLAY with GRAVEL No odor				3.0		M/W				
4	18	6 7 13 50	9 10	Brown CLAY with GRAVEL No odor E.O.B. @ 10.0 Feet				1.0		W				
			11 12											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Dave Lin

Firm: OMNNI, Environmental Division
303 S. Bluemound Dr., Appleton, WI 54914

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number	Length Recovered (in)								Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22											
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			27											
			28											
			29											
			30											
			31											
			32											

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
■ Underground Tanks
☐ Water Resources
☐ Other _____

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
City of Kaukauna		B4

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
GCME, Mike Griel	03 / 21 / 94 (M M D D Y Y)	03 / 21 / 94 (M M D D Y Y)	6.25" SSA

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			_____ Feet MSL	_____ Feet MSL	6.25 inches

Boring Location
State Plane _____ N, _____ E S/C/N
_____ 1/4 of N 1/4 of Gov. Lot 22, T 21 N, R 18 E

Lat __° __′ __″
Long __° __′ __″

Local Grid Location (if applicable)
38.00 Feet ☐ S ■ N 18.00 Feet ☐ W ■ E

County	DNR County Code	Civil Town/City/ or Village
Outagamie	45	City of Kaukauna

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/Comments
			1											
			2											
		4												
		5												
1	15	5	3	Black SILT with CINDERS (FILL) and GRAVEL No odor				0.0		M				
		4												
			4											
		4												
		4												
2	24	8	5	CLAY with GRAVEL and SAND Waste OIL odor at tip				111		W				
		4												
			6											
		5												
		7												
3	24	28	7	CLAY with GRAVEL and SAND Some WASTE OIL odor to 7 feet				15.0		W				Lab sample collected
		15												
			8											
		11												
		12												
4	24	12	9	Red brown CLAY with no GRAVEL or SAND No odor				0.0		W				
		15												
			10											
			11											
			12											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Dave [illegible] Firm OMNNI, Environmental Division
303 S. Bluemound Dr., Appleton, WI 54914

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number	Length Recovered (in)								Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
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			22											
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			27											
			28											
			29											
			30											
			31											
			32											

State of Wisconsin
Department of Natural Resources

Route To:
☐ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
■ Underground Tanks
☐ Water Resources
☐ Other _____

SOIL BORING LOG INFORMATION

Form 4400-122 7-91

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
City of Kaukauna		B5

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
GCME, Mike Griel	03/21/94 (M M D D Y Y)	03/21/94 (M M D D Y Y)	6.25" SSA

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			_____ Feet MSL	_____ Feet MSL	6.25 inches

Boring Location
State Plane _____ N, _____ E S/C/N
_____ 1/4 of N 1/4 of Gov. Lot 22, T 21 N, R 18 E
Lat __° __' __"
Long __° __' __"

Local Grid Location (if applicable)
11.00 Feet ☐ S ■ N
32.00 Feet ☐ W ■ E

County	DNR County Code	Civil Town/City/ or Village
Outagamie	4 5	City of Kaukauna

Sample Number	Sample Length Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	RQD/Comments
1		Push Spoon	3	SILT with SAND No odor				0.0		M				
2	9	Push Spoon	5	SILT with some GRAVEL No odor				0.0		M/W				Lab sample collected
3	2	Push Spoon	7	ORGANICS (SILT with WOOD) No odor				0.0		W				
4	1	Push Spoon	9	SILT No odor				0.0		W				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature _____ Firm OMNNI, Environmental Division
303 S. Bluemound Dr., Appleton, WI 54914

This form is authorized by Chapters 144.147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number	Length Recovered (In)								Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
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			25											
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			27											
			28											
			29											
			30											
			31											
			32											

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400–113B Rev. 4–90

Route to: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☒ Other ☐ _____

Facility/Project Name	County Name	Well Name
City of Kaukauna	Outagamie	MW1
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number** / **DNR Well Number**
	4 5	

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☒	41
Surged with bailer and pumped	☐	61
surged with block and bailed	☐	42
surged with block and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☐	51
pumped slowly	☐	50
Other _____	☐	

3. Time spent developing well: 2 2 min.

4. Depth of well (from top of well casing): 9 . 6 ft.

5. Inside diameter of well: 2 . 0 0 in.

6. Volume of water in filter pack and well casing: 5 . 2 gal.

7. Volume of water removed from well: 9 . 0 gal.

8. Volume of water added (if any): 0 . 0 gal.

9. Source of water added: N/A

10. Analysis performed on water added? ☐ Yes ☐ No (if yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 3 . 9 4 ft.	9 . 2 0 ft.
Date	b. 0 3/3 1/9 4 (m m d d y y)	0 3/3 1/9 4 (m m d d y y)
Time	c. 3 : 1 5 ☐ am ☒ pm	3 : 4 4 ☐ am ☒ pm
12. Sediment in well bottom	0 . 5 inches	0 . 0 inches
13. Water clarity	clear ☐ 10; Turbid ☒ 15	clear ☐ 20; Turbid ☒ 25
(Describe)	Very muddy brown	Very Cloudy
Fill in if drilling fluids were used and well is at solid waste facility:		
14. Total suspended solids	. mg/l	. mg/l
15. COD	. mg/l	. mg/l

16. Additional comments on development:

Well developed by: Person's Name and Firm

Name: Karl Breuer

Firm: OMNNI Associates, Environmental Division

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Karl Breuer

Print Initials: K G B

Firm: OMNNI Associates, Environmental Division

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

APPENDIX D

HANDBOOK OF FIELD PROCEDURES

HANDBOOK OF FIELD PROCEDURES

TABLE OF CONTENTS

	Page
PERSONNEL QUALIFICATIONS	1
SOIL BORING INSTALLATION PROCEDURES	2
SOIL SAMPLING PROCEDURES	2
Minimum Sample Headspace Equilibration Time	3
Instrument Specifications	3
MONITORING WELL INSTALLATION AND DEVELOPMENT PROCEDURES	3
GROUNDWATER SAMPLING PROCEDURES & V.O.C. SAMPLING NOTES	4
DECONTAMINATION PROCEDURES	6
Drilling	6
TABLE 1 - Soil Sample Preparation Guide	8
TABLE 2 - Soil Sample Analysis Guide for Petroleum Contamination	9
TABLE 3 - Water Sample Preparation Guide	10

PERSONNEL QUALIFICATIONS

Kurt F. Zacharias - Completed 40-hour hazardous waste training.
Bachelors Degree in Natural Science from the St. Norbert College DePere, WI.
Masters Degree in Geology from Michigan State University, East Lansing, MI.
Certified Site Assessor-05254.

Faye De Broux Ewald - Completed 40-hour hazardous waste training.
Bachelors Degree in Geology and Education from University Wisconsin-Oshkosh.
Certified Hydrogeologist according to NR 500.03 (64) and NR 500.31 (e)2.
Certified Site Assessor-03689.

David L. Fries - Completed 40-hour hazardous waste training.
Bachelors Degree in Geology from Lawrence University, Appleton, WI.
Masters Degree in Environmental Science from University of Wisconsin-Green Bay.
Certified Hydrogeologist according to NR 500.03 (64) and NR 500.31 (e)2.
Certified Site Assessor-01662.

Susan M. Courter - Completed 40-hour hazardous waste training.
Bachelors Degree in Environmental Geology from University Wisconsin-Oshkosh.
Certified Hydrogeologist according to NR 500.03 (64) and NR 500.31 (e)2.
Certified Site Assessor-01661.

Jim Riggs - Completed 40-hour hazardous waste training.
Associate Degree in Natural Resource Technology from Fox Valley Technical College.

Karl Breuer - Bachelors Degrees in Earth Science and Environmental Science, University of Wisconsin - Green Bay.
Certified Hydrogeologist according to NR 500.03 (64) and NR 500.31 (e)2.

Deanna Drum - Associate Degree in Mechanical Design, Fox Valley Technical College

BORING INSTALLATION PROCEDURES

A number of different drilling firms are used for environmental investigations. Borings intended to be converted to monitoring wells are advanced using 7 5/8" O.D. x 4 1/2" I.D. hollow stem augers or 4" O.D. solid stem augers powered by a truck-mounted drill rig. If bedrock drilling is required, borings are advanced using either air or mud-rotary drilling techniques. Soil borings not intended for monitoring wells are typically advanced using 4" O.D. solid stem augers. Soil borings that are not converted to groundwater monitoring wells are properly abandoned per NR 141.

Samples are typically obtained from each boring at 2.5' intervals by split-spoon sampling according to ASTM D-1586. A portion of each sample is screened with a photoionization detector (PID). At each sampling interval, a representative portion of the soil is also collected for possible laboratory analysis. Soil samples are chosen from each boring for laboratory analysis based on headspace screening data, and visual and olfactory observations. In general, the sample from each boring that exhibits the highest PID reading is chosen for analysis. See the Soil Sampling Procedures below, for further information pertaining to field headspace analysis and sample collection procedures.

SOIL SAMPLING PROCEDURES

All soil sampling is performed in accordance with DNR PUBL-SW-127, Soil Sampling Requirements for LUST Site Investigations and Excavations and DILHR ch. 10, Flammable and Combustible Liquids. The soil samples were collected and analyzed in accordance with DNR PUBL-SW-130 92REV, LUST Analytical Guidance, July, 1993. Our standard instruments and sample collection procedures are as follows.

1. Soil samples are collected from a split-spoon sampler during environmental drilling.

2. Sample collector wears new latex exam gloves when collecting samples to decrease the risk of personal exposure and cross contamination.

3. A portion of the sample is placed in a new glass jar with a teflon lined lid, immediately placed on ice, and later delivered to the laboratory for analysis. This procedure will be discussed in more detail later in this report. (See Table 1)

4. The remaining portion of the sample is placed in a clean 4 oz. jar (approx ½ filled), and sealed with aluminum foil and a teflon lined lid. The head space sample is then agitated for minimum of 30 seconds and then allowed to equilibrate. Minimum equilibration time will correspond to the following specifications.

Ambient Outside Air Temperature at the Time of Sample Collection	Minimum Amount of Time Sample Must Equilibrate at 70 o F or Greater Temperature
< 40°F	40 min.
41 - 55°F	20 min.
56 - 69°F	10 min.
> 70°F	5 min.

When the sample has completed equilibration, it will be promptly field analyzed with a portable photoionization detector (PID). OMNNI uses either a Photovac Inc. Microtip HL-200 or a Thermo Environmental Instruments Model 580A OVM, both equipped with a 10.6 ev lamp. A background reading is first taken. The PID probe is then inserted into the jar through a single hole in the aluminum foil. The instrument reading is measured at one-half the distance between the foil seal and the sample surface. The measured reading is then recorded.

Isobutylene at a concentration of 100 ppm is used for field calibration gas. The PID meter is field calibrated at the following times:

- At the beginning of each day
- After any significant change in temperature or humidity
- Every 3 hours
- After any repairs to the instrument are performed

5. All samples are returned to the laboratory as soon as possible, usually the day the sample was collected. All samples are returned to the lab with a chain of custody form, form #4400-151. Time of sample collection and sample PID reading is listed. Care is taken to ensure that the chain-of-custody form is properly and fully completed before submitting to the laboratory.

6. The samples will be sent to a laboratory certified by the Wisconsin Department of Natural Resources.

7. Table 2 on page 9 outlines the required DNR laboratory analysis for specific UST contaminants.

Soil analyses, other than those in Table 2 will be conducted in accordance with methods approved by the DNR.

MONITORING WELL INSTALLATION AND DEVELOPMENT PROCEDURES

The monitoring wells are typically constructed of two-inch, schedule 40, flush-threaded PVC casings and well screens. Prior to use, well parts are individually wrapped in plastic.

Wells are installed and developed according to NR 141, DNR Groundwater Monitoring Well Requirements. The monitoring wells are installed with ten or fifteen foot screens which are placed in the borings to intersect the water table. Piezometers are installed with five foot screens sealed beneath

the water table. Filter pack and annular space seal material are installed by gravity as the augers are withdrawn from the hole. Wells are cut to the required height using a PVC pipe cutter.

An as-constructed well and boring survey is performed by OMNNI once field work is complete. Elevations are either based on a local datum of 100 feet, or a U.S.G.S. elevation, assigned to a mark on a reference point located at the site. Ground elevation is surveyed to the nearest 0.1 foot, and the top of the well casing to the nearest 0.01 foot.

A horizontal grid system is established at the site with the origin of the grid set on the reference point. Wells and borings are located with respect to this grid system.

To properly develop each monitoring well, water is removed until a consistent water quality is obtained. This is done by removing 10 times the water volume in the well and filter pack, removing water until it is free of sediment, or removing the water until the well is purged dry. Water is removed from the wells by bailing the water with as little agitation as possible. If the water level is unaffected by bailing and large amounts of water are to be removed, the well is developed by using the surge and purge method with a Red Lion centrifugal pump. No water is added to the well during development.

The development water is barrelled, pending the results of analytical testing. If the well is suspected to be clean and small volumes of water are to be removed, the water may be spread on pavement to volatilize any possible contaminants.

GROUNDWATER SAMPLING PROCEDURES & V.O.C. SAMPLING NOTES

A. Devices used to measure water elevation, purge wells and retrieve samples:

1. Groundwater levels are measured with a fiberglass reel tape with a weighted stainless steel "sounder" at the end.

2. In wells that have free product on top of the water surface, depth to water and depth to product are measured with a fiberglass reel tape with an interface probe at the end.

3. Wells are purged and samples are collected by one of the following methods:

   a) Wells are purged with a Voss disposable bailer.

   b) Alternate purging and sampling equipment consists of Fultz centrifugal groundwater sampling pump.

B. Procedures for calculating purge volumes, purging wells and sampling:

1. Wells are normally sampled starting from the up-gradient area and progressing toward the down-gradient area of the site. When the degree of contamination is known, least contaminated wells are sampled first, the more contaminated wells sampled last.

2. All the wells are opened before the depth to groundwater is determined.

3. Wells are purged by removing four water volumes within a casing or all the water until the well runs dry.

4. Once all the wells have been purged, the samples are drawn using equipment mentioned above.

5. Sample, odor, turbidity, temperature, conductivity and pH are determined on the unfiltered portion of the sample and recorded on the well specific field sheet. A Hydac pH / Temperature / Conductivity meter is used for in field measurements.

6. When the sample requires filtering, the sample is filtered with an in-line pump (as soon after collection as possible).

7. Quality Assurance / Quality Control Samples

   a) Trip and field blanks will consist of three new 40 ml vials filled with deionized water. These are sent to the laboratory for (P)VOC analysis. If no field contamination has occurred, these samples will have no detectable (P)VOCs.

   b) One trip blank should be analyzed for every 10 samples collected. Trip blanks are poured, labeled, and sealed, then taken out in the field. Trip blanks are kept with all samples collected until reaching the field.

   c) Field blanks are used if the bailers are not dedicated to a specific well. If there is a possibility for field cross contamination of samples, field blanks may also be taken at the sample collectors discretion.

   d) One temperature blank is collected per batch of samples.

   e) One duplicate sample is collected with every 10 samples.

8. Samples are refrigerated, then transported to a State certified laboratory for testing as soon as possible.

9. A chain of custody will be filled out listing all samples collected, requested laboratory analysis, date and time of collection, and the name of the sample collector. This document will remain with the samples at all times and bear the names of all persons handling the samples until the samples are received by the laboratory.

C. Procedures for cleaning equipment:

1. In the field, sampling equipment is rinsed with a 10% methanol solution and then flushed three times with deionized water between each well sampled.

2. Equipment that is still contaminated after field cleaning will be rinsed with tap water, washed off with detergent, rinsed with a 10% methanol solution, and flushed three times with deionized water.

D. Transporting samples to lab:

1. Filtered, preserved, labelled, and sealed samples are iced and transported to the lab for analysis as soon as possible.

2. The laboratory will be notified by the sample collector when courier service is required.

E. The above procedures constitute normal groundwater sampling procedures. Modifications to each of the outlined items may be applicable for site specific conditions or special volatile organic sampling considerations. Methods used are consistent with WDNR "Groundwater Sampling Procedures Guidelines" Publ. WR-153, February, 1987.

DECONTAMINATION PROCEDURES

Decontamination is the process of removing and/or neutralizing contaminants that may have accumulated on PPE (personnel protective equipment) and equipment. Proper decontamination is a critical element in the control of hazards which helps ensure the health and safety of workers. Proper decontamination also contains the contamination to the site, thus preventing further environmental problems.

The following decontamination procedures should be used when completing borings, installing monitoring wells, and/or installing remediation systems.

A. Between samples, the split spoon will be cleaned in a multiple rinse, surfactant solution (soap and water or Alconox solution).

B. The sample will be collected while wearing new latex exam gloves.

C. The surface upon which the sample is collected will be cleaned between samples.

D. If sample collector(s) is wearing gloves, they will be changed between samples.

E. Soil which has accumulated around the boring will either be stockpiled or barreled. If the soil is stockpiled, it will be placed on and covered with visqueen. The stockpiled or barreled soil will later be disposed of in compliance with the DNR regulations.

F. Upon completion of the boring, the augers will be decontaminated before they are used again. The following procedures will be followed when decontaminating drilling equipment:

1. A decontamination basin lined with plastic (visqueen) is set up near the work area.

2. All contaminated equipment is placed in the decontamination basin.

3. A pressurized steam cleaner is used to clean all contaminated equipment.

4. Following steam cleaning, the auger is removed from the decontamination basin.

5. Upon completion of the job, the accumulated water in the decontamination basin is pumped out and placed in a barrel. Wash water used for cleaning the split spoons is also added to the barrel. The barrel will be disposed of in compliance with all regulatory agencies.

6. The visqueen used in the decontamination basin is disposed of in compliance with all regulatory agencies.

Table 1
SOIL SAMPLE PREPARATION GUIDE *

TEST	CONTAINER SIZE **	SAMPLE SIZE	PRESERVATIVE	HOLDING TIME
GRO Gasoline Range Organics	2 oz. wide mouth jar (2 per sample)	25 g	25 ml Methanol (purge and trap grade)	4 days
DRO Diesel Range Organics	4 oz. wide mouth jar (2 per sample)	4 oz.	None	4 days
Total Lead / Total Cadmium	4 oz. wide mouth jar (2 per sample)	4 oz.	None	6 months
VOC / PVOC Volatile Organic Compounds	4 oz. wide mouth jar (2 per sample)	4 oz.	None	14 days
PCB Polychlorinated Biphenyls	4 oz. wide mouth jar (2 per sample)	4 oz.	None	14 days
PAH Polynuclear Aromatic Hydrocarbons	4 oz. wide mouth jar (2 per sample)	4 oz.	None	14 days

* All samples will be sealed, labeled, and placed on ice immediately after collection.
** To ensure a proper seal between the sample container and the cap, no soil shall remain on the jar or cap threads.

Table 2

SOIL SAMPLE ANALYSIS GUIDE FOR PETROLEUM CONTAMINATION

PETROLEUM SUBSTANCE	CLOSURE ASSESSMENT	SOLID WASTE PRO./LANDFILLS	SITE INVESTIGATIONS
Gasoline Aviation Fuel	GRO	Free Liquids GRO Benzene Haz. Waste Det.	GRO PVOC Pb
Diesel Jet Fuel No.'s 1, 2, 4 Fuel Oil	DRO	Free Liquids DRO Benzene Haz.Waste Det.	DRO PVOC PAH
Crude Oil Lubricat. Oil No. 6 Fuel Oil	DRO	Free Liquids DRO Haz.Waste Det.	DRO PAH
Unknown Petroleum	GRO and DRO	Free Liquids GRO and DRO Pb, Cd, CH S Haz.Waste Det.	GRO and DRO VOC/PVOC PAH Pb, Cd
Waste Oil	DRO	Free Liquids DRO VOC Pb, Cd, CH S Haz.Waste Det.	DRO VOC/PVOC PAH PCB's Pb, Cd

Table 3
WATER SAMPLE PREPARATION GUIDE *

TEST	SAMPLE SIZE / CONTAINER	PRESERVATIVE	HOLDING TIME
VOC / PVOC Volatile Organic Compounds	3 - 40 ml vials filled with no headspace	0.5 ml of 1:1 HCl	14 days
DRO Diesel Range Organics	1 - 1 liter amber glass bottle	5 ml of 1:1 HCl	7 days
GRO Gasoline Range Organics	3 - 40 ml vials filled with no headspace	0.5 ml of 1:1 HCl	14 days
PAH Polynuclear Aromatic Hydrocarbons	1 - 1 liter amber glass bottles	None	7 days
PCB Polychlorinated Biphenyls	1 - 1 liter amber glass bottle	None	7 days
LEAD / CADMIUM metals **	1 - 250 ml plastic bottle	2 ml of HNO_3 or to a pH of <2	6 months

* All sample will be sealed, labeled, and placed on ice immediately after collection.
** When testing for dissolved metals, the sample will be field filtered before preservation.

APPENDIX E

LABORATORY ANALYSIS RESULTS
AND
CHAIN OF CUSTODY DOCUMENTATION

State of Wisconsin
Department of Natural Resources

EN CHEM INC.

CHAIN OF CUSTODY RECORD
LUST PROGRAM
Based on Form 4400-151 Rev. 4-93

Note: Use of this form is voluntary but is requested by the Department pursuant to ch. NR 149, NR 500-540, NR 158 and NR 419, Wis.Adm.Code. Personally identifiable information will be used for no other purpose.

Sample Collector(s)	Job #	Title/Work Station/Company	Telephone Number (include area code)
Dave Fries / OMNNI	N1019B	Hydro / OMNNI Associates	(414) 739-7814
Property Owner	**Property Address**		**Telephone Number (include area code)**
City of Kaukauna Municipal Serv. Bldg	201 W. Second St.		( )

I hereby certify that I received, properly handled and disposed of these samples as noted below:

Relinquished By (Signature) Dave Fries	Date/Time 3/22/94 12:12	Received By (Signature) W. Colin Burtess
Relinquished By (Signature) W. Colin Burtess	Date/Time 3/22/94 1:46pm	Received By (Signature)
Relinquished By (Signature)	Date/Time 3/22/94 1:40p	Received for EN CHEM by (Signature) [illegible]

LABORATORY USE ONLY

Temperature of temperature blank 0.0, cc

If samples were received on ice and there was ice remaining, you may report the temperature as 'received on ice'. If all of the ice was melted, the temperature of the melt may be substituted for a temperature blank

Field ID Number	Date Collected	Time Collected	Sample Type 1	Sample Device	Preserv. Type	Field Screening	Location/Description (see footnote 2)	Analysis Type	Lab ID Number	Sample Condition: no/Type of Containers	Cracked /broken	Improp. Sealed	Good Cond.	Other Comments
B1-2	3/21/94	9:18	Soil	SS	NA		4'-6'	2,5	112069 ~~112012~~ JT				✓	
B2-3	↓	9:58	↓	↓	↓		6'-8'	2,5	112070 ~~112013~~ JT				✓	
B3-2		10:33					4'-6'	2,5	112071 ~~112014~~ JT				✓	
B4-3		12:30					6'-8'	2,5,6, 3, PCB, Cd	112072 ~~112015~~ JT				✓	
B5-2	↓	2:10	↓	↓	↓		4'-6'	2,5	112073 ~~112016~~ JT				✓	

FOOTNOTES
1. specify groundwater, surface water, soil, leachate, sludge, etc.
2. sample description must clearly correlate the sample ID to the sampling location.

ANALYSIS CODES

1. GRO	5. DRO	9. Free Liquids	13. BETX
2. PVOC	6. PAH	10. pH	14. Protocol D1-GRO
3. Lead	7. Flashpoint	11. TCLP-Benzene	15. Protocol D1-DRO
4. 8021	8. Percent Solids	12. TCLP-Lead	16. 8260

BILLING ADDRESS:

DEPARTMENT USE ONLY

Split samples: Offered? __ yes __ no (Check one)
Accepted? __ yes __ no (Check one)

Accepted By:

Prelim 940327
30 min

EN CHEM INC.

...chemistry for the environment

1795 Industrial Drive
Green Bay, WI 54302
414-469-2436
800-7-ENCHEM
FAX:414-469-8827

Lab Certification No. 405132750
Location : PRO# N1019B MUNICIPAL SERV BDG
Your Sample ID: B1-2
Sample Desc. : 4-6'
Sample Matrix : SOIL Date Collected: 03/21/1994
En Chem Proj# : 9403130 Date Received : 03/22/1994
En Chem Lab # : 112069 Date Reported : 03/28/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
VOC-S	Benzene	1.7	ug/kg	1.1	SW846 5030	03/25/1994	SW846 8260	03/25/1994	HW
	Ethyl Benzene	ND	ug/kg	1.1					
	Methyl-tert-butyl ether	3.1	ug/kg	1.1					
	Toluene	ND	ug/kg	1.1					
	1,2,4-trimethylbenzene	ND	ug/kg	1.1					
	1,3,5-trimethylbenzene	ND	ug/kg	1.1					
	Xylenes, m + p	ND	ug/kg	1.1					
	Xylene, o	ND	ug/kg	1.1					
DRO-S	Diesel Range Organics(DRO)-Soil	ND	mg/kg	4.6		03/23/1994	WDNR MOD DRO	03/23/1994	NJS

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

Nicki Mellberg

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Lab Certification No. 405132750
Location : PRO# N1019B MUNICIPAL SERV BDG
Your Sample ID: B2-3
Sample Desc. : 6-8'
Sample Matrix : SOIL Date Collected: 03/21/1994
En Chem Proj# : 9403130 Date Received : 03/22/1994
En Chem Lab # : 112070 Date Reported : 03/28/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
VOC-S	Benzene	ND	ug/kg	1.2	SW846 5030	03/25/1994	SW846 8260	03/25/1994	HW
	Ethyl Benzene	ND	ug/kg	1.2					
	Methyl-tert-butyl ether	ND	ug/kg	1.2					
	Toluene	ND	ug/kg	1.2					
	1,2,4-trimethylbenzene	ND	ug/kg	1.2					
	1,3,5-trimethylbenzene	ND	ug/kg	1.2					
	Xylenes, m + p	ND	ug/kg	1.2					
	Xylene, o	ND	ug/kg	1.2					
DRO-S	Diesel Range Organics(DRO)-Soil	ND	mg/kg	5.2		03/23/1994	WDNR MOD DRO	03/23/1994	NJS

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Lab Certification No. 405132750
Location : PRO# N10198 MUNICIPAL SERV BDG
Your Sample ID: 83-2
Sample Desc. : 4-6'
Sample Matrix : SOIL Date Collected: 03/21/1994
En Chem Proj# : 9403130 Date Received : 03/22/1994
En Chem Lab # : 112071 Date Reported : 03/31/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
EDC-S	Benzene	ND	ug/kg	3.0	SW846 5030	03/30/1994	SW846 8260	03/30/1994	HW
	Ethyl Benzene	ND	ug/kg	3.0					
	Methyl-tert-butyl ether	ND	ug/kg	3.0					
	Toluene	ND	ug/kg	3.0					
	1,2,4-trimethylbenzene	ND	ug/kg	3.0					
	1,3,5-trimethylbenzene	ND	ug/kg	3.0					
	Xylenes, m + p	380	ug/kg	3.0					
	Xylene, o	ND	ug/kg	3.0					
DRO-S	Diesel Range Organics(DRO)-Soil	ND	mg/kg	5.1		03/23/1994	WDNR MOD DRO	03/23/1994	NJS

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

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Rob K Melby

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Lab Certification No. 405132750
Location : PRO# N1019B MUNICIPAL SERV BDG
Your Sample ID: B4-3
Sample Desc. : 6-8'
Sample Matrix : SOIL Date Collected: 03/21/1994
En Chem Proj# : 9403130 Date Received : 03/22/1994
En Chem Lab # : 112072 Date Reported : 04/05/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
VOC-S	Benzene	ND	ug/kg	1.1	SW846 5030	03/25/1994	SW846 8260	03/25/1994	HW
	Ethyl Benzene	2.4	ug/kg	1.1					
	Methyl-tert-butyl ether	ND	ug/kg	1.1					
	Toluene	ND	ug/kg	1.1					
	1,2,4-trimethylbenzene	ND	ug/kg	1.1					
	1,3,5-trimethylbenzene	ND	ug/kg	1.1					
	Xylenes, m + p	12	ug/kg	1.1					
	Xylene, o	1.1	ug/kg	1.1					
PCB	PCB-1016	ND	ug/kg	9.2		03/28/1994	SW846 8080	03/28/1994	*SUB
	PCB-1221	ND	ug/kg	32					
	PCB-1232	ND	ug/kg	98					
	PCB-1242	ND	ug/kg	31					
	PCB-1248	ND	ug/kg	28					
	PCB-1254	ND	ug/kg	9.2					
	PCB-1260	ND	ug/kg	4.0					
-S	Lead, soil	4.4	mg/kg	0.2	SW846 3050		SW846 6010	03/26/1994	*SUB
PAH-S	Acenaphthene	ND	ug/kg	19	SW846 3510	03/24/1994	SW846 8310	03/25/1994	NJS
	Acenaphthylene	ND	ug/kg	38					
	Anthracene	ND	ug/kg	0.8					
	Benzo (a) anthracene	ND	ug/kg	0.9					
	Benzo (a) pyrene	ND	ug/kg	0.8					
	Benzo (b) fluoranthene	ND	ug/kg	0.8					
	Benzo (ghi) perylene	ND	ug/kg	1.1					
	Benzo (k) fluoranthene	ND	ug/kg	0.8					
	Chrysene	ND	ug/kg	0.9					
	Dibenzo (a,h) anthracene	ND	ug/kg	0.8					
	Fluoranthene	ND	ug/kg	0.8					

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Lab Certification No. 405132750
Location : PRO# N1019B MUNICIPAL SERV BDG
Your Sample ID: B4-3
Sample Desc. : 6-8'
Sample Matrix : SOIL Date Collected: 03/21/1994
En Chem Proj# : 9403130 Date Received : 03/22/1994
En Chem Lab # : 112072 Date Reported : 04/05/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
[redacted]AH-S	Fluorene	ND	ug/kg	3.8	SW846 3510	03/24/1994	SW846 8310	03/25/1994	NJS
	Indeno (1,2,3-cd) pyrene	ND	ug/kg	0.8					
	1-Methylnaphthalene	ND	ug/kg	19					
	2-Methylnaphthalene	ND	ug/kg	19					
	Naphthalene	ND	ug/kg	19					
	Phenanthrene	ND	ug/kg	3.8					
	Pyrene	ND	ug/kg	3.8					
[redacted]RO-S	Diesel Range Organics(DRO)-Soil	280	mg/kg	11		03/24/1994	WDNR MOD DRO	03/25/1994	NJS
[redacted]-S	Cadmium, soil	0.03	mg/kg	0.03	SW846 3050		SW846 6010	03/26/1994	*SUB

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

Nick Melby

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FAX:414-469-8827

Lab Certification No. 405132750
Location : PRO# N1019B MUNICIPAL SERV BDG
Your Sample ID: B5-2
Sample Desc. : 4-6'
Sample Matrix : SOIL Date Collected: 03/21/1994
En Chem Proj# : 9403130 Date Received : 03/22/1994
En Chem Lab # : 112073 Date Reported : 03/29/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
VOC-S	Benzene	ND	ug/kg	1.2	SW846 5030	03/28/1994	SW846 8260	03/28/1994	HW
	Ethyl Benzene	ND	ug/kg	1.2					
	Methyl-tert-butyl ether	ND	ug/kg	1.2					
	Toluene	ND	ug/kg	1.2					
	1,2,4-trimethylbenzene	ND	ug/kg	1.2					
	1,3,5-trimethylbenzene	ND	ug/kg	1.2					
	Xylenes, m + p	ND	ug/kg	1.2					
	Xylene, o	ND	ug/kg	1.2					
DRO-S	Diesel Range Organics(DRO)-Soil	12	mg/kg	5.0		03/24/1994	WDNR MOD DRO	03/25/1994	NJS

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

Nikki Melbey

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State of Wisconsin
Department of Natural Resources

EN CHEM INC.

CHAIN OF CUSTODY RECORD
LUST PROGRAM
Based on Form 4400-151 Rev. 4-93

Note: Use of this form is voluntary but is requested by the Department pursuant to ch. NR 149, NR 500-540, NR 158 and NR 419, Wis.Adm.Code. Personally identifiable information will be used for no other purpose.

Sample Collector(s)	Title/Work Station/Company	Telephone Number (include area code)
Karl Brewer	Env. Tech - OMNNI	735-6900
Property Owner	**Property Address**	**Telephone Number (include area code)**
City of Kaukauna	N10193	

I hereby certify that I received, properly handled and disposed of these samples as noted below:

Relinquished By (Signature)	Date/Time	Received By (Signature)
Karl Brewer	4/12/94 2:15pm	Virginia Reader
Relinquished By (Signature)	Date/Time	Received By (Signature)
Relinquished By (Signature)	Date/Time	Received for EN CHEM by (Signature)
W. John Bodine	4/12/94 3:00p	Joanne Wiedel

LABORATORY USE ONLY

Temperature of temperature blank TOL

If samples were received on ice and there was ice remaining, you may report the temperature as 'received on ice'. If all of the ice was melted, the temperature of the melt may be substituted for a temperature blank

Field ID Number	Date Collected	Time Collected	Sample Type 1	Sample Device	Preserv. Type	Field Screening	Location/Description (see footnote 2)	Analysis Type	Lab ID Number	Sample Condition: no/Type of Containers	Cracked /broken	Improp. Sealed	Good Cond.	Other Comments
Trip	4/12/94	8:30	H2O	Grab	HCl		Trip Blank	4	13016	3-40 mL			X	
MW1	4/12/94	10:03	H2O	Grab	HCl/HNO3		Monitoring Well 1	3, 4, 5 Chromium	13017	3-40 mL 1-1 liter 1-250			X	

FOOTNOTES
1. specify groundwater, surface water, soil, leachate, sludge, etc.
2. sample description must clearly correlate the sample ID to the sampling location.

ANALYSIS CODES

1. GRO	5. DRO	9. Free Liquids	13. BETX
2. PVOC	6. PAH	10. pH	14. Protocol D1-GRO
3. Lead	7. Flashpoint	11. TCLP-Benzene	15. Protocol D1-DRO
4. 8021	8. Percent Solids	12. TCLP-Lead	16. 8260

BILLING ADDRESS:

DEPARTMENT USE ONLY

Split samples: Offered? __ yes __ no (Check one)
Accepted? __ yes __ no (Check one)

Accepted By:

94040 64

EN CHEM INC.

...chemistry for the environment

1795 Industrial Drive
Green Bay, WI 54302
414-469-2436
800-7-ENCHEM
FAX:414-469-8827

Lab Certification No. 405132750
Location : PRO# N1019B
En Chem Proj# : 9404069
Date Reported : 05/04/1994

Report to: OMNNI ASSOCIATES

Thank you for using En Chem! Samples were analyzed according to strict EPA or Wisconsin DNR methodology. Any comments or problems associated with the receipt of or analysis are reported below:

Sample no. 113017: The BS and BSD for DRO were within the recovery limits but the percent difference was out of control, 26%.

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FAX:414-469-8827

Lab Certification No. 405132750
Location : PRO# N1019B
Your Sample ID: TRIP
Sample Desc. : TRIP BLANK
Sample Matrix : WATER Date Collected: 04/12/1994
En Chem Proj# : 9404069 Date Received : 04/12/1994
En Chem Lab # : 113016 Date Reported : 04/20/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

nalysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
021	Benzene	ND	ug/l	0.6	SW846 5030	04/19/1994	SW846 8021	04/19/1994	RJN
	Bromobenzene	ND	ug/l	1.0					
	Bromodichloromethane	ND	ug/l	1.0					
	n-Butylbenzene	ND	ug/l	1.0					
	sec-Butylbenzene	ND	ug/l	1.0					
	tert-Butylbenzene	ND	ug/l	1.0					
	Carbon tetrachloride	ND	ug/l	1.0					
	Chlorobenzene	ND	ug/l	1.0					
	Chlorodibromomethane	ND	ug/l	1.0					
	Chloroethane	ND	ug/l	1.0					
	Chloroform	ND	ug/l	1.0					
	Chloromethane	ND	ug/l	1.0					
	2-Chlorotoluene	ND	ug/l	1.0					
	4-Chlorotoluene	ND	ug/l	1.0					
	1,2-Dibromo-3-chloropropane	ND	ug/l	2.0					
	1,2-Dibromoethane	ND	ug/l	1.0					
	1,2-Dichlorobenzene	ND	ug/l	1.0					
	1,3-Dichlorobenzene	ND	ug/l	1.0					
	1,4-Dichlorobenzene	ND	ug/l	1.0					
	Dichlorodifluoromethane	ND	ug/l	4.0					
	1,1-Dichloroethane	ND	ug/l	1.0					
	1,2-Dichloroethane	ND	ug/l	1.0					
	1,1-Dichloroethene	ND	ug/l	1.0					
	cis-1,2-Dichloroethene	ND	ug/l	1.0					
	trans-1,2-Dichloroethene	ND	ug/l	1.0					
	1,2-Dichloropropane	ND	ug/l	1.0					
	1,3-Dichloropropane	ND	ug/l	1.0					
	2,2-Dichloropropane	ND	ug/l	1.0					
	Di-isopropyl ether	ND	ug/l	1.0					
	Ethyl Benzene	ND	ug/l	1.0					

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Lab Certification No. 405132750
Location : PRO# N1019B
Your Sample ID: TRIP
Sample Desc. : TRIP BLANK
Sample Matrix : WATER Date Collected: 04/12/1994
En Chem Proj# : 9404069 Date Received : 04/12/1994
En Chem Lab # : 113016 Date Reported : 04/20/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
21	Hexachlorobutadiene	ND	ug/l	1.0	SW846 5030	04/19/1994	SW846 8021	04/19/1994	RJN
	Isopropylbenzene	ND	ug/l	1.0					
	p-Isopropyltoluene	ND	ug/l	1.0					
	Methylene chloride	ND	ug/l	2.0					
	Methyl-tert-butyl-ether	ND	ug/l	1.0					
	Naphthalene	ND	ug/l	2.0					
	n-Propylbenzene	ND	ug/l	1.0					
	1,1,2,2-Tetrachloroethane	ND	ug/l	1.0					
	Tetrachloroethene	ND	ug/l	1.0					
	Toluene	ND	ug/l	1.0					
	1,2,3-Trichlorobenzene	ND	ug/l	1.0					
	1,2,4-Trichlorobenzene	ND	ug/l	1.0					
	1,1,1-Trichloroethane	ND	ug/l	1.0					
	1,1,2-Trichloroethane	ND	ug/l	1.0					
	Trichloroethene	ND	ug/l	1.0					
	Trichlorofluoromethane	ND	ug/l	1.0					
	1,2,4-Trimethylbenzene	ND	ug/l	1.0					
	1,3,5-Trimethylbenzene	ND	ug/l	1.0					
	Vinyl chloride	ND	ug/l	1.0					
	Xylenes, m + p	ND	ug/l	1.0					
	Xylene, o	ND	ug/l	1.0					

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:

Peter Mellberg

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1795 Industrial Drive
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FAX:414-469-8827

Lab Certification No. 405132750
Location : PRO# N10198
Your Sample ID: MW1
Sample Desc. : MONITORING WELL 1
Sample Matrix : WATER Date Collected: 04/12/1994
En Chem Proj# : 9404069 Date Received : 04/12/1994
En Chem Lab # : 113017 Date Reported : 05/04/1994

Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
LEAD-GRAPH	Lead, Graphite Analysis	ND	ug/l	1.0	SW 846 3020		SW846 7421	04/21/1994	*SUB
DRO	Diesel Range Organics(DRO)-Water	690	ug/l	100		04/15/1994	WDNR MOD DRO	04/16/1994	NJS
	Blank spike	112	% recov						
	Blank spike duplicate	86	% recov						
CD-GRAPH	Cadmium	0.1	ug/l	0.1	SW846 3020		SW846 7131	04/20/1994	*SUB
8021	Benzene	1.2	ug/l	0.6	SW846 5030	04/20/1994	SW846 8021	04/20/1994	RJN
	Bromobenzene	ND	ug/l	1.0					
	Bromodichloromethane	ND	ug/l	1.0					
	n-Butylbenzene	ND	ug/l	1.0					
	sec-Butylbenzene	ND	ug/l	1.0					
	tert-Butylbenzene	ND	ug/l	1.0					
	Carbon tetrachloride	ND	ug/l	1.0					
	Chlorobenzene	ND	ug/l	1.0					
	Chlorodibromomethane	ND	ug/l	1.0					
	Chloroethane	ND	ug/l	1.0					
	Chloroform	ND	ug/l	1.0					
	Chloromethane	ND	ug/l	1.0					
	2-Chlorotoluene	ND	ug/l	1.0					
	4-Chlorotoluene	ND	ug/l	1.0					
	1,2-Dibromo-3-chloropropane	ND	ug/l	2.0					
	1,2-Dibromoethane	ND	ug/l	1.0					
	1,2-Dichlorobenzene	ND	ug/l	1.0					
	1,3-Dichlorobenzene	ND	ug/l	1.0					
	1,4-Dichlorobenzene	ND	ug/l	1.0					
	Dichlorodifluoromethane	ND	ug/l	4.0					
	1,1-Dichloroethane	ND	ug/l	1.0					
	1,2-Dichloroethane	4.9	ug/l	1.0					

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Lab Certification No. 405132750
Location : PRO# N1019B
Your Sample ID: MW1
Sample Desc. : MONITORING WELL 1
Sample Matrix : WATER Date Collected: 04/12/1994
En Chem Proj# : 9404069 Date Received : 04/12/1994
En Chem Lab # : 113017 Date Reported : 05/04/1994

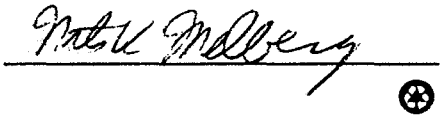
Report to: OMNNI ASSOCIATES
303 SOUTH BLUEMOUND DRIVE
APPLETON, WI 54914

Bill to: CITY OF KAUKAUNA

Analysis	Parameter	Result	Units	Detection Limit	Prep Method	Prep Date	Analysis Method	Analysis Date	Analyzed By
8021	1,1-Dichloroethene	ND	ug/l	1.0	SW846 5030	04/20/1994	SW846 8021	04/20/1994	RJN
	cis-1,2-Dichloroethene	ND	ug/l	1.0					
	trans-1,2-Dichloroethene	ND	ug/l	1.0					
	1,2-Dichloropropane	ND	ug/l	1.0					
	1,3-Dichloropropane	ND	ug/l	1.0					
	2,2-Dichloropropane	ND	ug/l	1.0					
	Di-isopropyl ether	ND	ug/l	1.0					
	Ethyl Benzene	3.6	ug/l	1.0					
	Hexachlorobutadiene	ND	ug/l	1.0					
	Isopropylbenzene	ND	ug/l	1.0					
	p-Isopropyltoluene	ND	ug/l	1.0					
	Methylene chloride	ND	ug/l	2.0					
	Methyl-tert-butyl-ether	17	ug/l	1.0					
	Naphthalene	ND	ug/l	2.0					
	n-Propylbenzene	ND	ug/l	1.0					
	1,1,2,2-Tetrachloroethane	ND	ug/l	1.0					
	Tetrachloroethene	ND	ug/l	1.0					
	Toluene	ND	ug/l	1.0					
	1,2,3-Trichlorobenzene	ND	ug/l	1.0					
	1,2,4-Trichlorobenzene	ND	ug/l	1.0					
	1,1,1-Trichloroethane	ND	ug/l	1.0					
	1,1,2-Trichloroethane	ND	ug/l	1.0					
	Trichloroethene	ND	ug/l	1.0					
	Trichlorofluoromethane	ND	ug/l	1.0					
	1,2,4-Trimethylbenzene	ND	ug/l	1.0					
	1,3,5-Trimethylbenzene	ND	ug/l	1.0					
	Vinyl chloride	ND	ug/l	1.0					
	Xylenes, m + p	23	ug/l	1.0					
	Xylene, o	ND	ug/l	1.0					

"ND" Indicates no detectable analyte at or above the listed detection limit. All results reported on a dry weight basis. All subcontracted analyses are performed by Wisconsin DNR certified laboratories.

These results have been reviewed and their authenticity verified by:



Printed on Recycled Paper

ENGINEERING
ARCHITECTURE
ENVIRONMENTAL

OMNNI
ASSOCIATES

OMNNI ASSOCIATES, INC.
303 S. BLUEMOUND DR.
APPLETON, WI 54914
414-739-7814
FAX 414-739-7765

March 7, 1994

RECEIVED
MAR 08 1994
WDNR OSH
LUST PROGRAM

Wisconsin Department of Natural Resources
Attn: Mr. Thomas Verstegen
905 Bayshore Drive
Box 2565
Oshkosh, WI 54903

RE: City of Kaukauna, 201 W. Second Street, Kaukauna, WI;
DNR LUST ID #45-1729

Dear Mr. Verstegen:

OMNNI has been contracted by the City of Kaukauna to perform a site investigation of subsurface conditions at the above mentioned location. (See Figure 1 - Site Location Map, enclosed.)

In December, 1993, petroleum contamination was discovered during maintenance of piping for an underground waste oil storage tank. (See Figure 2 - Site Detail Map, enclosed.) Laboratory analysis results indicated a diesel range organics (DRO) concentration of 1,200 ppm in a sample collected at this time. The waste oil tank remains in use.

As the next step in investigation of the site, OMNNI proposes to install three - five soil borings on the property with continuous sampling by field screening with a PID. Soil samples will also be collected and delivered to a certified analytical laboratory for analysis. Sampling parameters will be chosen in order to comply with leaking underground storage tank (LUST) analytical guidelines (DNR, July, 1993).

Groundwater monitoring wells will be constructed and developed per NR 141 in three of the borings. After development, groundwater sampling from the wells will be performed. Again, groundwater sampling parameters will be chosen in order to comply with leaking underground storage tank guidelines. (See Figure 2 - Site Detail Map, for proposed boring and monitoring well locations.)

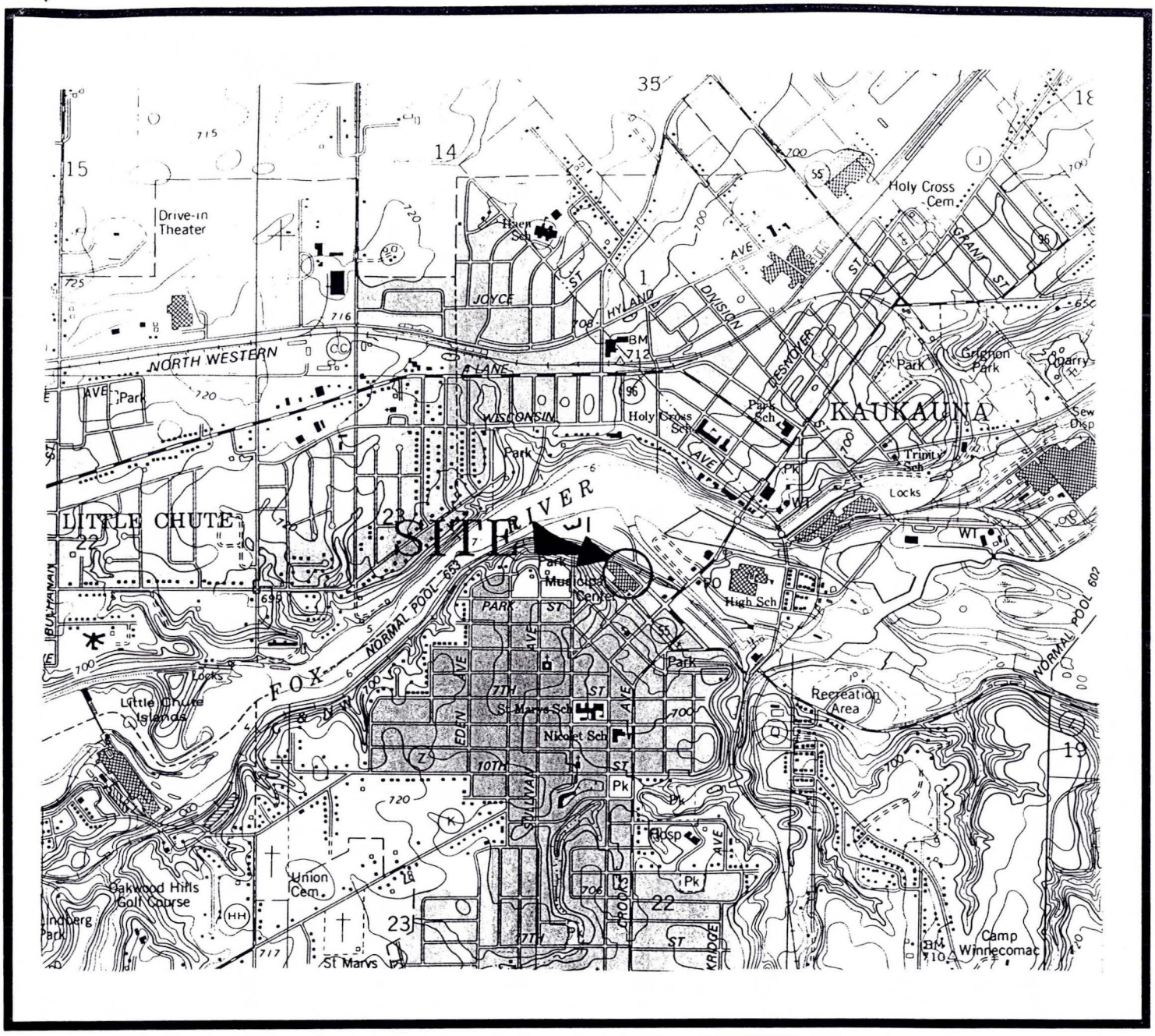
If you have any questions concerning this phase of work for the above mentioned site, please feel free to contact OMNNI. OMNNI is currently bidding the commodity services and has scheduled the work for the week of March 28, 1994. If we have not heard from you before our tentative schedule, we will assume that the work plan meets with your approval.

Sincerely,

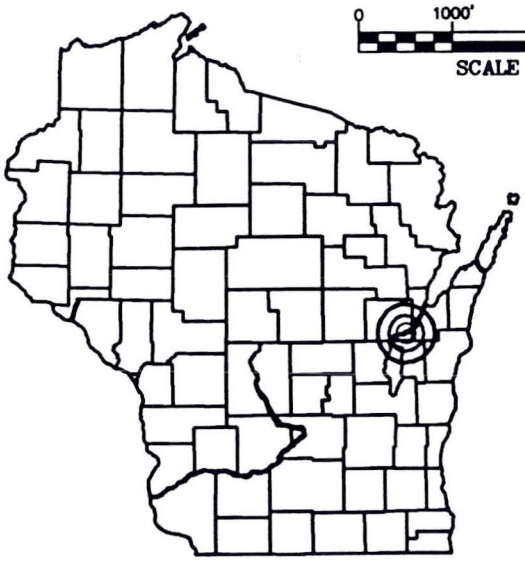
David Fries
Hydrogeologist

Enclosures

cc: Mr. John Sundelius
City of Kaukauna
201 W. Second Street
Kaukauna, WI 54130



SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC MAP, KAUKAUNA, WISCONSIN QUADRANGLE, 1974 – PHOTOREVISED 1984.



0 1000' 2000' 4000'

SCALE 1"= 2000'

N

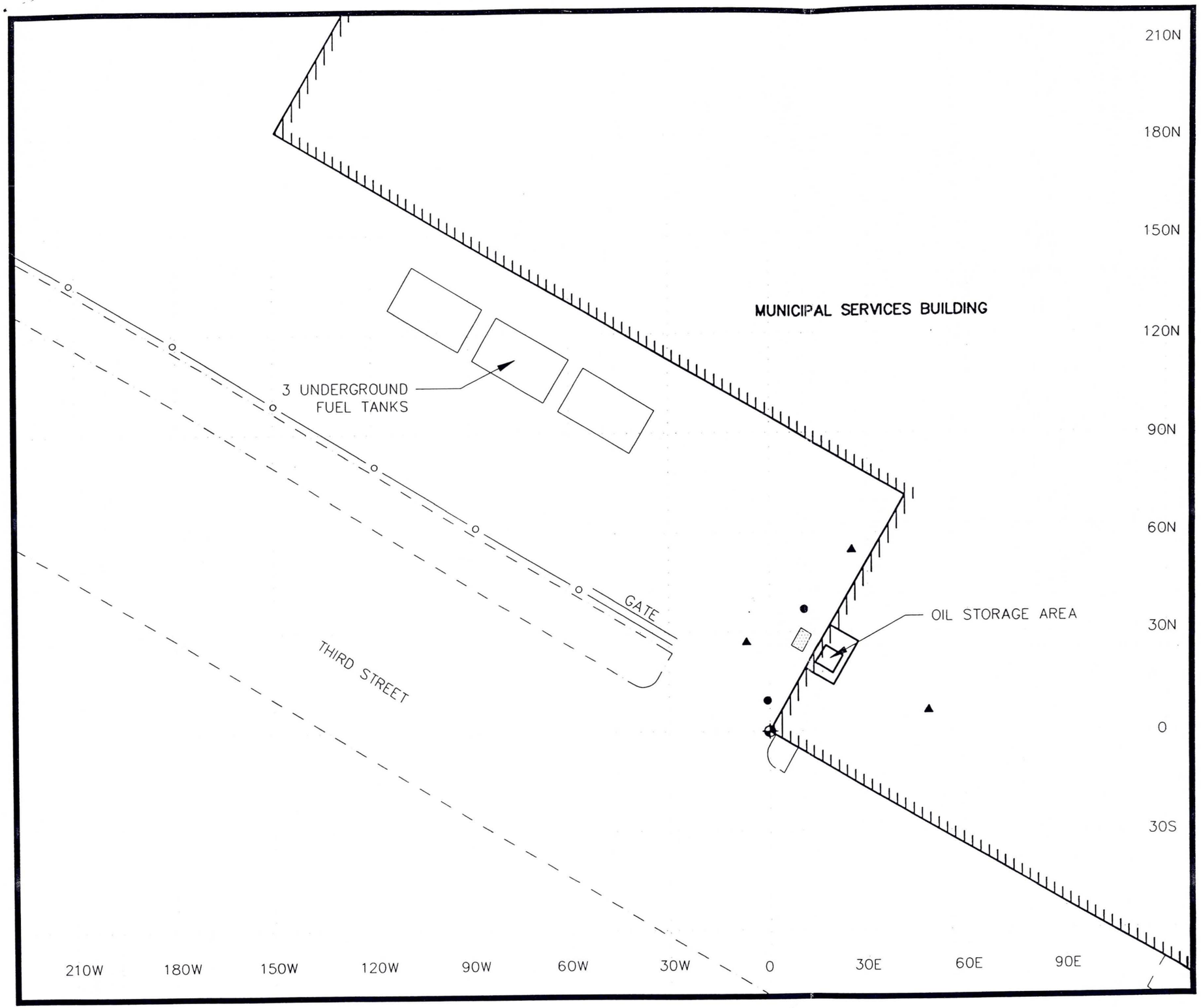
FIGURE 1
SITE LOCATION MAP

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

PROJECT :	N1019B
CAD FILE:	N1019B1.DWG
DRAWN :	DLD
REVIEWED :	
DATE :	3/1/94

303 SOUTH BLUEMOUND DRIVE APPLETON, WI 54914
PHONE : (414) 739-7814 FAX : (414) 739-7765



LOCAL GRID NORTH
N

0' 6' 15' 30'
SCALE: 1" = 30'

LEGEND:

- ▲ PROPOSED WELL LOCATION
- ● PROPOSED SOIL BORING LOCATION
- APPROXIMATE LOCATION OF 550 GALLON WASTE OIL TANK
- EDGE OF CONCRETE PAVEMENT
- FENCE
- BUILDING FACE
- 30N GRID LINE (30' INTERVAL)
- REFERENCE POINT

FIGURE 2
SITE DETAIL MAP

CITY OF KAUKAUNA
MUNICIPAL SERVICES BUILDING
201 W. SECOND STREET
KAUKAUNA, WISCONSIN 54930

OMNI ASSOCIATES

303 SOUTH BLUEMOUND DRIVE APPLETON, WI 54914
PHONE : (414) 739-7814 FAX : (414) 739-7765

PROJECT :	N1019B
CAD FILE:	N1019B2.DWG
DRAWN :	DLD
DATE :	3/1/94
REVIEWED :	

Petroleum Equipment & Environmental Services
A DIVISION OF U.S. OIL CO., INC.

425 S. Washington St., P.O. Box 25, Combined Locks, WI 54113 414-739-6101

January 11, 1994

RECEIVED
JAN 13 1994
WDNR OSH
LUST PROGRAM

Mr. Tom Verstegen
Wisconsin Department of Natural Resources
905 Bayshore Drive, P.O. Box 2565
Oshkosh, WI 54903-2565

Subject: **City of Kaukauna Municipal Services Building**
Kaukauna, Wisconsin

Dear Mr. Verstegen:

Subsurface petroleum contamination was encountered during maintenance of piping associated with an underground waste oil storage tank on December 28, 1993 at the subject site. A soil sample was collected and found to have a DRO concentration of 1,200 mg/kg. A copy of the analytic test report is included with this letter.

Copies of the analytic test report has also been sent to four consulting firms for preparation of proposals to conduct the required remedial investigation\remedial action planning (RI/RAP). As required by ILHR 47, the City of Kaukauna will review the proposals and select a consultant to perform the RI/RAP. We expect the proposals from the consultants to be received by the end of January 1994. A consultant should be selected in February 1994 and will submit their investigation workplan to you for review. The field work can potentially be initiated in March 1994.

Please contact me or the City of Kaukauna Street Superintendent (Mr. John Sundelius) if you have any objections to our proposed schedule. If you have any questions or comments, or require additional information regarding this project, please call me at (414) 735-8234.

Sincerely,
U.S. Petroleum Equipment

Mark J.K. Penzkover, E.I.T.
Environmental Engineer

cc: Mr. John Sundelius, City of Kaukauna Street Superintendent
KaukGar.Ltr

U.S. Oil Co., Inc.

Analytical Laboratory
425 S. Washington St. Combined Locks, WI 54113
Phone 414-735-8298

WI DNR Certified Lab #445027660

Jesse Rose
U S Petroleum Equipment

Combined Locks, Wisconsin

Report Date: 22-Dec-93

Project #: 371-400-12
Project : City of Kaukauna
Sample ID: WO1
Lab Code: 1616915
Sample Type: Soil
Sample Date: 14-Dec-93

Test	Result	MDL	Unit	Date Ext/Digested	Date Analyzed:	Analyzed By:	QC Code
TOTAL SOLIDS	92.3		%		17-Dec-93	B. Rettler	1
MODIFIED DRO WDNR APR 92	1200	100	MG/KG	17-Dec-93	19-Dec-93	C. Rotar	2

ND= Compound Not Detected

MDL=Method Detection Limit

QC SUMMARY

CODE:

1 All laboratory QC requirements were met for this sample.

2 DRO chromatogram indicates possible lube oil contamination.

Authorized Signature

CHAIN OF CUSTODY RECORD

U.S. Analytical Lab
425 S. Washington St., P.O. Box 25
Combined Locks, WI 54113 *(414) 735-8295*

Rev. Date: 07-02-93

Chain # Nº 1071

Page 1 of 1

Account No. : Quote No.:

Consulting Firm: USPE

Project No.: 371-400-12

Sample Integrity - To completed by receiving lab.
Method of Shipment : Client Temp. of Temp. Blank. ___ °C On Ice: ✓
Sample Condition (good, cracked/broken bottle, improper seal):

Project (Name / Location): City of Kaukauna. 201 West 2nd St, Kaukauna Wi

Sampler (Signature / Title) Jesse J Rose Sales Person

Send Reports to (Name / Company) USPE 558 Carter Ct

Send Invoice to (Company, Address, Phone) USPE, 558 Carter Court. Att: Jesse J Rose

Sample Handling Request

X Rush Analysis
Date Required 12/20 Chem

___ Normal Turn Around

Lab I.D.	Sample I.D.	Collection Date	Collection Time	No. of Containers Size and Type	Description Water	Description Soil	Description Other	Preservation
#133 16169/5	W.O 1	12/14	11:15			X		

Analysis Requested

DRO (Mod/TPH)	GRO (Mod/TPH)	PVOC (EPA 8020)	BTEX (EPA 8020)	VOC (EPA 8021)	O&G (EPA 413.1)	PAH (EPA 8310)	Pb	Flash Point	Other Analysis
X									

Department Use Only

Split Samples: Offered ? ____ Yes _____ No
Accepted? ____ Yes _____ No
Accepted By: _____

Comments/ Special Instructions

PLEASE call with RESULTS. Ext 232 THANK YOU!

Department Use Optional for Soil Samples

Disposition of unused portion of sample
Lab Should:
____ Dispose _____ Retain for ___ days
____ Return _____ Other

Relinquished By: (sign)	Time	Date	Received By: (sign)	Time	Date
Jesse J Rose	4:56	12/16	Cheri J Bhd	4:56	12/16

WISCONSIN
DEPT. OF NATURAL RESOURCES

George E. Meyer, Secretary
William R. Selbig, District Director

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Lake Michigan District Headquarters
Solid & Hazardous Waste Program
1125 N. Military Avenue, PO Box 10448
Green Bay, WI 54307-0448
TELEPHONE: (414)492-5916
TELEFAX: (414)492-5859

January 6, 1994

City of Kaukauna
Attn: John Sundelius
Superintendent of Public Works
201 West 2nd Street
Kaukauna, WI 54130

SUBJECT: Notification of Petroleum Contamination from Underground Storage Tank System
Kaukauna Waste Oil Collection Site, 200 Block of 3rd Street, Kaukauna
WDNR LUST ID #45-1729

Dear Mr. Sundelius:

On December 28, 1993, Jesse Rose of U.S. Oil notified the Wisconsin Department of Natural Resources (WDNR) that petroleum contamination was discovered at the above referenced location. The purpose of this letter is to inform you of your legal responsibilities to address this situation.

Releases from underground storage tanks regulated under Subtitle I of the Resource Conservation and Recovery Act require compliance with the provisions of 40 CFR, Parts 280 and 281. The Environmental Protection Agency (EPA) has the authority to take enforcement action at any time, but will generally not take actions against parties cooperating with the state. The WDNR proceeds in LUST cases under the authority of s. 144.76, Wisconsin Statutes, commonly referred to as Wisconsin's Hazardous Substance Spill Law. The definition of "hazardous substance" as found in s. 144.01(4m), Stats., includes petroleum products.

> Wisconsin Statute 144.76(2a) states: "A person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance shall notify the Department immediately of any discharge not exempt under sub. (9)."
>
> Wisconsin Statute 144.76(3) states: "A person who possesses or controls a hazardous substance which is discharged or who causes the discharge of a hazardous substance shall take the actions necessary to restore the environment to the extent practicable and minimize the harmful effects from the discharge to the air, lands, or waters of the state."

Because you possess or control a hazardous substance that has been released to the environment, the Department identifies you as the party responsible for taking the actions necessary to restore the environment. The conditions present at this site pose a potential threat to human health and/or the environment. You are required to immediately identify any risks or explosive vapors and/or well contamination. You are required to conduct an investigation to determine the extent of contamination, the potential for groundwater impacts, and the remedial action(s) necessary to clean up contaminated soil and groundwater. You must dispose of or treat all products, soils, wastewater, or sludges in compliance

with all applicable federal, state, and local laws and regulations. All groundwater remediation projects which discharge to surface or groundwater (including all discharges to storm sewers) must be covered by a WPDES Discharge Permit. The only discharges not requiring a permit are those to a sanitary sewer; however, in those cases, the treatment facility receiving the discharge and the owner of the sewer system must be contacted for approval. An application must be submitted as early as possible to allow time for needed monitoring or additional data collection prior to discharge. The permit will contain discharge limits for pollutants of concern, along with sampling frequency and test methods.

Before any contaminated soil can be treated or disposed, an "Application to Treat or Dispose of Petroleum Contaminated Soil" must be completed and approved by the DNR's Air Management staff. Until the contaminated soils can be treated or disposed of, they should be stored on an impermeable surface, bermed to prevent runoff and runon, and covered with an impermeable cover material such as plastic.

By February 15, 1994, you must hire an environmental consultant and have them submit written verification to this Department that they have been hired to investigate the extent of the contamination problem and oversee remediation at this site. By March 15, 1994, your consultant must submit a site investigation workplan.

Due to current workload and staffing levels, a WDNR project manager has not been assigned to this case; however, investigation and remediation must not be delayed pending WDNR review or approval of workplans. Correspondence and reports should be sent to the Department at the following address:

Wisconsin Department of Natural Resources
Attn: Thomas Verstegen
905 Bayshore Drive, Box 2565
Oshkosh, WI 54903
Phone: 414-424-7887

All correspondence and reports submitted by you or your consultant should be identified with the assigned WDNR LUST ID number. Unless otherwise requested, please send only one copy of all submittals. Please share this information with the consultant that you hire.

You are encouraged to contact the Department of Industry, Labor & Human Relations (DILHR), the state agency that administers the Petroleum Environmental Cleanup Fund (PECFA). This fund may reimburse you for eligible costs associated with the remedial investigation and cleanup. Linda Baldridge of DILHR should be contacted at (608) 266-2424 to obtain current information regarding the PECFA program.

Your cooperation in this matter will be appreciated. Failure to comply with these requirements could subject you to further enforcement action.

Sincerely,

Janis DeBrock

Janis M. DeBrock, Program Assistant
Leaking Underground Storage Tank Unit

Enc: Consultant List; Information about PECFA

cc: Jesse Rose, U.S. Oil Co., Inc. 425 Washington Street, Combined Locks, WI 54113

(TEL.LOG)

TELEPHONE LOG

SITE NAME: Kaukauna City Waste Oil Collection Site **DATE:** 12-28-93

SITE NO.: 45- **TIME:** 11:10

CONTACT : Jesse Rose **PHONE NO.:** (414) 739-6100

COMPANY/AGENCY: US Oil

- City of Kaukauna Waste Oil Collection facility.
- Performed tank tightness test, found loose pipe, did soil sampling, found 1200 ppm DRO. Just wanted to report.

→ This satisfies reporting requirement. Follow it up in writing with "who what when where" letter. Send to Janis DeBrock.

→ We'll send RP letter, require RI/RA.

- O.K.

Mailing office 201 W. 2nd street 54130

R.P. John Sundelius
~~Street~~ Superintendent of Public Works

Bud Gadow 766-6320 Fire Chief

2

12-28-93

Janis,

Jesse Rose (US Oil) called in to report a LUST. ~~Didn't~~ sounded like a low priority. Told him to follow up with a letter containing details, and to send to you. Once we get letter we'll track & send RP letter.

— Matt

Department of Natural Resources

(4) 12/2/98

LEAKING UNDERGROUND STORAGE TANK (Case Tracking)
Form 4400-146 Rev. 2-93

PROJECT MANAGER: UN/VN

UID Number: 1729 **FID Number:** **PMN Number:**

County: 45
Site Name: Kaukauna (City) Waste Oil Collection Site
Address: 200 Block 3rd Street
Kaukauna, WI 54130
Municipality: Kaukauna, City of
Legal Descript.: ___ 1/4 ___ 1/4 sec. ___ T ___ N R ___ (E/W)
Lat.: ___ Long.: ___

Initial Contact Date: 12/28/93
Date RPLetter Sent: 1/6/94
Date Closure Approved: ___/___/___

Person/Firm Reporting: Jesse Rose, U.S. Oil Co. Inc.
425 Washington St. Combined Locks, WI 54113
Phone Number: (414) 739-6400

Priority Screening	Scoring Criteria	Funding Source	Effective Date	LUST Trust Eligible
X 1 = High	1. 6	X 1 = RP	___/___/___	X 1 = Federal
___ 2 = Medium	2. 0	___ 2 = LTF	___/___/___	___ 2 = Non-Federal
___ 3 = Low	3. 3	___ 3 = EF	___/___/___	
___ 4 = Unknown	4. 4	___ 4 = Other	___/___/___	
	5. 6			

Score: 19 Init.: DA Date: 8/31/94

Case Status

	Start Date	End Date
___ (F) Free Product Removal	___/___/___	___/___/___
___ (E) RP Emergency Response	___/___/___	___/___/___
___ (R) LTF Emergency Response	___/___/___	___/___/___
___ (L) Long Term Monitoring	___/___/___	___/___/___

Responsible Party City of Kaukauna
Contact Person: c/o Mr. John Sundelius
Company Name: Superintendent of Public Works
Address: 201 West 2nd Street
Kaukauna, WI 54130
Phone Number: ( )

CC's:

Impacts
Enter "P" for potential and "K" for known

___ (1) Fire/Explosion Threat
___ (2) Contaminated Private Well(s) ___ # of Wells
___ (3) Contaminated Public Well
K (4) Groundwater Contamination
K (5) Soil Contamination
___ (6) Other: ___
___ (7) Surface Water Impacts
___ (9) Floating Product

Consultant
Contact Name: Dave Lies
Company Name: Dennis Associates
Address: 3035 Bluemound
Appleton WI
Telephone: (414) 739-7814

Substances	# Tank(s)	Size
___ (1) Leaded Gas		
___ (2) Unleaded Gas		
X (3) Diesel		
___ (4) Fuel Oil		
___ (5) Unkwn Hydrocrbn		
___ (8) Other ___		
___ (12) Waste Oil		

REMARKS: Performed tank tightness test, found loose pipe, did soil sampling, found 1300 ppm DRO.

LMD LUST Tracking

UID# 45-1729 SITE NAME Kaukauna City Waste Oil Collection Site PROJECT MGR UN/NN

ACTION CODES

02 = RP Letter Sent +
03 = Notice of Noncompliance *
04 = Enforcement Conference *
14 = Notice of Violation *
18 = Admin. Order Issued *
19 = Admin. Order Modified
20 = Admin. Order Cancelled
21 = Contest Case Hearing *
23 = Referral to DOJ *
30 = Notice to Proceed *
31 = Tnk Cls/SA Workplan Rec'd
32 = Tnk Cls/SA Workplan Appvd
33 = Tank Cls/SA Report Rec'd
34 = Tank Cls/SA Report Appvd
35 = SI Workplan Rec'd +
36 = SI Workplan Appvd *
37 = SI Report Rec'd *
38 = SI Report Appvd
39 = RA Workplan Rec'd
40 = RA Workplan Appvd *
41 = RA Report Rec'd *
42 = RA Report Appvd
43 = Status Reports *
44 = Form 4 Received
45 = Form 4 Approved
46 = Form 4 Denied
47 = PECFA Reimbursement
48 = Free Product Recovery *
49 = Alternate Water Supplied *

60 = Consent Order +

NOTE: * = EPA Reporting Requirements
+ = LMD Tracking Requirements

ACTION UPDATES

Entered in Tracking	Code	Action Date (Received / Sent)	Compliance Due Date	Comment	Compliance Achieved
8/31/94	02	1/6/94			
	35	3/8/94			
	37	7/7/94			
9/20/94	30	7/15/94			
1/11/95	02	1/11/95	2/13/95		1/18/95
1/22/95	43	1/18/95		OMNNI called S.I. cont.	
3/21/95	43	3/21/95		G.W. MON. Rep.	
	43	10/26/95			

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
2984 Shawano Avenue
Green Bay WI 54313-6727

Scott Walker, Governor
Cathy Stepp, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711



Decmber 17, 2012

File Ref BRRTS: #07-45-559282

Mr. Richard Washington
Retirement Housing Foundation
911 Studebaker Road
Long Beach, CA 90815

Subject: Liability Clarification and Current Environmental Conditions at the Round House Manor Property, 300 Bicentennial Court, City of Kaukauna, Outagamie County, WI, BRRTS #07-45-559282, Parcel #323-0406-00

Dear Mr. Washington:

Purpose

The purpose of this letter is to provide you with clarifications as to environmental liabilities and current environmental conditions at the property located at 300 Bicentennial Court, Outagamie Tax Parcel #323-0406-00, City of Kaukauna, Wisconsin ("the Property") The Property consists of approximately two acres in the NE1/4, NW1/4, Sec. 22, T21N, R18E, Outagamie County. Please refer to the attached Figure 1 for a map of the Property.

Summary Determination

Total Petroleum Hydrocarbons-Diesel Range Organics (TPH-DRO), metals, Volatile Organic Compounds (VOCs), and Polynuclear Aromatic Hydrocarbons (PAHs) were detected in soil and groundwater samples obtained from borings and temporary monitoring wells installed as part of a recent Limited Phase II Environmental Site Assessment; however the Department of Natural Resources ("Department") will not require additional investigation at this time and the case will be tracked as "No Action Required" ("NAR").

Request

On September 5, 2012, your consultant, Thomas Culp of SCS BT Squared requested on your behalf, that the Department issue a liability clarification letter. The letter is to contain a determination whether further response actions are needed under the ch. NR 700 rule series, Wis. Adm. Code (WAC), based on the release or presence of one or more hazardous substances at the Property. The Department received the fee for providing assistance, in accordance with s. NR 749.04(1), WAC.

In order for the Department to make this determination, you have requested a review of the following documents:

- Results of Additional Sampling, collected by SCS BT Squared, dated November 28, 2012
- "Limited Phase II Environmental Site Assessment, Property Located at 300 Bicentennial Court, Kaukauna, Wisconsin" ("Draft Phase 2 Report") containing analytical results for groundwater, soil and a site topographic map, prepared by D3G, dated January 12, 2012
- Unsigned "Phase I Environmental Site Assessment, Property Located at 300 Bicentennial Court, Kaukauna, Wisconsin" (Unsigned "Draft Phase 1 Report") containing legal descriptions and maps, prepared by D3G, dated August 4, 2011

- An application for "Technical Assistance and Environmental Liability Clarification", dated August 14, 2012 and the associated $500 review fee submitted by SCS BT Squared on your behalf

The Department has examined the reports listed above and provides the following summary of the facts of the case and opinions concerning environmental conditions at the Property.

Background and Summary of Environmental Conditions

The Round House Manor at 300 Bicentennial Court consists of a two-story age-restricted apartment structure and a one-story garage building both constructed in 1985. Prior to 1885, the Property held a railroad roundhouse, turn table, sand house, railroad water tank, portion of a coal shed, hoist, and coal dump, and railroad spurs. The former roundhouse, associated structures, and railroad spurs were demolished between 1973 and 1979.

D3G reported in the 2012 Limited Phase II Environmental Site Assessment (ESA) Report that a 2011 Phase I Assessment prepared by D3G identified a Recognized Environmental Condition (REC) at the Property. The REC appears to be related to suspected hazardous material usage associated with a former railroad roundhouse. The purposes of the Phase II ESA were to evaluate soil and groundwater quality at the site.

As part of the ESA, Four soil borings were advanced on the Property to depths of 10 to 16½ feet. Borings SB-3 and SB-4 were converted to temporary monitoring wells. Samples of soil from borings SB-1 to SB-4 and groundwater from temporary monitoring wells SB-3 and SB-4 were collected and analyzed at a state certified laboratory for TPH-DROs, Metals, VOCs, and PAHs (See Figure 1 for a map showing the locations of the borings).

SOIL

Soils at the Property are described to consist mostly of mixed layers of tightly packed fine to coarse grained sand, dense silty clay, weathered fractioned bedrock and fat clay with a mixture of rock fragments and pebbles down to 16½ feet.

Several TPH-DROs were detected in the soil samples collected from borings SB-1 to SB-4 but they did not exceed their respective allowable Residual Contaminant Level (RCL) as specified in ch. NR 720 WAC, except for borings SB-2 and SB-3. Borings SB-2 and SB-3 were completed in an area covered by concrete pavement.

Several metals were detected in the soil samples collected from borings SB-1 to SB-4. Concentrations of arsenic at borings SB-1 to SB-4 were above the respective RCL. Concentrations of lead at borings SB-1 and SB-3 were above the respective RCL. Borings SB-1 and SB-4 were located in an area covered by vegetation and borings SB-2 and SB-3 were in an area covered by concrete pavement.

Several VOCs were detected in the soil samples collected from boring SB-4 but they did not exceed their respective RCLs (See Table 1 for a summary of soil analytical results).

GROUNDWATER

Groundwater at the site was encountered from between approximately 10 ½ to 12 ½ feet below ground surface.

Several PAHs were detected in groundwater samples collected from temporary monitoring well SB-3. Concentrations of benzo[a]anthracene, benzo[a]pyrene, and phenanthrene at well SB-3 were above the ch NR 140 WAC Preventive Action Limit (PAL). Therefore on September 25, 2012, the Department requested the collection and analysis of a groundwater sample from a monitoring well, constructed according to the requirements of ch. 141 WAC, near temporary monitoring well SB-3. Elevated detections of contaminants are often seen in groundwater from temporary wells because the well screens are not properly developed and the water sample is often not an accurate representation of actual groundwater quality.

Upon discussion with the Department, SCS BT Squared installed monitoring well MW-1 according to ch. NR 141 WAC requirements and on November 8, 2012, collected a groundwater sample (Monitoring well MW-1) at a depth of 14 feet. Laboratory analysis revealed that lead was not detected at monitoring well MW-1. Several trace PAHs were detected in the groundwater sample collected from monitoring well MW-1 however they did not exceed their PALs (See Table 1 for a summary of groundwater analytical results).

After receipt and review of the above analytical results on December 4, 2012, the Department requested that monitoring well MW-1 be abandoned in accordance with ch. NR 141 WAC. Documentation that the monitoring well was properly abandoned was received on December 13, 2012.

Liability Determination

The Wisconsin Hazardous Substance Discharge Law, s. 292.11, Wis. Stats., commonly called the Spill Law, requires those who cause, possess or control a hazardous substance discharge to "take the actions necessary to restore the environment to the extent practicable and minimize the harmful effects from the discharge to the air, lands or waters of this state." Section 292.55, Wis. Stats., authorizes the Department to issue clarification letters concerning liability for environmental pollution.

Soil samples taken from borings SB-1 to SB-4 detected TPH-DROs, metals, and VOCs but there were no exceedances of ch. NR 720 RCLs, except for the concentrations of TPH-DROs at SB-2 and SB-3, arsenic at SB-1 to SB-4, and lead at SB-1 and SB-3. Borings SB-1 and SB-4 are in an area covered by vegetation and borings SB-2 and SB-3 are in an area covered by concrete pavement and therefore direct contact with the contaminated soil is limited.

In addition, several PAHs were detected in groundwater taken from temporary monitoring well SB-3. A follow-up sample collected from a monitoring well near SB-3 showed no detect for lead and PAH concentrations did not exceed the PAL.

The impacts to soil and groundwater at the property are likely related to the historic railroad activities at the Property. Based on the likely usage of petroleum based materials at the railroad roundhouse, the continued presence of trace contaminants could be expected.

Based on these conditions the Department has made a "No Action Required" determination for this case. This decision is based solely on information available and reviewed by the Department and makes no determination concerning the presence of hazardous substance in other areas of the property.

In the future, if the Department becomes aware of new information concerning the contaminants referenced above, or the presence of other contaminants on the Property not previously identified, the Department will need to evaluate that data to determine if response actions may be required.

Whenever possible, the Department requires the person who caused the discharge to take the appropriate response actions.

The Bureau for Remediation and Redevelopment Tracking System (BRRTS) identification number for this activity is shown at the top of this letter. The Department tracks information on all determinations such as this in a Department database that is available on the Internet at.http://dnr.wi.gov/botw/SetUpBasicSearchForm.do

Since there is no action required for this case, the Department has issued BRRTS case number 07-45-559282 and will track this site activity as a "No Action Required" determination. If you have any questions, please contact me at 920-662-5105, or in writing to the address at the top of this letter, or by email to kimberly.vickman@wisconsin.gov.

Sincerely,

Kimberly Vickman

Kimberly Vickman
Hydrogeologist
Remediation and Redevelopment Program

Attach: Figure 1 Well Location Map
Table 1 Select Soil and Groundwater Laboratory Analytical Results

C: Thomas Culp – SCS BT Squared

FIGURE 1

Round House Manor – Well Location Map
300 Bicentennial Court
Kaukauna, Wisconsin
SCS Project #25212212.01



TABLE 1
SELECT SOIL AND GROUNDWATER LABORATORY ANALYTICAL RESULTS
Round House Manor
300 Bicentennial Court
Kaukauna, Wisconsin 54130

Sample #	Date	Location	Depth of Sample (ft.)	Soil Results mg/kg: milligrams per kilogram	Groundwater Results ug/L: micrograms per Liter
SB-1	December 2011	W of building in grass	2'	Arsenic 11.4 mg/kg Lead 105 mg/kg	NA
SB-2	December 2011	SW of building under pavement	2'	TPH-DRO 170 mg/kg Arsenic 5.58 mg/kg	NA
SB-3	December 2011	S of building under pavement	2'	TPH-DRO 151 mg/kg Arsenic 8.70 mg/kg Lead 133 mg/kg	Benzo(a)anthracene 4.61 ug/L Benzo(a)pyrene 4.25 ug/L Phenanthrene 18.7 ug/L
SB-4	December 2011	N of building in grass	2'	Arsenic 6.98 mg/kg	No detect
MW-1	November 2012	S of building in grass and just off of pavement (near SB-3)	14'	NA	Below PAL

TPH-DRO: Total Petroleum Hydrocarbons-Diesel Range Organics
NA: Not Analyzed
PAL: ch. NR 140 Wis. Adm. Code Groundwater Quality Preventive Action Limit

EPA United States Environmental Protection Agency | Office of Emergency and Remedial Response | OSWER 9285.7-50 August 2003

Superfund Lead-Contaminated Residential Sites Handbook

Final: August 2003

Prepared by the

Environmental Protection Agency
Lead Sites Workgroup (LSW)

NOTICE

This document has been reviewed in accordance with U.S. EPA policy and is approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation.

DISCLAIMER

This document provides guidance to EPA Regions concerning how the Agency intends to exercise its discretion in implementing one aspect of the CERCLA remedy selection process. The guidance is designed to implement national policy on these issues.

Some of the statutory provisions described in this document contain legally binding requirements. However, this document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances. Any decisions regarding a particular remedy selection will be made based on the statute and regulations, and EPA decision makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate.

Interested parties are free to raise questions and objections about the substance of this guidance and the appropriateness of the application of this guidance to a particular situation, and the Agency welcomes public input on this document at any time. EPA may change this guidance in the future.

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CONTENTS

DISCLAIMER ii

CONTRIBUTING MEMBERS of Lead Sites Workgroup of U.S. Environmental Protection Agency . . iii

CONTENTS iv

LIST OF TABLES AND FIGURES vi

ACRONYMS vii

1.0 INTRODUCTION 1
1.1 BACKGROUND 4
1.2 GENERAL DISCUSSION ON CERCLA'S APPLICABILITY TO LEAD SITES 4
1.2.1 Background 4
1.2.2 Response Authorities 5
1.2.3 Applicable or Relevant and Appropriate Requirements (ARARs) 6
1.3 DEFINITION AND PURPOSE 7
2.0 COMMUNITY INVOLVEMENT 9
2.1 EDUCATION ACTIVITIES 9
2.2 COMMUNITY ADVISORY GROUPS 10
2.3 EPA'S TECHNICAL ASSISTANCE GRANT PROGRAM 11
2.4 INFORMATIONAL MEETINGS 12
2.5 COMMUNITY INVOLVEMENT SPECIALIST/COORDINATOR 13
3.0 HEALTH EDUCATION 14
3.1 APPROPRIATE USES FOR HEALTH EDUCATION 14
3.2 PLANNING FOR HEALTH EDUCATION 14
3.3 EVALUATION OF HEALTH EDUCATION ACTIVITIES 15
3.4 AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY (ATSDR) INVOLVEMENT 15
3.5 OUTREACH 16
4.0 SITE CHARACTERIZATION 17
4.1 CONTAMINANT ZONE DELINEATION 17
4.2 RESIDENTIAL PROPERTIES 19
4.2.1 Sampling Access 19
4.2.2 Residential Yards 21
4.2.3 Drip Zones 23
4.2.4 Play Areas, Gardens, and Driveways 24
4.2.5 Potable Water, Lead-Based Paint and Interior Dust 24
4.2.6 Backfill and Waste Soil 24
4.3 SAMPLING METHOD AND ANALYSIS 25
4.3.1 Sample Collection 25
4.3.2 Sample Depth 25
4.3.3 Sample Preparation 27
4.3.4 Sample Analysis 27
5.0 CLEAN-UP LEVEL SELECTION 29
5.1 PRIORITIZING RESPONSE ACTIONS 29
5.2 LONG-TERM REMEDIAL ACTION 35
6.0 APPLICATION OF CLEAN-UP NUMBERS/REMEDIATION 37
6.1 MINIMUM EXCAVATION DEPTH/SOIL COVER THICKNESS 37
6.2 SOIL CLEAN-UP OPTIONS 38
6.3 INTERPRETING SAMPLING RESULTS 39
6.4 OTHER CLEANUP CONSIDERATIONS 44
6.4.1 Background Lead Concentrations 45

6.5 YARD CLEANUP SPECIFICS 46
6.6 CLEANUP OF OTHER SOURCES OF LEAD 49
6.6.1 Lead-Based Paint 50
6.6.2 Interior Dust 50
6.6.3 Lead Plumbing/Tap Water 52
6.7 PREVENTION OF RECONTAMINATION 53
6.7.1 Early Actions 56
6.7.2 Long-term Remedial Action 57
6.7.3 Institutional Controls (ICs) 58
6.8 CLEAN-UP DOCUMENTATION 61
6.9 ENFORCEMENT 62
7.0 FIVE-YEAR REVIEW 64
8.0 FEDERAL FACILITIES 66

REFERENCES 70

APPENDIX A Title X and EPA's Toxic Substances Control Act (TSCA) Title IV Lead Program A-1

APPENDIX B 1998 OSWER Directive 9200.4-27P ('Clarification') B-1

APPENDIX C Contacts and Software for Sampling Design C-1

APPENDIX D Examples of Property Access Agreement Forms D-1

APPENDIX E Example of Dust Abatement Access Form E-1

APPENDIX F Example of Property Inspection Checklist F-1

APPENDIX G Examples of Property Closeout Forms G-1

APPENDIX H Examples of Clean Letters H-1

LIST OF TABLES AND FIGURES

Table 4-1.
Rationale for Sampling Residential Properties 20

Figure 1-1. An Overview to the Clean-up Process 3

Figure 4-1a. Recommended minimum soil sampling in yards less than or equal to 5,000 square feet with small side yard. 21

Figure 4-1b. Recommended minimum soil sampling in yards less than or equal to 5,000 square feet with substantial side yard. 22

Figure 4-2. Recommended minimum soil sampling in yards greater than 5,000 square feet 23

Figure 5-1. Recommended clean-up process for lead-contaminated residential sites. 30

Figure 6-1. Interpreting Sampling Results. 40

Figure 6-2a. Partial cleanup of residential lot less than or equal to 5,000 square feet in size. 42

Figure 6-2b. Partial cleanup of residential lot greater than 5,000 square feet in size 43

Figure 6-3. Implementing Best Management Practices (BMPs) during construction work 55

ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
ASTSWMO	Association of State and Territorial Solid Waste Management Officials
ATSDR	Agency for Toxic Substances and Disease Registry
BMPs	Best Management Practices
BRAC	Base Realignment and Closure
CAGs	Community Advisory Groups
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIC/CIS	Community Involvement Coordinator/ Specialist
DOD	Department of Defense
FOSL	Finding of Suitability to Lease
FOST`	Finding of Suitability to Transfer
FP-XRF	Field-Portable X-Ray Fluorescence
HUD	Department of Housing and Urban Development
IC	Institutional Control
LBP	Lead-Based Paint
IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead in Children
LSCG	Lead Sites Consultation Group
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NLLAP	National Lead Laboratory Accreditation Program
NTCRA	Non-Time-Critical Removal Action
OSWER	EPA Office of Solid Waste and Emergency Response
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
RCRA	Resource Conservation and Recovery Act
SEP	Supplemental Environmental Project
TAG	Technical Assistance Grant
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Removal Action
TITLE X	Title X of the Housing and Community Development Act of 1992, 42 U.S.C. 4822
TRW	EPA Technical Review Workgroup
TSCA	Toxic Substances Control Act
UAO	Unilateral Administrative Order

1.0 INTRODUCTION

This Superfund Lead-Contaminated Residential Sites Handbook (subsequently called the Handbook) has been developed by the U.S. Environmental Protection Agency (EPA) to promote a nationally consistent decision-making process for assessing and managing risks associated with lead-contaminated residential sites across the country.

The primary audience for this risk management document is Superfund project managers working on the characterization and cleanup of lead-contaminated residential sites; however, Resource Conservation and Recovery Act (RCRA) project managers may also find it useful. This information was developed primarily for EPA staff, but may prove useful to others working on lead-contaminated residential sites, including states, other federal agencies, tribes, local governments, public interest groups, and private industry. While this Handbook is not intended to apply to lead-contaminated commercial or industrial properties, other non-residential areas, or sites with ecological risks, some of the concepts may be useful for such properties. Addressing lead-contaminated properties at federal facilities requires a different approach, and this Handbook provides a special section (Section 8) on addressing this universe of sites.

Generally, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions are undertaken to address a release or threat of release of a hazardous substance such as lead into the environment. Lead contamination found inside homes may be caused by deteriorating lead-based paint (LBP), plumbing, or other sources not resulting from a release into the environment, and therefore may be more appropriately addressed by authorities and programs other than CERCLA (see Appendix A and Section 6.6 of this Handbook). However, it may be appropriate to use CERCLA authorities to conduct sampling and site characterization activities to determine the source of the lead contamination and to differentiate between various site-related sources.

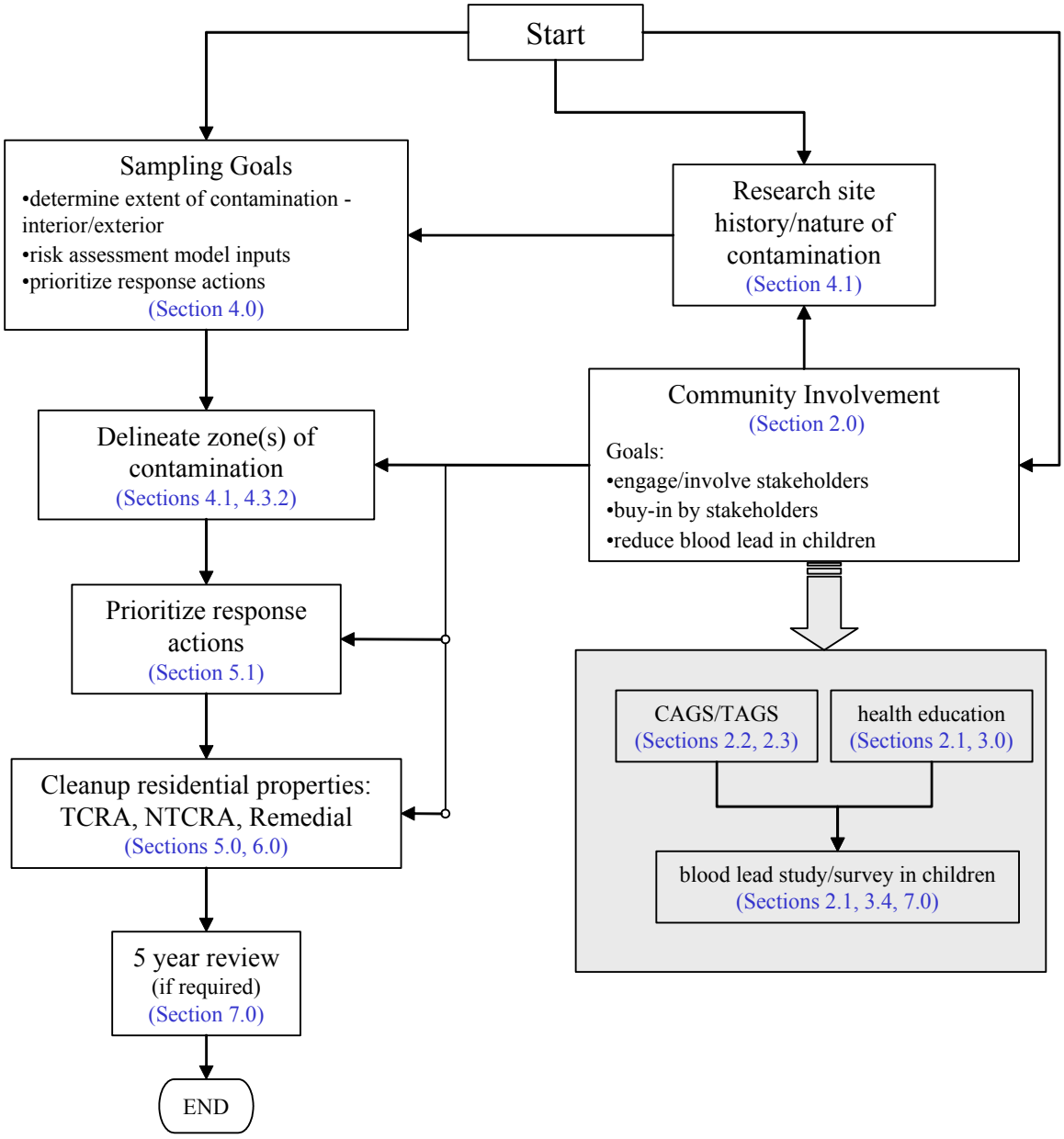
The Handbook lays out only the minimum considerations for addressing lead-contaminated residential sites and encourages users to refer to appropriate agency guidance and/or policy to conduct more stringent investigation and clean-up activities on a site-specific basis, if necessary. In addition, the site manager should determine the applicable and relevant or appropriate requirements (ARARs), including state laws and regulations, that apply to the site. It should also be noted that this Handbook does not, outside the federal facilities universe, apply to lead-contaminated residential sites addressed under Title X (HUD, 1992) procedures.

Lead site characterization and clean-up procedures are unique owing to the ubiquitous nature of lead exposures and the reliance on blood lead concentrations to describe lead exposure and toxicity. Lead

risks are characterized by predicting blood lead levels with computer models and guidance developed by EPA, which are available on the internet: http://www.epa.gov/superfund/programs/lead/products.htm. Major improvements in the removal of lead from gasoline, paint, and food packaging have significantly reduced the incidence of severe lead poisoning. The results of this progress mean that most environmental sources of lead exposure are more likely to cause subtle adverse health effects, primarily behavioral and learning impairments.

An overview to the clean-up process is provided as Figure 1-1. Section numbers are provided in the figure to help the reader locate information within this document.

Figure 1-1. An Overview to the Clean-up Process



1.1 BACKGROUND

Elevated blood lead concentrations in young children in the United States are still prevalent in many areas. Major sources of lead contamination historically included mining and milling sites, primary and secondary smelters, battery manufacturing and recycling facilities, pesticide formulators, pesticide use in orchards, and paint manufacturers (prior to 1978). Many of the source facilities are located near residential areas or have had residential areas develop around them. Fugitive emissions from the facilities have resulted in soil contamination in the yards of residences, which in turn can cause high blood lead levels in children.

Although numerous sites of this type exist, EPA has remediated, or overseen the remediation of, many of these sites and surrounding residences. Many different clean-up methods have been implemented with varying degrees of success. This document is based on the lessons learned from EPA's experience in remediating residential lead sites. It is intended to promote consistency in the characterization and cleanup of lead-contaminated residential sites, while retaining the flexibility needed to respond to different sites and communities to ensure success of the remedy and provide long-term protection of human health. The document also provides guidance on addressing lead sources and media that the Superfund does not usually remediate, such as LBP and lead plumbing. It is anticipated that this information will be periodically updated as we strive to improve our ability to respond to environmental lead hazards.

1.2 GENERAL DISCUSSION ON CERCLA'S APPLICABILITY TO LEAD SITES

This section provides a general discussion of the sections of CERCLA that address lead-contaminated sites. A description of Title X and EPA's Toxic Substances Control Act (TSCA) IV Lead Program is provided in Appendix A. The Title X discussion is provided for informational purposes and is primarily applicable to federal facilities. Section 4.2.5 also provides useful information for LBP and dust sampling.

1.2.1 Background

Historically, the CERCLA has been used as a tool to implement clean-up activities at a large number of sites across the country. CERCLA authorities have been used for cleanups ranging from the removal of drums of hazardous substances from long-abandoned sites, to major privately funded remedial actions at sites on the National Priorities List (NPL).

CERCLA may apply any time there is a release or threatened release of: (1) a hazardous substance into the environment, or (2) a pollutant or contaminant "which may present an imminent and substantial endangerment to the public health or welfare" (EPA, 2000a). The term "release" is defined broadly in the statute and includes discharging or leaking of substances into the environment. This also includes the abandonment of closed containers containing hazardous substances, pollutants, or contaminants.

The definition of hazardous substance is extremely broad, and is defined in CERCLA Section 101(14). A comprehensive list of these substances is provided in 40 CFR 302.4. In addition to general listings for “lead”, “lead and compounds”, and “lead compounds,” the regulation lists fourteen other subcategories of lead.

Additionally, CERCLA is not media-specific. Thus, it may address releases to air, surface water, groundwater, and soils. This multi-media aspect of CERCLA makes it possible to conduct environmental assessments and design clean-up projects that address site contaminants in a comprehensive way.

The Agency has pursued a number of CERCLA response actions involving lead-contaminated soil using the abatement authority under Section 106 (which also requires a showing of imminent and substantial endangerment). CERCLA covers almost every constituent found at mining and mineral processing (primary lead and other metals smelters) sites. Exceptions include petroleum (that is not mixed with a hazardous substance) and, in some cases, responses to releases of a naturally occurring substance in its unaltered form. It should be noted, however, that the latter exception does not include any of the releases typically dealt with at mining sites, such as acid mine drainage, waste rock, or any ore exposed to the elements by man.

1.2.2 Response Authorities

CERCLA's main strength is its response authorities. EPA can either use the Superfund to perform response (removal or remedial) activities (Section 104) or require private parties to perform such activities (Section 106). CERCLA gives EPA the flexibility to clean up sites based upon site-specific circumstances. EPA's clean-up decisions generally are based upon both risk assessment and consideration of ARARs. As long as the jurisdictional prerequisites have been met, CERCLA gives EPA the ability to perform virtually any clean-up activity necessary to protect public health and the environment.

There are potential limitations in CERCLA which may be relevant to lead-contaminated sites. For example, Section 104(a)(3) limits EPA’s ability to respond to releases within residential structures as follows:

> "Limitations on Response. The President (EPA) shall not provide for removal or remedial action under this section in response to a release or threat of release . . . from products which are part of the structure of , and result in exposure within, residential buildings or business or community structures . . . "

The above cited section of CERCLA generally limits EPA's authority to respond to LBP inside a structure or house as written in Section 6.6.1 of this Handbook. However as noted in Section 6.6.1 of the Handbook, EPA has the authority to conduct response actions addressing soils contaminated by a release of lead-contaminated paint chips from the exterior of homes to prevent recontamination of soils that have been remediated. In addition, Section 104(a)(4) provides an exception to the limitations in Section 104(a)(3).

CERCLA provides EPA with the authority to perform "removal" and "remedial" actions. Assessments generally are considered "removal" actions and evaluate contaminants of concern, exposure pathways, and potential receptors. The assessment process includes the review of available information, as well as sampling, to obtain other necessary information. The process is broad in its application and is a powerful tool in evaluating environmental risks posed by a site. Removal actions can be performed on mining and mineral processing (primary lead and other metals smelters) sites, and other sites with lead releases to the environment, of any size. Removal actions are subject to limits on time (12 months) and money ($2,000,000) under the statute; however, these limits are subject to exceptions.

Remedial actions are typically long-term responses performed at those sites placed on the NPL. Remedial actions also may be performed at non-NPL sites, through administrative orders on consent (AOCs) or consent decrees, if they are privately financed. Remedial actions are not subject to the time or dollar limitations imposed on removal actions, but require a more detailed and formal decision process.

1.2.3 Applicable or Relevant and Appropriate Requirements (ARARs)

Under Section 121(d) of CERCLA, remedial actions must comply with substantive provisions of federal environmental laws and more stringent, timely identified state environmental or facility siting laws. Removal actions should comply with ARARs to the extent practicable. "Applicable" requirements are those federal or state laws or regulations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. "Relevant and appropriate" requirements are not "applicable," but address problems or situations similar enough to those at the CERCLA site that their use is well suited to the site.

State requirements are not considered ARARs unless they are identified in a timely manner and are more stringent than federal requirements. The recently published TSCA §403 Soil Hazard Rule, which establishes a soil-lead hazard of 400 ppm for bare soil in play areas and 1,200 ppm for bare soil in non-play areas of the yard, should not be treated as an ARAR. As recognized in the TSCA §403 Rule, lead contamination at levels equal to or exceeding the 400 ppm and 1,200 ppm standards may pose serious health risks based upon a site-specific evaluation and may warrant timely response actions. However, the soil-lead hazard levels under the TSCA §403 Rule should not be used to modify approaches to addressing brownfields, NPL sites, state Superfund sites, federal CERCLA removal actions and CERCLA non-NPL facilities.

EPA has published a manual outlining potential federal ARARs that may be requirements at Superfund sites. Published in two parts, the manual is entitled *CERCLA Compliance with Other Laws Manua*l, Part I, August 1988, and Part II, August 1989, and is available at EPA libraries (EPA, 1988).

1.3 DEFINITION AND PURPOSE

Residential properties are defined in the Handbook as any area with high accessibility to sensitive populations, and includes properties containing single- and multi-family dwellings, apartment complexes, vacant lots in residential areas, schools, day-care centers, community centers, playgrounds, parks, green ways, and any other areas where children may be exposed to site-related contaminated media (EPA, 1996a, 1997a, 1998a). This document defines sensitive populations as young children (those under 7 years of age, who are most vulnerable to lead poisoning) and pregnant women. Focus is put on children less than 7 years old because blood lead levels typically peak in this age range (EPA, 1986, 1990a; CDC, 1991). Unfortunately, this age range is also when children are most vulnerable to adverse cognitive effects of lead (Rodder, 1995). Pregnant women are included due to the effects of lead on the fetus (Gayer, 1990; Graziano et al., 1990; Carbone et al., 1998). Other EPA guidance (EPA, 1995a, 2001b) and local zoning regulations should also be consulted prior to determining which properties will be treated as residential.

Lead-contaminated residential sites are defined, for the purposes of this document, as sites where lead is the primary contaminant of concern in residential soils. Generally, lead-contaminated sites contain other metals of concern, such as cadmium and arsenic. This document, while addressing primarily lead contamination, may also be appropriate for use in the remediation of sites contaminated by other metals. In all cases, looking at the site history (type of lead site, depositional environment for the lead contamination, fill activities, previous epidemiological studies, etc.) is important in the use of the Handbook. Typically, the types of sites addressed by the Handbook are sites where the lead contamination has resulted primarily from primary or secondary lead smelting, battery cracking, or

mining and milling operations. Lead paint and dust, along with other sources of lead and other toxic metals, may also be present at these sites.

The Handbook is primarily based on a compilation of the Superfund program knowledge and experiences, as well as existing technical and scientific literature addressing lead-contaminated residential sites. The Handbook has undergone broad review by the Agency for Toxic Substances and Disease Registry (ATSDR), the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), and national and regional EPA offices. Because the Handbook is written for use by CERCLA program staff, there are frequent references to guidance or other documents developed under the Superfund auspices. The Handbook does not supersede or modify any existing EPA guidance or policy. This guidance does not suggest that CERCLA authorities are to be applied at all lead-contaminated residential sites. Rather, these references are provided to the reader as resources to be considered in developing site characterization and clean-up strategies under whatever regulatory or non-regulatory approach is appropriate at a particular site. However, the NCP should be followed and other applicable guidance consulted when addressing lead-contaminated residential sites under CERCLA. The Handbook does not address ecological risks from lead and lead sites.

2.0 COMMUNITY INVOLVEMENT

The sustainability of a residential clean-up project in many ways is contingent upon support from affected residents, elected officials, local public health agencies, municipal and public works staff, state government personnel, and other stakeholders. Few sites impact more citizens of a community than large residential clean-up projects, with many projects exceeding a thousand homes and several thousand residents. If the residents recognize the risks posed to their community and feel involved in the decision-making process, they are more likely to accept the need for cleanup. House-to-house personal interaction with residents can be useful to learn their concerns (or lack of concerns) and can also be an effective part of educating the public regarding risks posed by the site. The project manager should issue bulletins and/or fact sheets to help keep the community informed of site activities and should consider establishing a toll free number for residents to contact her/him with questions about the site. Likewise, without the support of local governments, portions, if not all, of the selected remedy may be more difficult to implement. Many remedies rely in part on health education and institutional controls (ICs) as part of the actions taken to protect human health, both of which may rely on the active participation of local governments and health departments. The following sub-sections provide information on involving the community.

2.1 EDUCATION ACTIVITIES

This section discusses how to involve the local health departments and community in the education activities and the overall benefits and limitations of health education. Section 3 addresses health education activities in detail.

Several studies have shown that a significant short-term reduction in blood lead concentrations can be achieved through the education of the public on the dangers of lead exposure and on methods they can take to limit their exposure (Kimbrough et al., 1994; Hilts et al., 1998; Schultz et al., 1999). However, EPA does not consider health education, as the only action, to be an effective, permanent remedy for Superfund sites (Appendix B). Often, in-home education activities have been combined with regular house cleaning. One key to begin reduction of elevated blood lead concentrations in children is to initiate health education activities, and where appropriate, blood lead screening, as early as possible in the process. These activities should be started as soon as elevated blood lead levels or elevated soil levels are detected at a site. Education should be sustained throughout the project. If residual contamination, such as encapsulated wastes, LBP, or other such potential sources are left on site after completion of the remedy, then education activities should be sustained in perpetuity.

Generally, EPA does not directly conduct the majority of education activities. One of the responsibilities of the project manager is to educate the community on the risks of lead exposure and to coordinate with various health agencies in establishing lead education programs. These programs are often implemented by local health districts that, in turn, typically coordinate with schools and other community groups working with families and children. Initial tasks include educating the community regarding their lead exposure and associated health risks. Typically, a significant amount of effort will be required to explain the rationale and procedures of the EPA risk assessment method for lead, using the Integrated Exposure Uptake Biokinetic Model (IEUBK), and the need to collect data to estimate site-specific values for model parameters. It is advisable to obtain input on exposure parameters specific to the community (e.g., how often they frequent locations that are not residential). Community input into the risk assessment is not relevant to those parameters that require site-specific studies to generate empirical data (e.g., an animal feeding study to determine bioavailability). Often, local health officials will be unfamiliar with EPA's risk assessment process and will benefit from education along with the general public. The need for community education is heightened by the subtle nature of the low-dose adverse health effects of lead, which cannot be diagnosed in an individual because the scientific basis for cognitive impairments caused by low to moderate exposures relies on carefully controlled comparisons of large numbers of children exhibiting a range of blood lead levels (NRC, 1993; Needleman and Bellinger, 2001). Once the public and local health officials are made aware of the potential risks presented by the site, specific programs, discussed in detail in Section 3 (Health Education), can be implemented. Education and clean-up activities should be easier to implement, more effective, and more widely accepted by the community when the citizens understand the risks and believe that the community is at risk.

> Integrated Exposure Uptake Biokinetic Model (IEUBK) – Predicts blood-lead concentrations (PbBs) for an individual child, or group of similarly exposed children (6 months to 7 years old), who are exposed to lead in the environment. More information is available from the Technical Review Workgroup for Lead (TRW) web site: http://www.epa.gov/superfund/programs/lead/ieubk.htm

2.2 COMMUNITY ADVISORY GROUPS

Community Advisory Groups (CAGs) can be invaluable in assuring the success of the project (EPA, 1995b). A supporting and active CAG, comprised of a wide cross section of the community, has been demonstrated on several projects to greatly contribute to the success of meeting the remedial goal. Establishing an open dialogue with the CAG

> Community Advisory Group (CAG) – Members of the community make up a CAG, which serves as the focal point for the exchange of information among the local community, EPA, the state regulatory agency, and other pertinent federal agencies involved in cleanup of the Superfund site. Additional information is available online: http://www.epa.gov/superfund/tools/cag/index.htm

and understanding and addressing its concerns, leads to increased satisfaction in the community at the completion of the project. Concurrent with the establishment of health education activities, formation of citizens groups should be encouraged at the very onset of the project. Delay in forming the groups until significant progress has occurred may lead to mistrust by the community, as well as delay or loss of the valuable contributions they can make in assisting EPA.

Citizens groups should be representative of the community. Examples include residents, workers, and business owners from affected neighborhoods, as well as minority leaders, realtors, bankers or lending institution officers, school board members, health officials, elected officials, city public works staff, local environmental group members, and other groups in the community. Additionally, the project manager should coordinate with other federal and state agencies to attend citizen group meetings. Relevant agencies may include the ATSDR, HUD, and state health and environmental departments.

Citizens groups can create a feeling of ownership that facilitates the long-term success of the remedy. They can contribute significantly to education activities in numerous ways. A few examples of the successful programs and activities accomplished by citizens groups at sites include: general education and awareness of the segment of the community they individually represent; creating site-specific education material such as coloring/story books; hosting health fairs; creating health education programs for local school districts; establishing lead poisoning prevention merit badges for girl and boy scout organizations; developing instructional videos; and establishing pre- and post-natal education programs at local hospitals.

2.3 EPA'S TECHNICAL ASSISTANCE GRANT PROGRAM

EPA provides assistance grants to communities to help citizens understand site-related information. By regulation, EPA must inform communities about the availability of Technical Assistance Grants (TAGs) and assist them in applying for these grants (EPA, 1992). EPA also informs citizens about obtaining assistance through other programs such as the university-based Technical Outreach Services for Communities program and the Department of Defense's Technical Assistance for Public Participation (TAPP) program.

Under the TAG program, initial grants of up to $50,000 are available to qualified groups affected by a response action. Additional funding is available for unusually large or complex sites. A group applying for a TAG need not be incorporated as a non-profit organization at the time it submits its application, but must incorporate as a non-profit organization before EPA can award the grant.

The group must contribute 20 percent of the total project costs to be supported by the TAG grant. This requirement can be met in a number of ways, including with cash, donated supplies, and volunteered services. TAG groups must prepare a budget and work plan for using the funds. There may be only one TAG award per NPL site. If more than one group applies for the same TAG, they are encouraged to form a coalition to apply for the grant.

TAGs are used to hire a technical advisor, who is an independent expert who can review site-related documents, interpret them, and explain technical or health-related information to community members. A TAG advisor will often make site visits to gain a better understanding of the clean-up activities. A technical advisor can also help communicate the community's concerns to EPA. TAG funds may not be used to generate new data (e.g., to conduct additional sampling) or for lawsuits or other legal actions. For further information on TAGs, see the recently revised TAG regulation (EPA, 2000b), which is available from the EPA TAG web site.

2.4 INFORMATIONAL MEETINGS

As important as the health education activities and the establishment of citizens groups are, the project manager should consider holding frequent public meetings to inform the community of current and planned EPA activities and to collect feedback and concerns from citizens. If a CAG has been formed at the site, meetings with the group should be frequent and open to the general public. It is recommended that in the early phases of the project, information sessions should be held at least monthly. Once the community becomes aware of the site risks, current site activities, and becomes relatively involved in the process, the frequency of the meetings can be reduced. However, it is recommended that public informational meetings, separate from the citizens task force meetings, be conducted at least once every six months. This frequency can help ensure that the public stays informed of site progress and has an opportunity to provide meaningful input to the process.

In addition to the meetings pursuant to CERCLA (e.g., prior to release of the Record of Decision) meetings are helpful at the following points in the process: (1) before sampling is conducted, to explain the reason that lead contamination is suspected, how residents can reduce exposure as a safety precaution while awaiting sampling results, and the overall goals of the project (e.g., if the goal of the project is to reduce exposure by remediating only surface soils and therefore the sampling is designed to evaluate only surface soils, the issue of ICs for any contaminated soils remaining at depth should be discussed with the property owners early in the process); (2) after sampling is conducted, to explain results, reiterate how residents can reduce exposure (if results show elevated levels), explain plans and the schedule for conducting remediation, discuss plans for re-landscaping the property, and discuss what sort of ICs may be appropriate; and (3) after remediation is completed, to explain what was done, provide documentation

of the results of the remediation, discuss any problems with the landscaping, and discuss any applicable ICs.

2.5 COMMUNITY INVOLVEMENT SPECIALIST/COORDINATOR

When the site is large and cleanup is expected to last several years, consideration should be given to housing a full time community involvement specialist/coordinator (CIS/CIC) at the site. The roles of the CIS/CIC are (1) to coordinate community involvement activities, and (2) to be readily accessible to the public to provide information and answer questions concerning site activities. The CIS/CIC should be intimately familiar with all activities at the site, as well as the documented health risks, and should maintain an office with business hours convenient to the public. Additionally, the CIS/CIC can use information gained from their constant contact with the local community to brief project staff on issues important to the successful remediation of the site.

> Community Involvement Specialist/ Coordinator - is the primary point of contact for a community and a Community Advisory Group (CAG), if one was formed for the site. He or she answers questions and provides other assistance directly as well as sees that a CAG's concerns and other issues are transmitted to other Regional Office staff who can help.

3.0 HEALTH EDUCATION

Health education provides information to the public about the risks associated with exposure to contamination and, in turn, how to reduce the exposures. Health education may be considered one of many tools the project manager can use at lead-contaminated sites to reduce exposure to humans.

3.1 APPROPRIATE USES FOR HEALTH EDUCATION

Health education is an informational device and this type of instrument is largely unenforceable. Furthermore, health education has not been demonstrated to be effective over the longer term. Health education may be effective when combined with other measures as an overall remedy for a site. Health education is not a stand-alone remedy. EPA's policy is that health education is only appropriate as a supplemental component of the permanent, health protective remedy selected at a contaminated lead site.

For these reasons, EPA advocates that health education be layered or implemented in series with ICs and engineered remedies. Layering means using different types of ICs and engineered remedies at the same time to enhance the protectiveness of the remedy. Using ICs in series is the use of ICs at different points in the investigation and remediation process to ensure the short- and long-term protection of human health and the environment.

3.2 PLANNING FOR HEALTH EDUCATION

Generally, the specific goals of the health education program should be described in a site-specific decision document. A plan that clearly defines the goals and how they should be achieved is also more likely to succeed. Health education at large lead sites may have a performance period of several years and cost hundreds of thousands of dollars. For these large projects, a clearly defined health education program is even more important.

An early step in any health education planning process includes conducting a community profile and assessing the educational needs of the community. A comprehensive health education program for a typical large lead site would normally attempt to focus on reaching the general public, with special emphasis on schools and other groups involved with young children. Also, it is important to coordinate with city, county, and other local governmental entities. The most important target population, though, is parents, particularly young parents, and parents with a child whose blood lead tested high. Other means of targeted education may include those homes with children that have high dust lead concentrations or lead loadings, which have been shown to be highly predictive of homes where a child is likely to have an elevated blood lead level during the summer peak (EPA, 1996b; von Lindern and Spalinger, 2001).

The response plan should describe what actions and activities are necessary to reach the community-at-large and the targeted groups. It is very important to consider that there are costs associated with the development, implementation, and follow up of health education and that these factors should be thoroughly understood and estimated. Other key points to consider are that the responsibilities for conducting this work should be clear and agreements should be made in writing in the planning stages of site response process.

3.3 EVALUATION OF HEALTH EDUCATION ACTIVITIES

It is important to monitor the effectiveness of health education projects that have been implemented at lead-contaminated sites. Many sites may include health education activities as a major component of the remedy, especially in the early phases of the cleanup. Failure to establish the education part of the remedy may trigger reconsideration and imposition of additional requirements, or more extensive and costly clean-up efforts.

The project manager should monitor the organization(s) performing the educational activities for proper implementation of the health education program and assess the effectiveness of the program. Project managers should ensure that the objectives of the program are being met to protect children's health. If health education is included as part of the final remedy, it should be carefully scrutinized during the Five-Year Review process.

3.4 AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY (ATSDR) INVOLVEMENT

Health education is often implemented through grants from ATSDR to its partners in state health departments or directly through agreements with local health departments. When health education is specified as a major part of EPA's clean-up activities, strong consideration should be given to establishing an interagency agreement with ATSDR to assist in funding the required activities. ATSDR as a federal health agency is well positioned in terms of health education resources to administer such grants. ATSDR can provide expertise not only with the CAGs but also with public health assessments, health consultations, and health surveillance. An emphasis should be placed on developing the collaborative partnerships between EPA, ATSDR, and other federal, state, and local health departments for health education activities at contaminated lead sites.

Health education at lead sites is often accompanied with blood lead screening. Centers for Disease Control and Prevention (CDC) has issued guidelines for increasing intensity of health intervention activities based on blood lead test results (CDC, 1991). Increased collaboration among the involved

agencies is important to properly implement a health education/blood lead screening project. Additionally, ATSDR and many state and local health departments have ongoing lead screening and health education programs. Information from targeted screening is valuable for (1) targeting follow-up education to individual families with children identified with elevated blood lead levels; (2) determining the areal and demographic extent of the problem; and (3) effectively evaluating the impact of health education.

3.5 OUTREACH

EPA has had success in health education activities at several sites because the programs were tailored specifically for the site by the site team (i.e., project manager, toxicologist, on-scene coordinator, CIS/CIC, etc.). These programs have included significant amounts of outreach activities in the communities. The success of any health education program generally can be attributed to the amount of community outreach that is conducted at the site. As discussed in Section 2, the outreach can consist of a wide variety of activities. A few examples include the following: site specific coloring books distributed to the parents of young children, scouting merit badges on lead-poisoning prevention, school curriculums developed to inform student of the hazards of lead and good hygiene, health and environmental fairs conducted in the community, and blood lead testing events held at community celebrations. Consultation with local health officials and community groups can provide numerous ideas for outreach, which can be incorporated into specific programs to best meet the needs of the community. Typically, the local health officials should lead the outreach efforts. Funding should be provided by EPA when other funds, such as from ATSDR, are unavailable to support the outreach activities.

4.0 SITE CHARACTERIZATION

EPA has reviewed various sampling designs historically employed at lead-contaminated residential sites and assessed the ability of these sampling designs to meet risk assessment needs and support the development of clean-up levels. Over a 20-year period, several large area lead sites (e.g., Bunker Hill, Shoshone County, Idaho; Joplin, Missouri; NL Industries/Taracorp-Granite City, Illinois; Tar Creek, Ottawa County, Oklahoma) have used a variety of sampling techniques to characterize residential properties. Additionally, many different approaches to applying selected clean-up levels have been taken. As stated, this document was developed to promote consistent procedures, criteria and goals in the investigation and clean-up activities at Superfund lead-contaminated residential sites. However, a level of flexibility is needed to best respond to different site conditions, communities, and uncertainties.

The overall goals of the sampling effort are to estimate an average soil lead concentration for risk assessment purposes and to provide information to determine the scope of any required clean-up actions. This information can also be used for public education and intervention. The sampling designs discussed in this section are intended to provide, within one sampling effort, the necessary data for all phases of a clean-up project so that residents are not inconvenienced by repeated sampling of the same property. Project managers should carefully choose the sampling points needed to estimate the average lead concentration in a cost-effective manner. Some uncertainty is acceptable to reduce the overall cost of sampling at large lead sites. The selection of sample locations within areas with potential for exposure has been the subject of recent articles which describe methods to manage decision uncertainty by balancing sampling and clean-up costs (Englund & Heravi, 1994; Crumbling et al., 2001). Table C-1 (Appendix C) lists contacts within the agency who can provide assistance in various aspects of sample planning and design, and also lists software that may be used for sample planning and decision support.

Section 4.0 discusses: (1) delineating the contamination zones; (2) residential property sampling locations; (3) sampling method; (4) sampling requirements for backfill material and excavated soil for off-site disposal.

4.1 CONTAMINANT ZONE DELINEATION

Historical information on site operations and use is crucial for the design of sampling plans that are intended to delineate contaminant zone(s), and for the interpretation of data generated from the sampling effort. In addition to gathering data on the nature of the source of contamination, information should be gathered to identify areas where soils may have been moved or where fill or topsoil may have been placed. Guidance on how to gather historical site data is available (EPA, 2001f, 2001g). Sites that have been contaminated primarily by airborne-derived lead, such as smelter areas, can initially be sampled in a

grid pattern. This will usually allow concentration contours to be defined across the community and to establish the extent of horizontal contamination for cleanup and costing purposes. If grid sampling is used for initial characterization to define the horizontal extent of contamination, follow-up sampling of each yard located within the identified clean-up zone should be used to characterize each individual property for clean-up requirements. For other sites where the variability is expected to be higher, such as mining sites with discrete individual tailings piles located throughout the area, delineating the contaminant zones by establishing concentration contours will be more uncertain and consideration should be given to sampling every home in the potentially affected area, moving laterally away from the source until clean areas of the community have been identified.

Delineating the zone of contamination generally amounts to distinguishing soil with "background" lead concentration from soil that has been impacted by site-related activities. There are basically two types of background: naturally occurring and anthropogenic (see insert for definitions) (EPA, 1989, 1995c, 2002). EPA guidance defines background for inorganics as *"...the concentration of inorganics found in soils or sediments surrounding a waste site, but which are not influenced by site activities or releases"* (EPA, 1995c). Natural background concentrations of lead vary widely with the local geology, and can be as high as 250 ppm or more in mining areas (SRC, 1999). Local background concentrations, which include natural and non-site-related anthropogenic sources (e.g., historic automobile emissions) can be substantially higher. Background samples should be collected from areas near the site that are not influenced by site contamination, but that have the same basic characteristics (e.g., soil type, land use).

Types of Background

naturally occurring: ambient concentrations of lead present in the environment that have not been influenced by humans

anthropogenic: lead concentrations that are present in the environment due to human-made, non-site sources (e.g., automobile exhaust)

Statistical approaches to delineating contaminant zones are useful for some sites. In these cases, the project manager should consult with a statistician to design an efficient sampling plan. The Agency is developing guidance on characterizing background chemicals in soil that includes statistical methods for delineating contaminated areas (EPA, 2001i). Geostatistics is widely recognized for offering graphical methods that are ideally suited for delineating contaminant zones (Gilbert and Simpson, 1983; Flatman and Yfantis, 1984; Journel, 1984; Englund and Heravi, 1994; Goovaerts, 1997). Geostatistics also provides powerful methods for detecting contaminated areas from background when sample locations have not been randomly selected (e.g., Quimby, 1986; Borgman and Quimby, 1996), for sampling plan design (e.g., Flatman and Yfantis, 1984; Borgman et al., 1996), and for aiding in the design of remedial

responses (e.g., Ryti, 1993). For smaller sites, rigorous statistical analyses may be unnecessary because site-related and non-site-related contamination clearly differ. For these sites, the sampling plan should focus on establishing a reliable representation of the extent (in two or three dimensions) of a contaminated area (EPA, 1989) .

4.2 RESIDENTIAL PROPERTIES

For the purposes of this document, a residential property includes properties that contain single and multi-family dwellings, apartment complexes, vacant lots in residential areas, schools, day-care centers, playgrounds, parks, and green ways (EPA, 1996a, 1997a). In all cases, historical site information (type of lead site, fill activities, previous epidemiological studies, etc.) is important in the application of this Handbook.

Rationale for collecting yard soil samples and water samples on a residential property is provided in Table 4-1. The collection of other types of media are important to determine overall risk, however CERCLA has limited authority to address these media (e.g., interior paint, dust, and potable water).

4.2.1 Sampling Access

Prior to conducting any sampling or clean-up activities at a residential property, access must be obtained from the property owner; access obtained from tenants or renters is not sufficient. It is essential to begin access procurement as early as possible in the remedial process to avoid potentially lengthy delays. It is recommended that access be obtained by going door-to-door. If residents are not home, a blank access agreement with instructions for signature and submission to EPA, along with relevant contact information should be left at the residence (but not in the mailbox). Examples of access agreements are presented in Appendix D, pages D-2 and D-3. If possible, access for remediation should be obtained at the same time access for sampling is sought. Examples of combined sampling/remediation access agreements are included on pages D-4 and D-5 of Appendix D. Combining sampling and clean-up access will avoid potentially lengthy delays. Additionally, access should be obtained for any interior dust sampling and/or cleaning that will be performed at the residence (Section 6.6.2). Sample access agreements for dust cleanup are presented in Appendix E.

Table 4-1.
Rationale for Sampling Residential Properties

Sample Location	Rationale for Sample Collection
Residential yard soils	Residential soil may present a direct exposure pathway to persons working, playing, or conducting other recreational activities on the property. Soil samples should be collected and quantitatively analyzed to estimate lead concentrations. Residential soils may also present an indirect exposure pathway via house dust exposure (see below).
Gravel driveways	Fine-grained driveway material may present a direct exposure pathway to persons working or engaged in recreational activities on driveways. Soil samples should be collected and quantitatively analyzed to estimate lead concentrations. Gravel driveways with elevated soil concentrations may also contribute to the transport of contaminants throughout the community.
Drip zones and soils below roof gutter downspouts	Rooftops may collect fine-grained sediments that contain high concentrations of lead. In yard areas where downspouts discharge during a storm event, the fine-grained material washed from a roof may accumulate and result in a localized increase in soil lead concentrations. Soil samples should be collected and quantitatively analyzed to estimate lead concentrations. Drip zone areas may also contain LBP influences and are important to characterize for health intervention purposes, as drip zones are often used as play areas.
Soils in play areas	Play area soils may present a direct exposure pathway to children under the age of seven. Soil samples should be collected and quantitatively analyzed to estimate lead concentrations.
Garden soils	Garden soils may present a direct exposure pathway to persons who actively maintain a garden. Soil samples should be collected and quantitatively analyzed to estimate lead concentrations.
Interior lead dust	Lead in household dust may be a significant contributor to elevated blood lead levels, especially in younger children. Dust samples should be collected and quantitatively analyzed to estimate lead concentrations. Lead-contaminated interior dust can be derived from multiple sources; dust mat samples and speciation can be used to identify lead sources.
Lead-based paint	Deteriorating LBP may contribute lead to household dust, which can be a significant source of lead exposure, particularly for young children. If elevated concentrations of lead are found in interior dust, samples of interior paint should be collected and quantitatively analyzed to estimate lead concentrations. Exterior LBP may contribute to the recontamination of remediated properties. Samples of exterior LBP should be collected and quantitatively analyzed to estimate lead concentrations.
First run and purged tap water	Groundwater and surface water near the site may contain elevated lead concentrations. Some residences located within the site may use local groundwater or nearby surface water as a source of drinking, cooking, bathing, or irrigation water. The water may represent a direct exposure or ingestion pathway. Samples of both water standing in the pipes (first run sample) and water discharged after the system has been flushed (purged sample) should be collected and quantitatively analyzed to estimate lead concentrations. These results can also be used to help determine if the drinking water is contaminated with site-related contamination (exceedance in purged), or to determine if there is lead in the home's plumbing (exceedance in first run), or both, which may be used for remediation or intervention purposes, respectively.
Crawl Spaces	Crawl space sampling is recommended if the crawl space is accessible to children or pets. At some sites (e.g., Bunker Hill) this has been found to be a significant pathway (IDHW, 2000; TerraGraphics, 2000). Even when spaces are too small for children, pets have been found to access these spaces and move significant amounts of fine dust containing elevated lead levels into the child's bedroom (e.g., where a pet may sleep on the child's bed at night). Information on concentrations of lead beneath the structure may be used to document the need to preclude access or take other remedial measures.
Other areas	During field work, other potential sources of lead contamination may be identified. If the sources appear to represent a potential exposure pathway to occupants of a residence, sampling may be recommended. Other areas should be evaluated on a case-by-case basis and could include sediment, surface water, or secondary play areas. If deemed appropriate, samples should be collected and quantitatively analyzed to estimate lead concentrations.

4.2.2 Residential Yards

It is recommended that when sampling residential lots with a total surface area less than 5,000 square feet (a typical urban lot size), five-point composite samples should, at a minimum, be collected from each of the following locations: the front yard, the back yard, and the side yard (if the size of the latter is substantial). The front, back, and side (if needed) yard composites should be equally spaced within the respective portion of the yard, and should be outside of the drip zone and away from influences of any other painted surfaces (Figures 4-1a and 4-1b). Composites should consist of aliquots collected from the same depth interval.

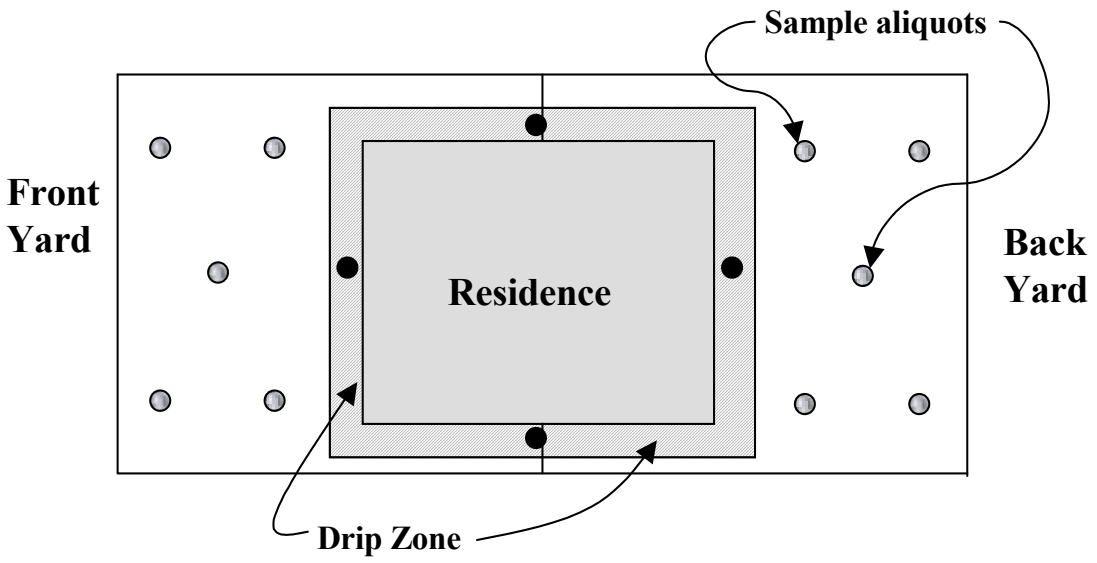


Figure 4-1a. Recommended minimum soil sampling in yards less than or equal to 5,000 square feet with small side yard. Five point composite samples should be collected from each of the front and back yards. Four point composites should be collected from the drip zone; each aliquot should generally be collected from the midpoint along each side of the residence. Aliquots for a single composite sample should be collected from the same depth interval. Soil samples should also be collected from distinct play areas and gardens if they are present, as well as unpaved driveways and minimal use areas such as areas under porches and crawl spaces. The locations of the aliquots should be equally spaced within the area of the yard the composite is collected from. The figure illustrates one possible arrangement of the sample aliquots. Please refer to Section 4.2.2 for further explanation.

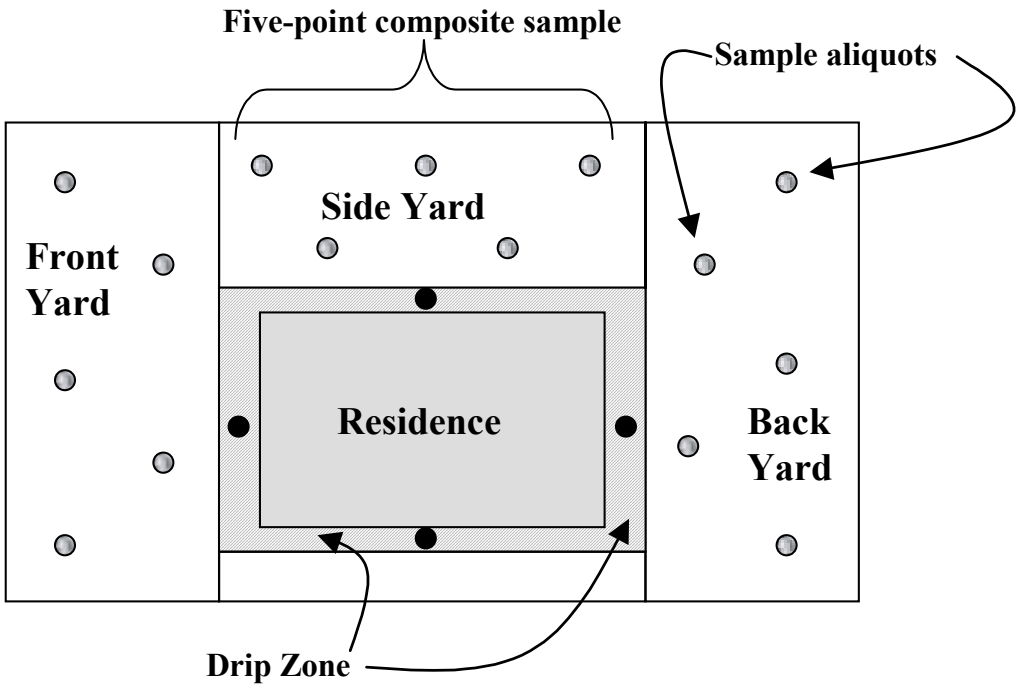


Figure 4-1b. Recommended minimum soil sampling in yards less than or equal to 5,000 square feet with substantial side yard. Five point composite samples should be collected from each of the front, back, and side yards, along with other areas as described in Figure 4-1a. The locations of the aliquots should be equally spaced within the area of the yard the composite is collected from. The figure illustrates one possible arrangement of the sample aliquots Aliquots for a single composite sample should be collected from the same depth interval. Please refer to Section 4.2.2 for further explanation.

For residential lots with a total surface area greater than 5,000 square feet, it is advisable that the property be divided into four quadrants of roughly equal surface area. The two quadrants in the front yard should encompass one half of the side yard; likewise for the two quadrants in the back yard. One five-point composite of aliquots collected at equal spacing and from the same depth interval should be obtained from each quadrant. Each aliquot should be collected away from influences of the drip zone and any other painted surfaces (Figure 4-2).

Properties over one acre in size should be divided into 1/4 acre sections. One five-point composite sample should be collected from each section. For large properties, consideration should be given to whether elevated concentrations trigger partial removal of soils or access restriction (see Section 6.5).

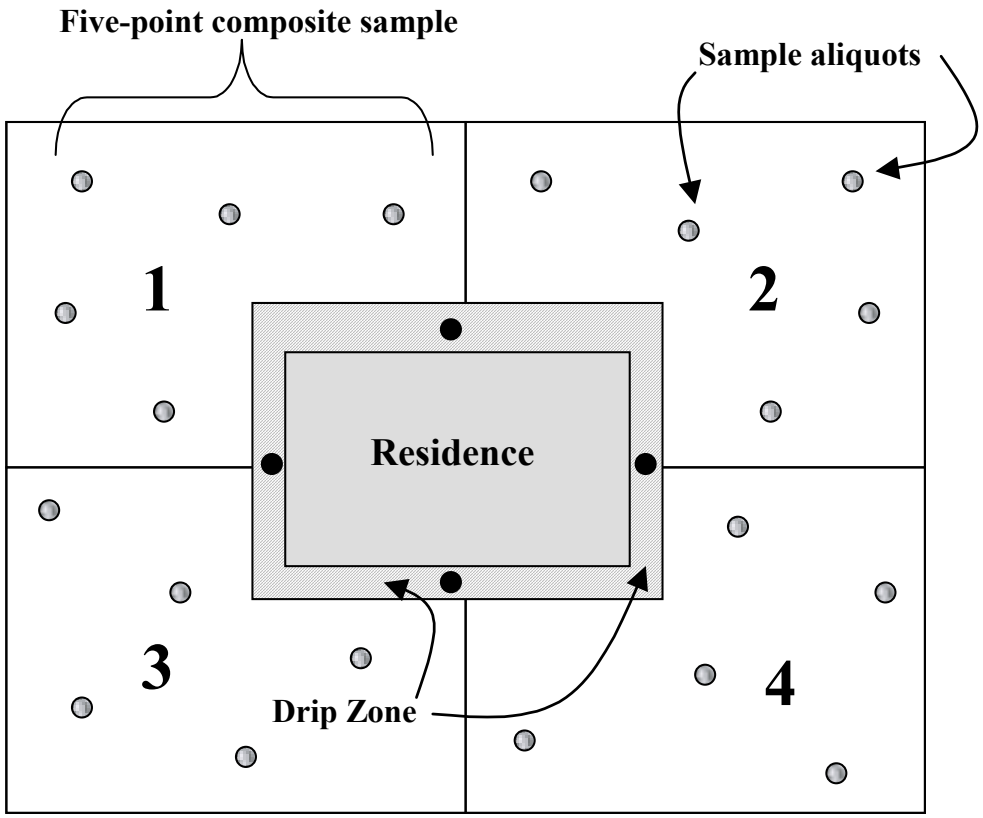


Figure 4-2. Recommended minimum soil sampling in yards greater than 5,000 square feet. Five point composite samples should be collected from each of the four quadrants as indicated above. The locations of the aliquots should be equally spaced within each of the quadrants. The figure illustrates one possible arrangement of the sample aliquots. Four point composites should be collected from the drip zone; each aliquot should generally be collected from the midpoint along each side of the residence. Aliquots for a single composite sample should be collected from the same depth interval. Additional samples should be collected from distinct play areas and gardens if they are present, as well as unpaved driveways and minimal use areas such as areas under porches and crawl spaces. Please refer to Section 4.2.2 for further explanation.

4.2.3 Drip Zones

Lead-contaminated soils are frequently found within the drip zone of houses. It is recommended that a four-point composite sample be collected from the drip zone of each residential property (Figures 4-1a, 4-1b, and 4-2). The composite sample (taken from any size lot) should consist of a minimum of four aliquots collected between 6 and 30 inches from the exterior walls of the house. Each aliquot should generally be collected from the midpoint of each side of the house. Collection of additional aliquots should be considered if other factors exist, such as bare spots, distinct differences in the house exterior, and areas where runoff collects. Rooftops may collect fine-grained sediments that contain high concentrations of lead. In yard areas where downspouts discharge during a storm event, the fine-grained material washed from a roof may accumulate and result in a localized increase in soil lead

concentrations. Samples of the soil from the downspout discharge area should also be sampled if present.

4.2.4 Play Areas, Gardens, and Driveways

Distinct play areas and gardens, if present, should generally be sampled separately as discrete areas of the yard. At some sites, collection of a right-of-way/easement composite may also be appropriate, such as residential areas with unpaved streets and alleys. Paved surfaces such as asphalt/concrete driveways, patios, alleys, and parking lots should, in most cases, not be sampled. Samples should also be collected in other locations depending upon the potential for exposure or recontamination, for example, under porches and crawl spaces and areas with incomplete barriers such as gravel driveways.

4.2.5 Potable Water, Lead-Based Paint and Interior Dust

Drinking water supply samples should be collected to determine if exposure to lead in drinking water is occurring. First-run and purged samples of potable water should be collected to differentiate site-related sources of lead from lead derived from plumbing that is located within the residence. CERCLA authority for remedial action may be limited with regard to lead derived from plumbing that is located within the residence.

Deteriorating LBP may contribute lead to household dust. If elevated concentrations of lead are found in interior dust, samples of interior paint should be collected. Exterior LBP may contribute to the recontamination of remediated properties (Section 6.7). Samples of exterior LBP should be collected and analyzed to estimate lead concentrations. Lead in household dust may be a significant contributor to elevated blood lead levels, especially in younger children. Lead-contaminated interior dust can be derived from multiple sources; dust mat samples and speciation can be used to identify lead sources. Dust samples should be collected and analyzed to estimate its potential contribution to lead exposure. Guidance on LBP and dust sampling is available from HUD (HUD, 1995).

4.2.6 Backfill and Waste Soil

Backfill soil should be sampled to ensure that uncontaminated material is being placed on the site. The list of analytes and the frequency of sampling should be based on site-specific factors including the location of the source for the backfill material relative to potential sources of contamination, the geology of the borrow area, and the heterogeneity of the material. For example, on the Bunker Hill Superfund Site, four-point composite samples were collected for each 200 yd^3 of soil (TerraGraphics, 1997a). Gravel for driveway backfill was also sampled every 200 yd^3 (TerraGraphics, 1997b). Samples of excavated soil should be analyzed by the toxicity characteristic leaching procedure (TCLP) method to

determine the appropriate method of disposal. The frequency required for TCLP sampling should be based on the heterogeneity of the lead and other contaminant(s), if any, on the site.

4.3 SAMPLING METHOD AND ANALYSIS

4.3.1 Sample Collection

Composite samples should consist of discrete aliquots of equal amounts of soil. The soil from each aliquot should be collected into one clean container, such as a stainless steel bowl or plastic bag, and thoroughly mixed. After mixing, the sample can then be analyzed by X-Ray Fluorescence (XRF) (see Section 4.3.4) or sent to the laboratory. Remaining sample volume can then be disposed in the general location from where it was collected, or archived, depending on the requirements of the project. In some cases, material other than grass and/or soil will be encountered at a sample location, e.g., wood chips and sand are often found in recreational areas of day-care and school playgrounds. Samples of the soil below the cover material should be collected.

The use of a dynamic sampling and analysis strategy should be considered (EPA, 2001d). A dynamic sampling and analysis strategy takes full advantage of the real-time that data field analytical methods provide, which can limit the sampling effort and minimize cost (EPA, 2001d). This document suggests the use of field portable X-Ray Fluorescence (FP-XRF) analysis.

4.3.2 Sample Depth

The following sampling design is based on the assumption that removal of surficial contaminated soils and placement of a cover of clean soil will be protective of human health and the environment (see Section 4.0). Furthermore, the sampling design outlined below is based on the assumption that a minimum of 12 inch soil cover is adequate.

Initial sampling for lead contamination in residential soils should be conducted to a depth of at least 18 inches, but does not need to exceed 24 inches to define the vertical extent of contamination for clean-up purposes. Composite samples should be collected at 6 inch depth intervals, i.e., 0–6 inches, 6–12 inches, 12–18 inches, and 18–24 inches. Additional sampling may be required at lead sites in cold weather regions when contamination is associated with coarse grained material. Stone-sized material, such as tailings and crushed battery casings, will, over time, migrate upward through the soil via freeze/thaw effects. At such sites, composite sampling should be conducted at 6 inch intervals to the approximate maximum frost depth for the region. In all cases, composites should consist of aliquots collected from the same depth interval.

In site-specific situations, deeper sampling may be conducted to determine the total vertical extent of contamination for groundwater issues or ICs, and to determine if complete removal of contaminated soil is possible. Depth sampling should be conducted until the vertical extent of contamination has been adequately defined, but does not need to be conducted on every property.

In addition to the composite samples collected to define the vertical extent of contamination, five-point composite surface soil samples should be collected from 0 to 1 inch for human health risk assessment purposes (EPA, 1989, 1996c). The samples should be collected using the procedure described in Section 4.3.1. These surface soil samples should be collected from every property within the identified zone of contamination; however, after collecting a statistically valid number of both 0–1" and 1–6" samples, the project manager may want to compare both sample horizons (e.g., paired-sample t-test; Wilcoxon Rank Sum test) (Gilbert, 1987; Snedecor and Cochran, 1989) to determine if the 0–1" depth can be eliminated (i.e., sample from 0–6"), to further decrease sampling costs. This may be particularly useful at mine waste sites where contamination often extends to depth or at sites where lead-contaminated soil has been used as fill material; in such cases, the lead concentration may increase with depth. Conversely, the 0–1" horizon may be far more contaminated than the 1–6" at smelter sites, making individual horizon sampling crucial to remedial decision-making.

Collection of samples from specified depth intervals serves two primary purposes: risk assessment and remedial decision-making. With respect to risk assessment, the top inch of soil best represents current exposure to contaminants (EPA, 1989, 1996c) and is the source of data used in the IEUBK model to represent exposure from soil. The various depth intervals are used in remedial decision-making to determine if a residential yard requires cleanup by evaluating if any of the horizons exceed the site-specific action level. The lower soil horizons represent possible future exposures, such as homeowner projects, children's play areas, and other home activities that periodically go beneath the top inch of vegetation/soil (EPA, 1989). All soil horizons should be used for clean-up decision-making. The 6 inch depth intervals recommended in this document are based on the performance that may be reasonably expected of operators of small equipment working in relatively small spaces around homes. Specifically, a "bobcat" is most efficiently used for soil removal on a property if the soil is removed in 6 inch intervals, rather than in smaller increments, which would be far more difficult to achieve in a consistent or cost-effective manner. This approach has been developed to ensure a residential yard is cleaned up if it poses an immediate or long-term risk to human health in a manner that relates the sampling methodology closely to reasonable and cost-effective construction equipment performance.

A secondary goal of the sample collection effort is to facilitate the implementation of ICs for sites where contamination at depth is left in place.

4.3.3 Sample Preparation

Residential soil lead samples should represent the exposure potential of young children who are most vulnerable to adverse effects of exposure. Children inadvertently ingest lead in soil and dust that adheres to their hands (Succop et al., 1998). The smaller particles are more representative of this type of exposure (Duggan et al., 1985; Kissel et al., 1996; Mielke et al., 1997). Additionally, smaller particles are preferentially brought into the home. Sieving is conducted to better represent the soil fraction that is ingested by the typical child. Sieving has also been used in soil ingestion and bioavailability studies (Calabrese et al., 1996; Casteel et al., 1997; Stanek et al., 1999). Samples collected from all depth intervals should be sieved. Samples should not be ground prior to sieving, as this changes the physical structure of the soil and may bias the analytical results. To reduce sampling costs, it may be desirable to develop a correlation between sieved and unsieved data, to eliminate the need to sieve all samples. The correlation can be used to predict sieved results from unsieved samples. The EPA Technical Review Workgroup (TRW) and American Society for Testing and Materials (ASTM) have issued guidance on sieving (ASTM, 1998; EPA, 2000c). The EPA TRW guidance addresses appropriate sieve size (No. 60) and a method for predicting the concentration in the fine fraction using concentrations measured in unsieved samples.

Technical Review Workgroup (TRW) – The TRW is an interoffice workgroup that consists of key scientific experts from various EPA regions, labs, and headquarters that supports and promotes consistent application of the best science in the field of lead (Pb) risk assessment at contaminated sites nationwide.

The presence of paint chips in a soil sample can represent a large proportion of the total lead concentration that is measured. On this issue, the Handbook directs the reader to existing HUD guidance, which states “If paint chips are present in the soil, they should be included as part of the sample. However, there should be no special attempt to over-sample paint chips. The laboratory should be instructed to disaggregate (‘break up’) paint chips by forcing them through a sieve in the laboratory. Although paint chips should not be oversampled, they should not be excluded from the soil sample, since they are part of the soil matrix.” (HUD, 1995). The TRW website should be checked periodically for additional sampling guidance.

4.3.4 Sample Analysis

EPA’s experience in sample analyses at large residential contamination sites (with several thousand homes on a site) shows that both FP-XRF or fixed-site laboratory analyses (acid digestion/Inductively Coupled Spectroscopy) provide reliable information (EPA, 1996d, 1998b, 2001c, 2001d; Crumbling et al., 2001). The objective of using a FP-XRF is to predict Contract Laboratory Program (CLP) values with

less expensive real-time data. A sufficient amount of data should be collected to develop a site-specific relationship (i.e., correlation) between FP-XRF and CLP lab data.

The comparison should consider sample preparation (drying and sieving) and analytical methods. Typically, a large number of laboratory confirmation samples should be analyzed at the beginning of the project to estimate the correlation between the FP-XRF and the CLP results and the FP-XRF precision and accuracy. Additional confirmatory samples should then be analyzed at key decision points when the FP-XRF results are close to action levels or when the reliability of the FP-XRF unit is in question (EPA, 2001d). For example, initial sample analyses using an FP-XRF instrument could include 20 percent laboratory confirmatory samples to assess the accuracy and precision of the FP-XRF. Once the accuracy and precision of the FP-XRF results have been determined (and assuming they satisfy the requirements of the project), the number of laboratory confirmatory samples could be reduced (e.g., to 5 percent). Additional information on analyzing soil (and other media) in the field with FP-XRF is available on the EPA web site: http://www.epa.gov/superfund/programs/dfa/ (EPA, 2001e).

Proper calibration of the FP-XRF unit is important to obtaining reliable results (EPA, 1996d). Correlation between the FP-XRF and laboratory analyses is best achieved with small sample volume. Laboratory confirmatory samples should be collected in the specimen cup available from the FP-XRF manufacturer. The sample is first analyzed with the FP-XRF and then sent to the laboratory for wet chemistry analysis. Soil moisture can introduce error in FP-XRF results to varying degrees, depending on the instrument being used (EPA, 1996d). The correlation between the FP-XRF measurements on dried and undried samples should be estimated. The correlation analysis should then be used to establish a cutoff or ‘soil moisture ceiling’. The ‘soil moisture ceiling’ represents the maximum moisture content at which useful results (i.e., of sufficient precision and accuracy) can be obtained with the FP-XRF. Field portable instruments capable of measuring moisture content are available and should be used to compare sample moisture content to the ‘soil moisture ceiling’. Samples with moisture contents greater than the ‘soil moisture ceiling’ should be dried prior to analysis with the FP-XRF.

5.0 CLEAN-UP LEVEL SELECTION

Generally, the approach to human health risk assessment for lead differs from that of other metals and contaminants. Typically, risks from lead exposures are estimated from long-term exposures, although elevated blood lead concentrations also result from short-term exposures (CDC, 1991). EPA has developed the IEUBK model to predict blood lead (PbB) concentrations in children exposed to lead. The model considers several different media through which children can be exposed to lead.

EPA and the CDC have determined that childhood PbB concentrations at or above 10 micrograms of lead per deciliter of blood (: g Pb/dL) present risks to children's health (CDC, 1991). Accordingly, EPA seeks to limit the risk that children will have Pb concentrations above 10 : g Pb/dL. The IEUBK model predicts the geometric mean PbB for a child exposed to lead in various media (or a group of similarly exposed children). The model also calculates the probability that the child's PbB exceeds 10 : g Pb/dL (P_{10}). Preliminary remediation goals (PRGs) generally are determined with the model by adjusting the soil concentration term until the P_{10} is below 5%. Final clean-up level selection for Superfund sites generally is based on the IEUBK model results and the nine criteria analysis per the National Contingency Plan (NCP) (EPA, 1990b), which includes an analysis of ARARs. More information on the IEUBK model is available from the EPA TRW web site.

Typically at large lead sites, early actions taken to mitigate the identified site risks consist of time-critical removal actions (TCRAs), most often taken as an interim action. These actions are usually followed by long-term remedial actions. The following sections describe the different approaches that should be used for prioritizing response actions and selecting clean-up levels for both early (interim) and long-term (permanent) response actions.

5.1 PRIORITIZING RESPONSE ACTIONS

For early, interim actions, a tiered approach should be used for prioritizing clean-up actions. A tiered-response approach is recommended when sufficient resources are not available to fully address lead risks. The size and complexity of many lead sites often requires implementation of response actions over an extended period of time; therefore, it is often necessary to implement interim clean-up actions to manage short-term health risk concerns while response actions to address long-term risk are planned and implemented. Early removal actions at residential lead sites should contribute to the performance of the long-term permanent remedy.

The tiered approach is depicted in Figure 5-1. Figure 5-1 is a flowchart that provides a roadmap of the recommended clean-up process for lead-contaminated residential sites. An overview to the clean-up process is provided in Figure 1-1. The first page of Figure 5-1 provides a more detailed overview; the subsequent pages provide additional details of the process.

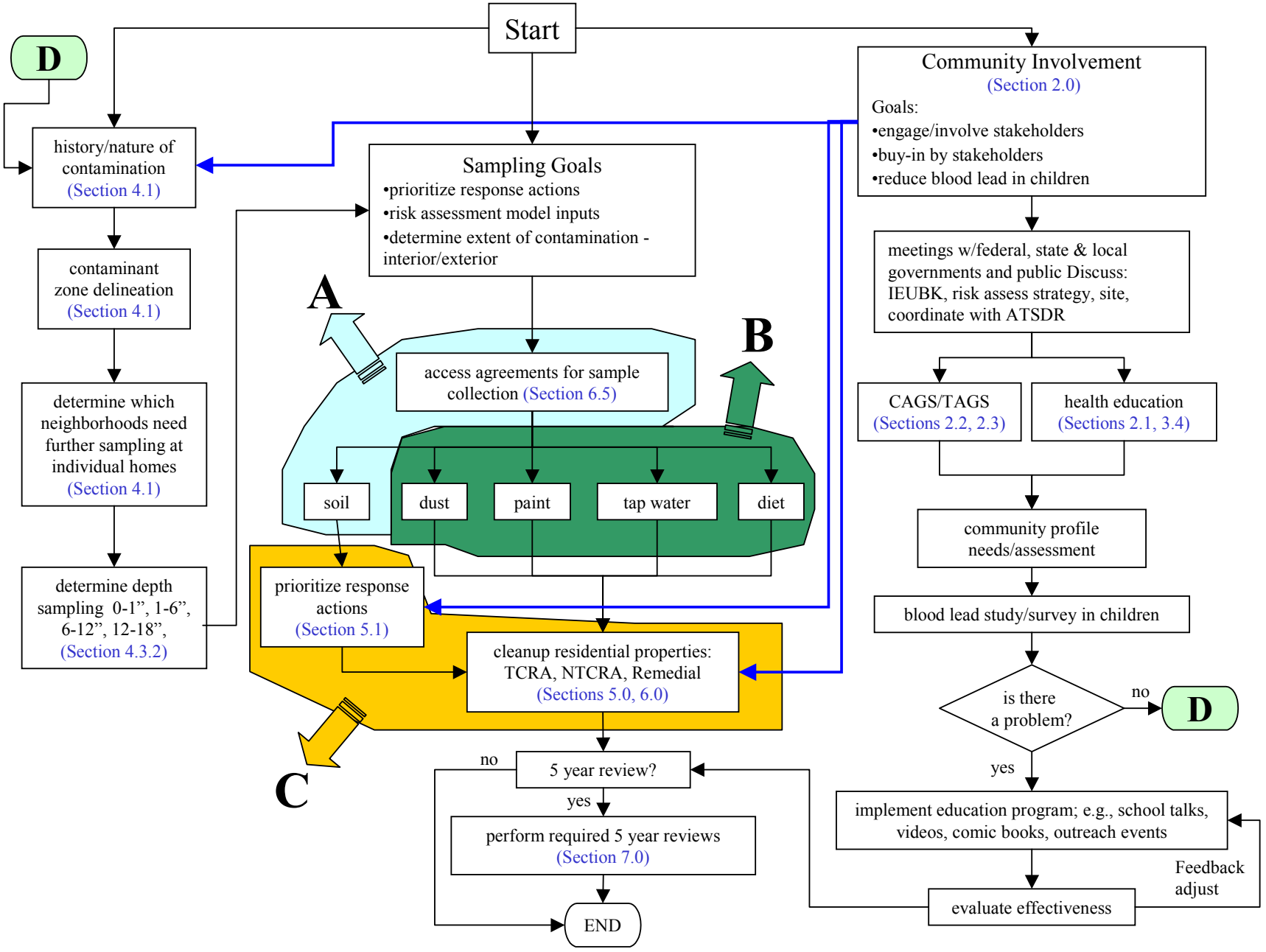


Figure 5-1. Recommended clean-up process for lead-contaminated residential sites. Refer to Figure 1-1 for an overview of the process. The shaded portions of the figure, labeled A-C, are expanded on the second through the fourth pages of the flowchart.

Figure 5-1. (continued)

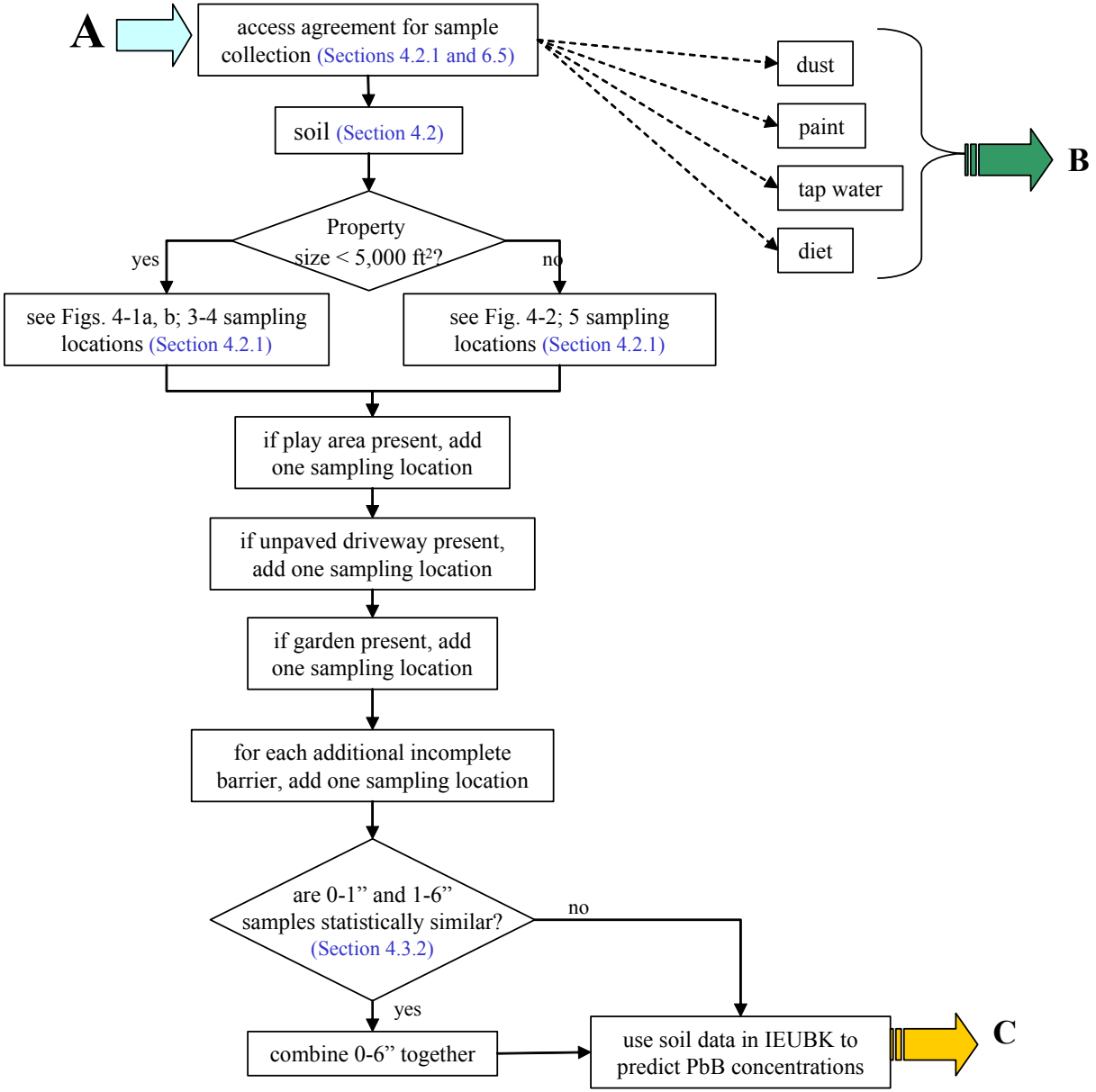


Figure 5-1. (continued)

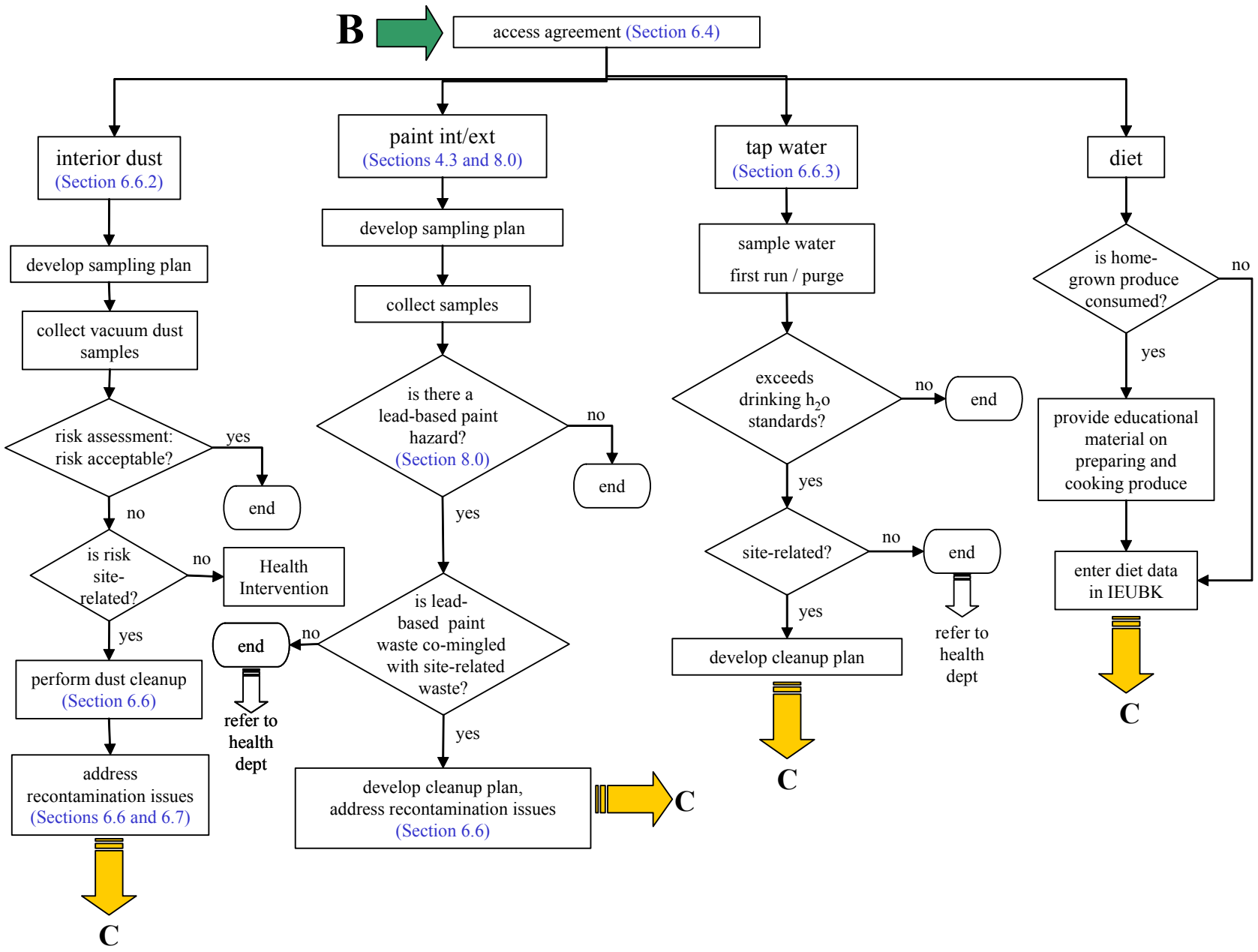
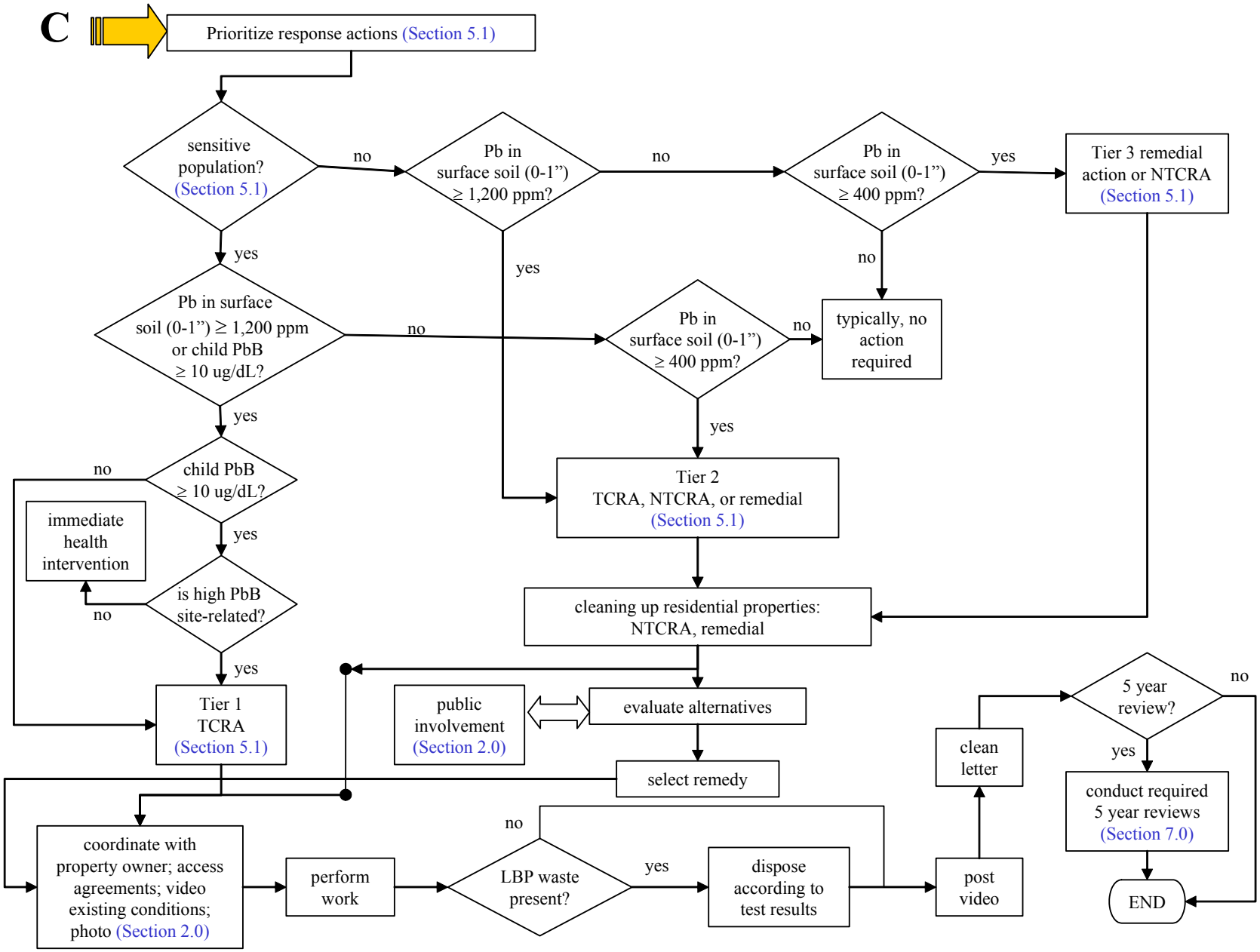


Figure 5-1. (continued)



The concentrations that are used to define tiers should not be confused with clean-up numbers, which are based on the PRG determined with the IEUBK model and an analysis that includes the nine criteria listed in the NCP (EPA, 1990b). The 1,200 ppm concentration is not an action level for TCRAs, but is intended to provide an alternative to running the IEUBK model if the project manager believes the site poses an urgent threat (EPA, 1997b, 1997c). Certainly, a TCRA could be justified above or below this concentration depending on the conditions at the site. The tiers, for the purposes of this guidance, are defined below (see also Figure 5-1). (Please note the Agency is considering developing new guidance for removal actions.)

- Tier 1 properties have both sensitive populations (children up to 7 years old or pregnant women) and soil concentrations in the surface soils (0–1" depth) at or above 1,200 ppm (EPA, 1997b, 1997c). Also, Tier 1 sites can be identified based upon a demonstration of children's blood lead levels at or above 10 µg/dL. Generally, TCRAs would be taken at Tier 1 properties.

- Tier 2 properties have either sensitive populations and soil lead concentrations in surface soils between 400 ppm and 1,200 ppm, or no sensitive populations and surface soil lead concentrations above 1,200 ppm, but not both. Tier 2 properties can be addressed through TCRAs, or non-time-critical removal actions (NTCRAs), or long-term remedial actions.

- Tier 3 properties have surface soil concentrations below 1,200 ppm, but above 400 ppm, and no sensitive populations present. Tier 3 sites would typically be addressed through long-term remedial actions or NTCRAs.

Tier 1 should be the highest priority for immediate action and Tier 3 should be the lowest priority for immediate action. Residential properties can move into a different tier if conditions change (e.g., small children or pregnant women move into a house). A typical residential lead site will contain a combination of properties that fit into different tiers. The project manager should use judgement to determine whether or not to perform a complete cleanup of contaminated residential properties (as defined in Section 1.3).

As discussed below, remedial actions for residential lead sites should use the IEUBK model. The IEUBK model should be used to assess risks posed by contaminated soils and to determine PRGs for soils at residential lead sites. In order to facilitate TCRAs, a demonstration of elevated blood lead levels or elevated soil-lead levels at or above 1,200 ppm will usually be sufficient. If elevated blood lead levels are the basis for concern, occupational contributions of lead, elevated lead levels in drinking water, lead from LBP, and lead dust in the homes of children or adults with elevated blood lead should be investigated first because these sources of lead can be significant (Appendix B). At this stage, consultation with Regional

risk assessors and public health officials (such as ATSDR) to better understand health impacts is encouraged.

The Agency plans on publishing a future lead removal directive which includes further information on site-tier approaches.

5.2 LONG-TERM REMEDIAL ACTION

The 1994 Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12 states OSWER's risk reduction goal for residential lead sites: "... generally, OSWER will attempt to limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% exceeding the 10 : g lead/dL blood lead level." (P_{10}<5%) (EPA, 1994b). It is important to note that this recommendation (i.e., P_{10}<5%) is meant to apply to a single residential property or another discrete exposure area, not on an area- or community-wide basis (i.e., 5 children out of every 100 actually exceed 10 : g/dL). It is also important to note that selecting a soil lead concentration in this manner will not guarantee that a given child will not exceed a blood lead level of 10 : g/dL. Many factors other than soil concentration cause variance in blood lead levels: pica behavior, or other sources of lead not included in the exposure unit, such as paint, diet, etc. (e.g., this could include soil at a camping site or other remote site frequented by the child).

The 1998 OSWER Directive 9200.4-27P ('Clarification') (EPA, 1998a) recommends that the IEUBK Model be used as the primary tool to generate risk-based soil clean-up levels at lead sites for current and future residential use (Appendix B). Additionally, the 1998 Clarification states that response actions can be taken using IEUBK predictions alone, and that blood lead studies, while providing useful information, should not be used for establishing long-term remedial or non-time-critical removal clean-up levels at lead sites. Regarding exposure units at residential lead sites, the 1998 Clarification states: "... it is recommended that risk assessments conducted at lead-contaminated residential sites use the individual residence as the primary exposure unit of concern" (EPA, 1998a; Appendix B). This document clarifies the definition of exposure unit provided in the 1998 Clarification. In addition to the individual residence, accessible site-related lead sources outside the residential setting should also be evaluated to understand how these other potential exposures contribute to the overall risk to children. When the evaluation indicates a significant contribution to risk, clean-up measures should be determined for those areas.

Empirical blood lead data occasionally deviates significantly from IEUBK Model predictions. This can be due to numerous factors, including the implementation of lead exposure-reduction and health education programs, and uncertainties in the exposure parameters of the Model as well as uncertainties in the blood lead data (Mushak, 1998). Regarding this issue, the 1998 Clarification states: "Where actual

blood lead data varies significantly from IEUBK Model predictions, the model parameters should not automatically be changed. In such a case, the issue should be raised to the TRW to further identify the source of those differences" (Appendix B). Basically, model inputs should be changed only when defensible, site-specific information that is specifically applicable to the parameters is collected. Moreover, these changes should also ensure that model outputs are protective of future residents. Examples of such information are dust lead concentration, drinking water concentration, bioavailability data (e.g., *in vivo* pig studies), and soil-to-dust ratio. The predictive capacity of the IEUBK Model depends upon the representativeness of the inputs. Section 4 discusses the collection of the data used to estimate some of these inputs.

In summary, there is no national clean-up standard for lead in residential soil on a Superfund site; however, there is a consistent process by which residential soil lead clean-up levels are selected. One step is to gather site-specific data as recommended in Section 4 of this Handbook and review other guidance on the use of the IEUBK Model (EPA, 1994b; TRW web site: http://www.epa.gov/superfund/programs/lead/ieubk.htm). Risk assessors (and other data users) should be consulted early to assist with data collection and planning (EPA, 2000d). Another step is to get assistance from the regional risk assessor(s) to run the IEUBK Model with applicable site-specific inputs. Running the model should allow the determination of a site-specific PRG that corresponds to a P_{10} for a typical child, or group of similarly exposed children, that is no more than 5%. Another step is to select a site-specific residential soil lead clean-up level that is based on the model-derived soil lead PRG and an analysis of the nine criteria consistent with the NCP (Superfund sites only) (EPA, 1990b). If the proposed clean-up level is outside of the range of 400 ppm to 1,200 ppm lead, then the draft decision document for the site is sent to the Lead Sites Consultation Group (LSCG) for review (EPA, 1997b).

Lead Sites Consultation Group (LSCG) – The Lead Sites Consultation Group (LSCG) was created in 1997 to promote national consistency in decision-making at lead sites across the country (EPA, 1997b). The main purpose of the group is to review key response decisions at lead sites. The LSCG is comprised of senior management representatives from the Waste Management Divisions in all 10 EPA regions along with senior representatives from the Office of Emergency and Remedial Response in EPA headquarters.

The LSCG is supported by EPA's Technical Review Workgroup for Lead (TRW) and the national Lead Sites Workgroup (LSW). According to Agency policy, there are three triggers that cause the review of lead-related proposed plans by the LSCG (EPA, 1997b):

1) Residential contaminated lead sites with proposed cleanup levels outside a 400 to 1,200 ppm soil-lead level;
2) Sites that envision actions to address non-soil lead-contaminated media;
3) Routine LSW deliberations that identify a unique or precedent setting site issue(s).

6.0 APPLICATION OF CLEAN-UP NUMBERS/REMEDIATION

The following section provides a detailed discussion of recommended minimum considerations to remediate residential soil and other sources of lead in residential settings. The guidelines stated below apply to early/interim actions and long-term remedial actions. However, due to statutory funding limitations that apply to time-critical removal actions, site-specific determinations regarding yard size limitations, and whether to clean up empty lots and other sources of lead (paint, dust, tap water), should be made by the project manager on a site-by-site basis.

6.1 MINIMUM EXCAVATION DEPTH/SOIL COVER THICKNESS

Based on Agency experience, it is strongly recommended that a minimum of twelve (12) inches of clean soil be used to establish an adequate barrier from contaminated soil in a residential yard for the protection of human health. Cover soil can either be placed after excavation as backfill or placed on top of the contaminated yard soil. The rationale for establishing a minimum cover thickness of 12 inches is that the top 12 inches of soil in a residential yard can be considered to be available for direct human contact. With the exception of gardening, the typical activities of children and adults in residential properties do not extend below a 12-inch depth. Thus, placement of a barrier of at least 12 inches of clean soil will generally prevent direct human contact and exposure to contaminated soil left at depth.

Removal of lead-contaminated soil to depths greater than 12 inches should be considered at sites in cold regions with non-soil lead-contamination sources, such as tailings and crushed battery casings, and whenever it is cost-effective. The additional response cost should be compared to future IC and monitoring costs associated with leaving the material in place. Full vertical removal of residential soil has many advantages, such as reducing or avoiding the costs of maintaining the soil cover, the placement of subsurface barriers/markers, and obtaining environmental easements. Full removal of contaminated soil also satisfies EPA's preference for permanent remedies and normally allows the remediated yard to return to unrestricted use.

Twenty-four (24) inches of clean soil cover is generally considered to be adequate for gardening areas; however, site specific conditions that may require more soil cover (e.g., presence of burrowing animals) should be considered. A 24-inch barrier normally is necessary to prevent contact of contaminated soil at depth with plant roots, root vegetables, and clean soil that is mixed via deep rototilling. Raised garden beds may be built to obtain 24 inches of clean soil, and may be more cost effective than excavating to 24 inches in depth, e.g., excavate 12 inches of contaminated soil, then add 24 inches of soil to create a 12" raised bed.

6.2 SOIL CLEAN-UP OPTIONS

Currently, there are only two remedial actions that generally are considered to be protective, long-term (not interim) remedial actions at residential properties: (1) excavation of contaminated soil followed by the placement of a soil cover barrier and (2) placement of a soil cover barrier without any excavation of contaminated soils. Excavation followed by the placement of a soil cover is the preferred method and is strongly recommended at sites with relatively shallow contamination, such as many smelter sites. In most cases, excavation and placement of a soil cover should be performed whenever the specific conditions of a site do not preclude it. For example, it may not be feasible to fully excavate a very large site cost-effectively, therefore capping, also considered to be protective, may be more appropriate. The advantage of the preferred method is that it is a permanent remedy in terms of removal of lead from areas where children may be exposed.

Several treatment technologies are currently under development to reduce the bioavailability of soil lead, but have not yet been proven to be protective in the long-term. These include amending the soil with phosphorus or high iron biosolids composts. Preliminary results have shown phosphate treatment to reduce the bioavailability of lead in soil by as much as 50 percent. This would mean that soil with lead concentrations in the range between clean-up levels calculated with the pre- and post-treatment bioavailability values could be treated instead of removed (e.g., if the IEUBK model-derived clean-up number using the pre-treatment bioavailability were 400 ppm lead, and the calculated post-treatment clean-up level were 800 ppm lead, then the yards with lead concentrations between 400 ppm and 800 ppm could be treated rather than excavated or capped).

Over time, the efficacy of the phosphorous treatments appears to increase. This is consistent with what is predicted using thermodynamics. To date, the treatability studies have been monitored for 3–5 years. Additional monitoring will be necessary to assure the long-term stability of the observed reduction in bioavailability.

Some other existing technologies for soil remediation that are not currently considered acceptable for residential lead cleanups are rototilling, phytoremediation, and interim controls, such as mulching, seeding, and sodding (without prior removal of contaminated soil). Rototilling is not considered a permanent, protective remedy in that no lead removal occurs, and adequate mixing of soil is difficult, if not impossible, to achieve; additionally, rototilling may increase the volume of soil, which ultimately requires remediation. Mulch, sod, or other vegetative covers are generally not considered permanent, protective remedies in that no lead removal occurs, and there is no guarantee that grass, mulch, or other vegetative cover will be maintained in good condition over time.

Additionally, land use changes that may occur within a yard, such as starting a garden or putting in a swing set, are not precluded in any way by mulch, sod, or other vegetative cover. Lastly, phytoremediation is not currently an appropriate technology for residential lead cleanups due to several factors: (1) the lead concentrations at many residential sites are not within the optimal performance range for the plants; (2) the plants may concentrate lower level lead contamination and present an increased disposal cost if the plants fail the TCLP test, but the unremediated yard soil does not fail; (3) the length of time required for remediation; (4) the potential conflicts with local regulations pertaining to yard maintenance; and (5) the depth of remediation achieved may be inadequate.

6.3 INTERPRETING SAMPLING RESULTS

Based upon the results of the sampling efforts (Section 4.0), this section describes the implementation of two clean-up options: (1) excavation and backfill (and placement of a visible barrier if applicable); or (2) soil cover placement (and placement of a visible barrier if applicable). The options should be performed as described below (see also Figure 6-1). The goal should be to remove all contaminated soil or provide a minimum 12" clean soil barrier. The following describes the implementation of option 1:

- If the 0–1" horizon exceeds the clean-up level, a 6 or 12" excavation is recommended, depending on the 6–12" sample horizon results;
- If the 1–6" or 0–6" horizon exceeds the clean-up level, a 6 or 12" excavation is recommended, depending on the 6–12" sample horizon results;
- If the 6–12" horizon exceeds the clean-up level, a 12" excavation is recommended. A visual barrier is required if the 12–18" horizon exceeds the clean-up level;
- If the 0–1, 0–6 or 1–6" horizons exceed the clean-up level and the 6–12" horizon does not exceed the clean-up level, a 6" excavation is recommended; a visual barrier is not needed.

	Depth	Soil Concentration Exceed Action Level?							
	0-1”	Yes	Yes	Yes	Yes	No	No	No	No
	1-6” (or 0-6”)	Yes	Yes	No	No	No	Yes	No	Yes
Remedial Action Options	6-12”	Yes	No	Yes	No	No	No	Yes	Yes
Option 1: Excavation (& Backfill)	Depth of excavation	12”	6”	12”	6”	No action	6”	12”	12”
Option 2: Capping	Soil cover thickness	12”	12”	12”	12”	No action	12”	6”	12”

Figure 6-1. Interpreting Sampling Results. The figure suggests remedial actions based on the results of composite soil samples collected for each of the depth intervals shown. The figure includes two remedial action options: (1) excavation followed by backfilling, and (2) placement of a clean soil cover without removal of soil that exceeds the action level. To use the figure, find the column of the table that agrees with the soil sample results for your site, then read down the table to determine the depth of soil to remove (option 1: excavation remedies) or the thickness of the soil cover recommended (option 2: capping remedies). For example, the heavy border around the third column of the table corresponds to a situation where the average lead concentration in the 0–1" and 1–6" depth intervals exceed the action level, but the 6–12" interval does not. In this example, it is recommended to remove the top 6" of contaminated soil and replace it with clean soil, or to place a 12" clean soil cover (cap). The goal is to provide a minimum 12” barrier of clean soil when the underlying soil exceeds the action level. Please refer to Section 6.3 for further explanation.

The following describes the implementation of option 2:

- If the 0–1" horizon exceeds the clean-up level, a 12" soil cover and visual barrier should be used;
- If the 0–6" or 1–6" horizon exceeds the clean-up level, a 12" soil cover and visual barrier should be used;
- If the 6–12" horizon exceeds the clean-up level (but not the 0–1", 1–6", or 0–6" intervals), a 6" soil cover should be used;
- If only the 12–18" horizon exceeds the clean-up level, no capping is needed.

The decision to perform soil cleanup to depths greater than 12 inches should be considered on a site-by-site basis. Some advantages to full vertical soil cleanup are listed in Section 6.1. However, there are many sites where lead contamination is located at depth. Full vertical soil cleanup may not be cost-effective and/or feasible at such sites. The depth of excavation and soil cover thickness is an important factor to be considered during the analysis of the nine criteria per the NCP (for Superfund sites) (EPA, 1990b). Potential for freeze/thaw upward migration, groundwater contamination, and the cost, extent, and effectiveness of ICs are some of the factors to be considered in this analysis.

Sampling results obtained for residential lots may indicate that only a portion of the lot contains soil that exceeds the selected clean-up level. For properties less than 5,000 square feet, the spatial scale for the remedial decision should be one-half of the yard. For properties greater than 5,000 square feet, the property should be divided into four quadrants and a remedial decision should be made for each quadrant. It is usually protective to excavate only the portion(s) of the lot that exceed the clean-up level (Figures 6-2a and 6-2b). However, removal of the sod layer and resodding/reseeding the unexcavated portion(s) of the lot is strongly recommended to promote consistency in the vegetative cover of the yard for homeowner satisfaction. When interpreting sampling results for a property, the sampling results of surrounding properties should also be considered to lessen the probability of mislabeling the property as being below the clean-up level, when it is actually above, and to avoid “patchwork clean-up” patterns, which are prone to recontamination.

If the only portion of the yard that exceeds the selected clean-up level is the drip zone, the exterior paint should be checked for lead content. If the drip zone contamination does not appear to be paint-related, the drip zone should generally be cleaned up. If the drip zone contamination appears to be solely paint-related, EPA should promote the remediation of the exterior LBP by local health agencies, other local government agencies, state health agencies, and/or the homeowner. At a minimum, the resident should be notified and informed of the disclosure requirements (Appendix A). Consideration should be given to also notifying the relevant local government agencies and informing them about available remedies, such as HUD grants.

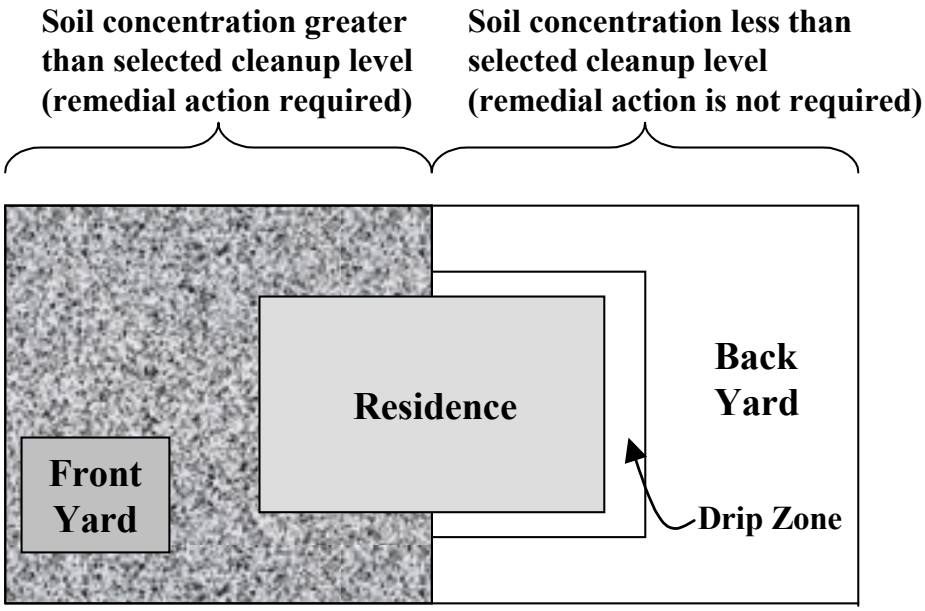


Figure 6-2a. Partial cleanup of residential lot less than or equal to 5,000 square feet in size. In this example, the lead concentration measured in the front yard exceeds the selected clean-up level while the concentration measured in the backyard does not. Cleanup may be limited to the front yard although it is recommended that the sod layer in the entire lot be removed to promote consistency in the vegetative cover on the property for homeowner satisfaction. The entire drip zone should be cleaned up if the average lead concentration exceeds the clean-up level. For example, in the above figure, the drip zone in the back yard (as well as the front yard) should be cleaned up if the average concentration in the drip zone exceeds the clean-up level. Please refer to Section 6.3 for further explanation.

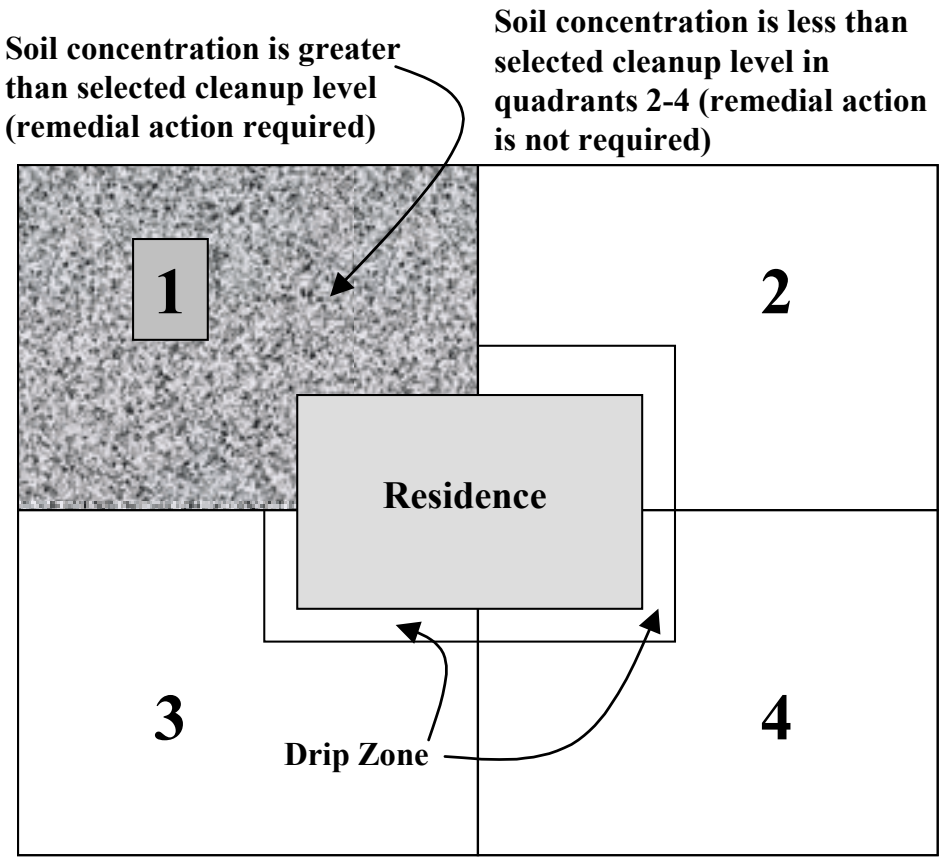


Figure 6-2b. Partial cleanup of residential lot greater than 5,000 square feet in size. In this example, the lead concentration measured in quadrant 1 exceeds the selected clean-up level while the concentration measured in quadrants 2–4 do not. Cleanup may be limited to quadrant 1 although it is recommended that the sod layer in the entire lot be removed to promote consistency in the vegetative cover on the property for homeowner satisfaction. The entire drip zone should be cleaned up if the average lead concentration exceeds the clean-up level. For example, in the above figure, the drip zone in quadrants 2–4 (as well as quadrant 1) should be cleaned up if the average concentration in the drip zone exceeds the clean-up level. Please refer to Section 6.3 for further explanation.

6.4 OTHER CLEANUP CONSIDERATIONS

The area remediated on a single property normally should not exceed one acre. This limitation is based on three factors: (1) typical lot sizes in residential areas throughout the country generally do not exceed one acre; (2) the portion of a property where the majority of exposure to contaminated soil occurs generally does not exceed one acre; and (3) EPA should generally not excavate/cover with soil the entirety of very large yards due to cost-effectiveness considerations.

The goal for cleanup of a yard that exceeds one acre is to excavate or cap the portion of the yard that is in frequent use and continue to limit exposure in the unremediated portion of the yard. To this end, it is recommended that the unremediated portion of such a yard be fenced to clearly delineate the remediated and unremediated areas and to limit the potential for off-site migration of contaminants (e.g., vehicle tracking). Exceptions to this general approach may include areas outside the one-acre area that are used for recreation and gardening, areas with the potential for residential development, and areas in close proximity to other residential areas. As stated in Section 6.5, any unremediated areas of a property should be documented on the clean-up documentation letter for such property, and consideration should be given to implementing ICs for those areas.

If contaminated soil is not removed to the full depth of contamination (i.e., where soil concentration is greater than clean-up level) on a property, a permanent barrier/marker that is permeable, easily visible and not prone to frost heave, should be placed to separate the clean fill from the contamination. This applies to both incomplete vertical excavation with placement of a soil cover and placement of a soil cover without excavating contaminated soil. Selection of an appropriate permanent barrier/marker should be based on the type of contamination left in place, the chemical/physical characteristics of the soil (e.g., pH), the potential for upward migration of the contamination, and/or the types of ICs developed for the site. Examples of suitable barriers/markers include snow fencing (usually orange), a clean, crushed limestone layer, and geofabric.

Empty lots that are zoned residential and contain soils with lead concentrations greater than the clean-up level should be cleaned up when in close proximity to other residential lots. Examples of this are lots between two houses and lots that are near occupied lots. A site-specific determination should be made for these situations. Also, unpaved lots used for vehicle parking should be sampled, and cleaned up if necessary, or access restrictions put in place to prevent recontamination (e.g., vehicle tracking of contaminants) even if no current direct exposure exists. However, it is not the intent of EPA to clean up tracts of remote, undeveloped, lead-contaminated land that may be developed into residential lots in the future. This clean-up responsibility should be borne by the land developer. Institutional controls should

be developed to ensure safe development in these areas, since under CERCLA developers could be held liable for improper cleanup.

6.4.1 Background Lead Concentrations

Many of the “Lead Sites” on the NPL are located in areas with high natural background lead concentration. Often this problem is exacerbated by the presence of high background concentrations of lead in various media (such as soil and groundwater) from anthropogenic sources such as automobile emissions, mining, and smelting (the latter two sources would be considered ‘background’ if they are not associated with the site). It should be noted that CERCLA 104 (a)(3) limits the Agency from taking response actions to address "... naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found” (EPA, 2000a). Generally, under CERCLA, clean-up levels are not set below natural or anthropogenic background concentrations (EPA, 1996c, 1997d, 2002). Cleanup below natural or anthropogenic background concentrations is normally not performed because it is not cost-effective, it is technically infeasible and there is a high likelihood of recontamination by surrounding areas that have not been remediated (EPA, 2002).

Public education about ubiquitous risks should be incorporated early in the process to help the community understand that Superfund actions are designed to address risks from specific releases to the environment (EPA, 2002). In situations like these, it may be appropriate to examine land uses that limit exposures through implementation of ICs. For more information on this approach, please refer to the 1998 Clarification to the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (Appendix B). Site-specific factors should determine what range of alternatives and what clean-up levels will achieve a protective remedy satisfying the nine criteria specified in the NCP.

Remedial decisions often involve a comprehensive response coordinated with other responsible authorities, such as a local public health district, state departments of environmental protection, housing agencies, and private parties. An effort should be made to identify other programs or regulations that may have the authority and capability of addressing risks associated with high natural or anthropogenic background (EPA, 2002). Additional guidance is available for developing a risk management-based response strategy that is protective of human health and the environment (EPA, 1988).

6.5 YARD CLEANUP SPECIFICS

It is important to define the limits of the properties that will be remediated. The use of property lines rather than temporary features, such as fence lines, to delineate boundaries is recommended. The use of temporary features may result in partial cleanup of some properties.

Whether remediation consists of excavation and placement of soil cover or just the placement of a soil cover, consultation with the property owners is important to the development and implementation of response actions and may necessitate property-specific deviations to the guidelines listed in this section. Flexibility is essential to a successful residential lead clean-up program. Some residents may want to pay for upgrades during the cleanup of their yard, such as paving a driveway after excavation, or to have some yard features removed, such as taking out a damaged patio. Within reasonable limits, such requests should be entertained on a yard-by-yard basis. Granting such requests can greatly contribute to building public trust and satisfaction with the clean-up program. All additional costs associated with special requests and considerations must be borne by the homeowner.

Prior to cleanup of a residential yard, access from the property owner should be obtained; access obtained from tenants or renters is not sufficient. It is recommended that access be obtained by going door-to-door. If residents are not home, a blank access agreement with instructions for signature and submission to EPA, along with relevant contact information should be left at the residence (but not in the mailbox). An example access agreement form is presented on page D-6 of Appendix D. As stated in Section 4.2.1, it is suggested that access for remediation be obtained at the time access for sampling is sought. Examples of combined sampling/remediation access agreements are presented on pages D-4 and D-5. An example of a dust cleanup access agreement form is presented on page E-2 of Appendix E. Many residents may refuse access for dust cleanup while granting access for yard-soil cleanup. Combining dust access agreements with other access agreements is not recommended.

Prior to initiating clean-up activity, the condition of each property should be documented and recorded on videotape. 'Clean-up activity' includes any disturbance of the property, including the removal of debris and dilapidated structures that may be required prior to initiating the excavation of contaminated soil. An example of a property inspection form is provided in Appendix F. EPA should enter into a written agreement with the resident regarding any special requests or considerations in cleaning up the yard, e.g., replacing concrete walkway with brick. All additional costs associated with special requests and considerations must be borne by the homeowner. Any contaminated yard areas that will not be cleaned up, special resident concerns, and any deviations from strict soil excavation or capping should be noted on this agreement.

Other possibilities for cleanup-related agreements include sod/lawn watering agreements. A sod-watering agreement basically allows for payment to residents for watering the sod that is placed by the remediation contractor. A payment is made before watering is required to cover the water bill and some of the time involved. A second payment is made if, at the end of one month, the sod is in good condition. A similar agreement should be established for maintaining lawns that have been initiated by hydroseeding. This can be a useful incentive program that can also save money. The contract with the remediation contractor should require the contractor to establish vegetation on each property, restore the pre-construction drainage patterns on each property, and perform repairs for damages to the property.

Relocation of residents during yard soil remediation is rarely needed and is generally not recommended (EPA, 1999b). (Guidance is available online at: http://www.epa.gov/oerrpage/superfund/tools/topics/relocation/index.htm.)

Specific safety issues during residential yard cleanup, including ingress and egress to the home, should be coordinated with the property owner/residents and spelled out in the Health and Safety Plan.

Incomplete barriers (such as rock or gravel) or minimal use areas (such as areas under porches), which exceed the applicable clean-up level, should be cleaned up to the extent practical. Although removal is preferred, if it is not feasible to clean up the area, a barrier, which effectively limits access, should be constructed. For example, for areas underneath porches, typically the preferred barrier would be shot-crete (sprayed concrete that can easily be placed in tight or confined areas). It may be preferable to place asphalt rather than gravel on heavily-trafficked roads or driveways, especially those that experience severe erosion.

In all cases, every attempt should be made to clean up the entire yard (subject to cost limitations discussed below), however, any residential yard areas without permanent barriers that the resident requests to leave unremediated, such as gardens or patios, should be sampled separately to determine if the selected clean-up level is exceeded. If the clean-up level is exceeded and the owner refuses to allow cleanup of that portion of the yard, then the clean-up documentation letter issued to the owner should note the unremediated area.

The steps of a typical soil cleanup are shown in the text box below.

Steps of a Typical Soil Response Action

Step 1 (Access Agreement) - Collect access agreement(s) from each owner and/or tenant before any work is conducted.

Step 2 (Initial Survey) - Interview the resident(s) to determine if there are any specific problems that need attention, and if there are any structures or property the owner wants to have disposed, stored, or left untouched. The contractor will conduct a thorough documentation of the property using drawings, digital photographs, and videotapes. Once documented, the owner is required to sign a property agreement which documents any special requests or considerations in cleaning up the yard, any contaminated yard areas that will not be cleaned up, provisions for structural concrete and fence restoration, and deviations from strict soil excavation and capping.

Step 3 (Excavation) - Each tract is excavated by the contractor(s), who will also complete documentation and provide depth confirmations.

Step 4 (Backfill) - After excavation of properties where full excavation to depth has been performed, the excavated area is backfilled and compacted. After excavation of properties with a vertical excavation limit, a permanent, permeable barrier/marker is placed in the excavated area. After placement of the barrier/marker, the excavation area is backfilled and compacted.

Step 5 (Restoration) - Restoration of the property, including landscaping, sod/seeding, fencing, and concrete (if needed) is conducted.

Step 6 (Final Inspection) - After restoration activities are complete, the EPA, PRP, or its agent (e.g., Corps of Engineers) will conduct a final inspection.

Step 7 (Closeout Form) - A property closeout form should be signed by the property owner, which documents the owner is satisfied with the remediation of the property. Any outstanding issues between the EPA and the homeowner that have not been fully resolved should be documented in the closeout form.

Step 8 (Clean Letter) - After the homeowner signs at property closeout form, the EPA issues a "clean" letter, which documents the property has been remediated. Any areas that are not cleaned up via the owner's request, such as gardens, should be noted in the "clean" letter. For properties where contamination is not completely removed, the clean letter should also document the presence of contamination at depth, and should describe the protective measures that were taken to prevent exposure to the remaining contamination (i.e., barriers/markers).

6.6 CLEANUP OF OTHER SOURCES OF LEAD

Lead in the environment can originate from many sources. In addition to soil, the main sources to consider when performing clean-up activities are interior and exterior LBP, lead-contaminated interior dust, drinking water, and occupational exposure resulting in subsequent contamination of homes. Generally, sources other than soil, exterior paint, dust, and tap water cannot be remediated by EPA in the course of residential lead cleanups.

Ultimately, the project managers should strive to address any unacceptable lead-exposure risks at the residence. Sampling and the establishment of clean-up mechanisms needed to take action, such as HUD grants for paint abatement, should be completed as early in the remedial process as possible. Even so, it may not be possible to address all sources of lead in the ideal sequence. When this occurs, other measures should be taken to minimize the potential for recontamination (i.e., to protect the remedy). For example, if deteriorating exterior LBP is present, it is recommended that it be removed prior to initiating any soil clean-up activities in the yard.

Due to transport of lead among media, the preferred sequence of lead clean-up activities at a residence with LBP and lead-contaminated soil would be to clean up the paint first, then the yard soil, and then the interior dust. Clean-up activities performed counter to this sequence increase the risk of recontamination. For example, performing a soil cleanup first at a residence with exterior paint problems increases the potential for recontamination of the soil from the exterior paint. Similarly, interior dust can be recontaminated by interior LBP. Exterior sources have been shown to cause recontamination of the interior when cleaned before community-wide yard cleanup is completed (EPA, 2000e). Accordingly, project managers should make every effort to coordinate the sequence of clean-up activities to prevent recontamination.

CERCLA and the NCP limit Superfund authority to address interior LBP (see Section 1.2) (EPA, 1990b). If a mechanism exists for addressing the paint, such as a HUD grant or a Supplemental Environmental Project (SEP), then the timing of the paint encapsulation or abatement activities may not coincide with the soil cleanup. Additionally, residents may be more reluctant to grant access for dust remediation since it is more intrusive. On the other hand, EPA actions taken to address lead in drinking water from site sources usually can be taken independently from any soil, dust, or paint cleanups, and should be done as soon as practical.

> Supplemental Environment Project (SEP) – Environmentally beneficial projects which a defendant/respondent agree to undertake in settlement of an enforcement action, but which the defendant/respondent is not otherwise legally required to perform.

6.6.1 Lead-Based Paint

The 1998 Clarification presents OSWER's policy with respect to remediation of interior paint, exterior paint, interior dust, and lead plumbing. Regarding interior LBP, the 1998 Clarification states:

> "EPA has limited legal authority to use Superfund to address exposure from interior lead-based paint. As a policy matter, OSWER recommends that such exposures not be addressed through actual abatement activities. However, EPA Regions should promote addressing interior paint risks through actions by others, such as HUD, local governments and health authorities, or individual homeowners as a component of an overall site management strategy. Any activities to clean up interior lead-based paint by potentially responsible parties (PRPs) or other parties should not result in an increase of the risk-based soil clean-up levels" (EPA, 1998a; Appendix B).

Regarding exterior LBP, the 1998 Clarification indicates that the Regions should avoid using the Superfund trust money for removing exterior LBP and soil contaminated from LBP. However, Superfund dollars may be used to respond to exterior LBP to prevent recontamination of soils that have been remediated, but only after determining that other funding sources are not available (EPA, 1998a; Appendix B). The 1998 Clarification states: "As with interior lead-based paint abatement, EPA Regions should promote remediation of exterior lead-based paint by others, such as PRPs, local governments, or individual homeowners. Clean-up activities of exterior paint conducted by PRPs or other parties should not result in an increase of the risk-based soil clean-up levels" (EPA, 1998a; Appendix B).

As a practical matter, project managers should inform each resident regarding the presence or absence of LBP in their home, and options for encapsulation and abatement. The local health agency and/or the state health agency should be informed regarding the availability of HUD grants for paint assessment and abatement. Additionally, regarding PRP-funded cleanups, if any penalties are being considered for non-compliance (Section 6.9), consideration should be given to allowing the PRPs to perform a SEP for paint assessment and abatement in lieu of some or all of the penalty amount.

6.6.2 Interior Dust

Lead-contaminated interior dust can be derived from multiple sources, including exterior soil, interior and exterior paint, homeowner hobbies, workplace, and other exterior sources; thus, it may be difficult to differentiate between sources of dust contamination. Household lead dust contamination may be a significant contributor to elevated blood lead levels, especially for younger children (under the age of three), and may need to be evaluated in determining risks and clean-up actions at residential lead sites. However, as pointed out previously, there are limitations on EPA's authority to abate these sources of contamination to the extent they are not related to releases or threatened releases to the environment (Appendix B).

Based on the 1998 Clarification, OSWER recommends that Superfund monies should generally not be used to take CERCLA response actions for addressing residential dust exposures due solely to interior paint or other interior sources. However, Superfund monies can be used to address interior dust if it can be shown to be derived from an exterior pollution source (e.g., air lead concentration caused by lead smelter, mining, or mineral processing). Dust mat sampling, which was done at the Bunker Hill Site in Idaho (EPA, 2000e), is one possible method of lead source identification; speciation, which is costly, is another method. (Dust mats are used to measure dust lead concentration and loading rates in residences and other structures.) Where interior dust is being addressed by other authorities, the recommendations presented here may be helpful to guide the dust cleanup.

If the lead in interior dust is solely derived from interior paint, EPA should promote addressing interior dust risks through the actions of others, such as HUD, state and local governments, PRPs, or individual homeowners, as a component of an overall site management strategy. The overall site strategy, as outlined below, should also consider the proper phasing/sequencing of actions to address the multiple sources of lead risks at residential lead sites, as discussed at the beginning of Section 6.6.

The baseline risk assessment should document the relative contributions of lead uptake from all relevant media including direct soil exposures and secondary exposures to soil in indoor dust. Replacement of defaults with a site-specific value for the interior dust concentration, or the soil-to-dust relationship (M_{sd}), should be justified through the use of high quality, compelling, site-specific data (EPA, 1994b, 1998c). Dust sampling is preferred for risk assessment and remedial decisions, but dust modeling may be needed to develop or refine soil action levels.

Lead-contaminated interior residential dust presents a significant exposure pathway that can readily be addressed. Consequently, significant health benefit is gained by removal of contaminated interior dust as early in clean-up activities as possible. However, exterior contamination sources present a threat of recontamination to interior of residences (EPA, 2000e; TerraGraphics, 2001). Therefore, any interior dust clean-up actions should be periodic throughout the project and should culminate in a final cleaning of all residences exceeding an action level after the exterior sources have been remediated. As a practical matter, risk management and reduction may need a phased strategy as recommended below:

Early-Phase Actions: Public awareness and health education efforts should be initiated immediately. Entry way dust mats should be provided to residents. HEPA-filter vacuum cleaners should be provided for use by residents. If warranted, a program to abate interior lead-contaminated dust in homes with acute levels should be initiated to provide temporary risk reduction.

Establish appropriate public health partnerships with state and local health departments, ATSDR, and HUD as early as practical.

Mid-Phase Actions: The source of the interior dust lead contamination should be identified. Monitoring of the changes in lead-contaminated dust (e.g., lead loading in dust, lead concentration in dust, exterior-to-interior lead transport) should be initiated. The public awareness/health education efforts and availability of HEPA-filter vacuum cleaners for use by residents should be continued. Assistance to remove and dispose of old carpets should be provided to residents after yard cleanup has occurred.

Final-Phase Actions: Once the exterior lead sources that were found to contribute to interior dust have been addressed, the final step should consider the active remediation of interior lead-contaminated dust. Actions may include: removal of carpeting, cleaning heat and ventilation ducts, wet wiping hard surfaces and soft surfaces (furniture, draperies, bedding, clothing, etc.). Most of these actions should be limited to living spaces. Areas such as attics, crawl spaces, and other non-living spaces need not be addressed unless they are shown to be a continued source of contamination to the living areas . It is important for dust remediation to be performed as the last phase in the site clean-up process to minimize the risk of recontamination.

6.6.3 Lead Plumbing/Tap Water

The 1998 Clarification states: “Generally CERCLA does not provide legal authority to respond to risks posed by lead plumbing within residential dwellings. It should be noted that the water utility is responsible for providing clean water to the residences. As with interior dust, OSWER recommends that EPA Regions coordinate with local agencies to establish a health education program to inform residents of the hazards associated with lead plumbing and how to protect themselves by regularly flushing, or preferably, replacing lead pipes. Soil clean-up levels should not be adjusted to account for possible remediation of lead plumbing” (EPA, 1998a; Appendix B).

With regard to tap water, it should be sampled, and lead levels in the purged sample in excess of the maximum contaminant level (MCL) established by the Safe Drinking Water Act should be addressed. In general, lead concentrations in the purged sample greater than a removal action level (RAL) of 30 : g/L should be addressed through TCRAs; concentrations between the MCL and RAL should be addressed through NTCRAs or long-term remedial actions. Actions that could be taken include provision of bottled

water, connection to a municipal water supply, tap filtration, and installation of deep wells (in remote areas and where shallow groundwater is contaminated). Regarding first run exceedance for lead, the homeowners should be notified that they may need to address a plumbing or corrosion problem, which is outside of the scope of Superfund.

6.7 PREVENTION OF RECONTAMINATION

Project managers should take steps to mitigate recontamination. During site closeout and five-year reviews, the project manager should also check for recontamination at levels which may threaten the remedy.

At many large-area lead sites, cleanup occurs over a long period of time and through multiple phases, throughout which the potential for recontamination exists. During each of these phases, windblown dust sources, vehicle tracking, flooding, and other mechanisms can recontaminate previously cleaned areas. Although best management practices (BMPs) should minimize the movement of contaminated material from each residence being cleaned, vehicle tracking of contamination from areas yet to be cleaned up can significantly raise concentrations of contaminants in cleaned areas. During the early phase, typically an emergency response action, cleanup is focused towards Tier 1 properties, and cleanup favors a "hop scotch" approach to address the worst risks first. This method of remediation can result in recontamination of clean properties. Confirmation samples should be collected in any areas that have been potentially recontaminated.

Another aspect of large-area lead sites is that complete cleanup of residential properties does not always take place for a variety of reasons (see Sections 6.2 and 6.4); instead a barrier or soil cover is put in place over contaminated soils. Flooding can pose a serious problem for these areas in that flood waters can erode away clean materials leaving subsurface contamination exposed, and entrained sediments bearing contamination may be left on top of newly remediated properties. Inadequate drainage of runoff can move lead into cleaned areas (e.g., lead particles on a crowned road with no curb and gutter may be rinsed onto adjacent residential properties with normal rainfall). Additionally, the activities of burrowing animals can bring contaminated soils to the surface.

Best Management Practice (BMP) – In general, BMPs are a combination of practices that are determined to be the most effective and practicable means of controlling point and nonpoint pollutants at levels compatible with environmental quality goals. In this document, BMPs specifically refer to measures taken during construction activities on properties where contamination has been left at depth to prevent the transfer of those contaminants to other media.

Recontamination of clean soil cover can be caused by ongoing homeowner projects, such as digging a hole through a clean barrier to install fence posts or a new tree or shrub, if preventative measures are not taken. Education and licensing of contractors who work on clean barriers/markers should generally be required (e.g., as part of a local ordinance) to ensure the longevity of the remedy. Also, at many sites (e.g., Bunker Hill), ICs have been most effective when linked to the "call before you dig" program typically operated by many counties to avoid disruption of utility service. In addition, large scale residential development projects that may raze old housing in favor of new will frequently recontaminate areas where lead-contaminated soil was left at depth, without appropriate BMPs in place. BMPs include silt fences, hay bales, etc., to limit movement of contamination off a project site, and stockpiling of contaminated soil on a tarp to prevent contamination of underlying soil (Figure 6-3). EPA provides guidance on the implementation of BMPs in construction activities at sites where contamination is present (EPA, 1997e). Best management practices typically add about 5 percent to project cost (TerraGraphics, 2000). Periodic inspections of residential areas should be performed by the local government to ensure that projects within the site are implementing BMPs.

Wind blown dust can pose a significant threat to the health of individuals at a site and can cause recontamination. Tailings impoundments that have dried can be large sources of windblown lead dust. Most tailings impoundments are large; a wind sweeping across the face of one can carry substantial amounts of contaminated dust and then deposit these particles on a downwind residential area, both causing increased exposure to contaminants, and recontaminating clean areas. Wind blown dust sources are typically a key issue to be addressed early in the sequencing of site activities to minimize this migration.

These are but a few examples of how recontamination can be an ongoing problem that needs to be considered at every site during each phase of cleanup. Although mechanisms vary from site to site, the types of response actions put in place and the sequence in which these actions take place can play a significant role in enhancing the permanence and effectiveness of a remedy.

A disposal area may be needed to dispose of contaminated soil from the site to support typical homeowner projects, as some municipal landfills may not accept contaminated soil. Without free or low cost disposal for contaminated soil available to each homeowner and renter, improper disposal is more likely, which would result in recontamination. In addition, a disposal area may be needed if certain materials at a site, such as carpets, fail TCLP and cannot be commingled with solid waste. It may even be appropriate for the remedy to provide free removal of contaminated soil and provision of clean soil to homeowners (but contractors may be required to pay for these services, or obtain material from approved sources) to encourage maximum compliance and further ensure the longevity of the remedy. The

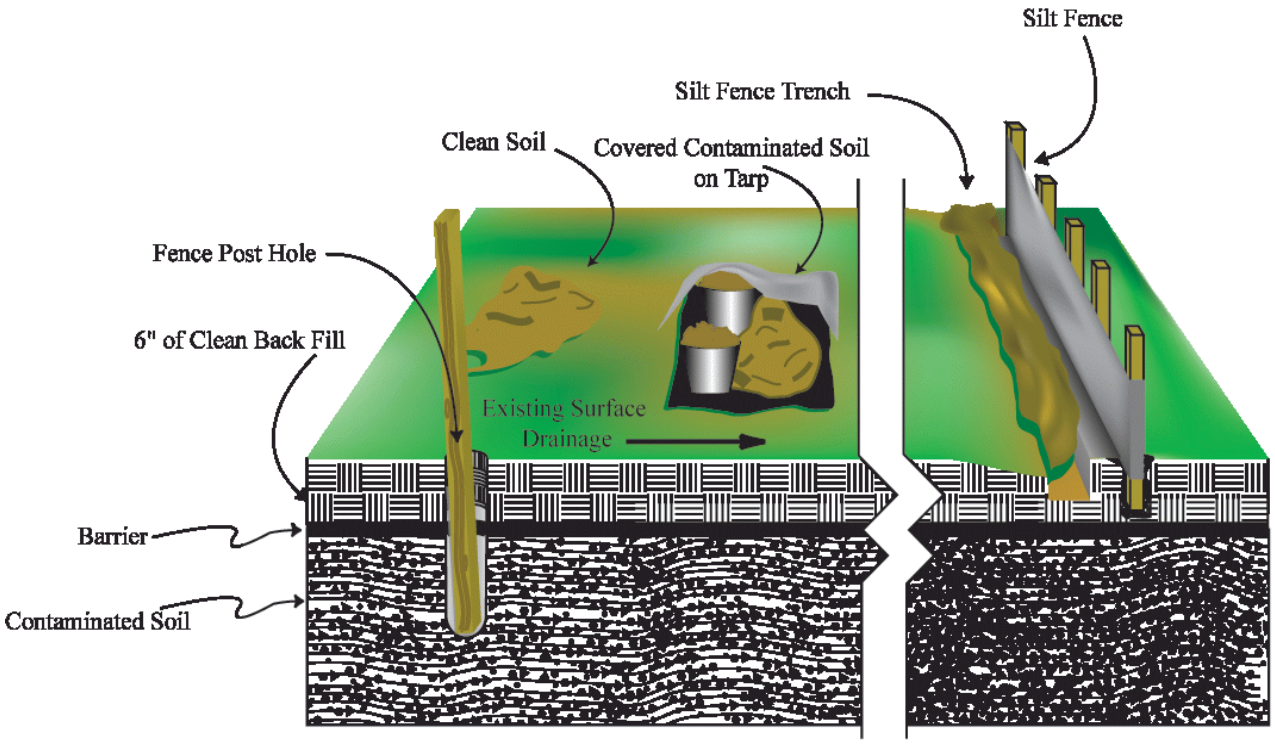


Figure 6-3. Implementing Best Management Practices (BMPs) during construction work. The best management practices (BMPs) shown in the above figure (e.g., a clean soil barrier) represent one component of the ICs which may be put in place by local ordinance to ensure the long-term protectiveness of the remedy and to prevent recontamination. The purpose of BMPs is to minimize the potential for accidental exposure of humans during construction and maintenance activities on sites where wastes have been left in place. The staging of contaminated soil on tarps and/or in small buckets, and the installation of silt fences downgradient of the construction area are examples of BMPs intended to prevent the migration of contaminated material from the construction site. Please refer to Section 6.7.3 for further explanation.

maximum concentration of lead (and perhaps other constituents) allowed in "clean" soil, and the required sampling frequency, should be specified in an IC.

Over the long term, cleanups may not be possible at every property at the same time. A trust fund should be established for the site for the cleanup of properties that are deferred for various reasons, which should be implemented by the local government. In this manner, changes in property ownership over time may be more closely monitored to determine when cleanup at deferred properties might be appropriate (see Section 6.9). Local implementation of the trust fund will ensure that cleanup of these properties occurs as soon as possible, further ensuring the protectiveness of the remedy, further ensuring the protectiveness of the remedy by minimizing the potential for recontamination to the extent possible.

6.7.1 Early Actions

Early response actions (including cleanups for sensitive subpopulations) can be an essential aspect of the response action at a site, as discussed above. These actions should be conducted simultaneously with source area control. The following are considerations that may reduce the potential for recontamination when scoping an early action.

C Seek permanence in selecting the clean-up alternative(s), if possible, such as complete removal to depth of soil contamination at properties where there is an acute risk.

C Consider cleanup of adjacent properties simultaneously that may threaten the permanence or effectiveness of the early action.

C Control fugitive dust sources, access, tracking, and erosion of contaminants to the extent possible.

C Perform HEPA street sweeping to minimize tracking of contaminants throughout a community.

C Evaluate the feasibility of conducting the cleanup of residential areas in their entirety during the early removal phase if contamination is widespread. If this is not possible, limit the early removal actions to immediate risks (Tier 1 and Tier 2 residential properties, including residences with elevated blood lead levels) in order to minimize the potential area where recontamination might occur.

C Provide informational fact sheets to homeowners on how to minimize recontamination on their property.

C Establish an IC to manage cleaned areas. This could involve local and state government agencies, and PRPs that are available to recommend best management practices for homeowner projects and provide education to the homeowner, as well as utility districts and companies likely to breach the barriers/markers put in place.

C Provide site plans or other documentation of areas that have been cleaned up, as well as information on areas that are still contaminated, to the local governmental entity responsible for the maintenance of the remedy, i.e., for monitoring ICs and for tracking properties over time.

• Establish a geographic information system (GIS) for monitoring ICs and properties.

6.7.2 Long-term Remedial Action

Some or all of the following measures may be useful to address the risk of recontamination during the remedial action (Tiers 2 and 3, if a tiered approach is used) and post-design phase:

- Evaluate the permanence and effectiveness of the various remedial actions under consideration. Consider the economic feasibility of complete contaminated soil removal to minimize reliance on ICs.

- Conduct a cost analysis comparing the cost of long term ICs to those of complete removal (EPA, 2000f). For example, property depreciation, tax base impact, additional procedures/cost of utility work, flooding complications/costs, and long term IC administration cost should be taken into account when comparing the cost of a partial removal of contaminants to a complete removal. Property depreciation, while possibly subtle for each property, may add up to substantial losses for the entire community in reference to a county tax base. Also, losses for an individual property over a lifetime of sales could add up to a significant cost. Following cleanup, increases in property valuation from source removal or drainage/infrastructure enhancements (and savings/in-kind services to municipalities) should be considered.

- Remedial action should strive to remediate the contamination in the community by segregable areas, such as a town, or a divisible segment of town. Each segregable area should be cleaned up as quickly as possible (e.g., within one construction season) to minimize recontamination of cleaned properties and to compound the protection to human health (EPA, 2000e). Each community should be cleaned up block by block within these segregable areas, utilizing BMPs to mitigate tracking of contaminants. Site experience suggests that cleanup of up to 800 properties per site per year is possible.

- Fugitive dust that may be a source for recontamination, and access to such sources should be controlled. Air monitoring along with depositional modeling may be necessary to determine if windblown dust presents a significant threat of recontamination. Significant sources of windblown dust should be controlled prior to or simultaneously with cleanup of adjacent residential areas. Consider HEPA street sweeping during remediation and immediately following completion of cleanup to minimize tracking of contaminants throughout a community.

- Complete removal of contaminants should be considered in flood prone areas or areas with a high groundwater level due to the inherent difficulty in maintaining a soil cover remedy in a flood prone area. Drainage-ways containing contamination within their 100-year floodplain, which are

not addressed in the remedy could also lead to remedy failure if the contaminants are eroded to other areas.

C Remediation of contaminated rights-of-way should occur within segregable areas simultaneously, if possible, or as close together in time as possible to minimize vehicle tracking and recontamination of driveways from the rights-of-way.

C Control measures for all remaining sources, such as mining waste piles surrounding the community, should be developed to ensure the remediated neighborhoods are kept clean. ICs should be established to ensure the control, or proper use and disposal of any wastes remaining on site.

C If the residential remedy includes replacement of soils, removal of deteriorating exterior LBP (e.g., by pressure washing) should be considered to minimize the soil recontamination potential.

• Other sources of residential property recontamination should also be considered. For example, homeowners may bring in contaminated soil for fill or other uses on their property.

C Establish permanent funding for ICs. Unless all contaminants are removed, some level of ICs may be necessary. Early establishment of a program is the key to success of a remedy that consists of a partial removal of contaminants.

6.7.3 Institutional Controls (ICs)

EPA defines ICs as administrative and/or legal mechanisms that: (1) help minimize the potential for human exposure to contamination, and (2) protect the integrity of the remedy. ICs accomplish these objectives by directly limiting land or resource use, and/or by providing information that modifies behavior. ICs are used throughout the remedy pipeline, including (1) when contamination is first discovered (i.e., prohibition of excavation of newly discovered soil contamination), (2) when the remedy is ongoing (i.e., restrictions on property use until clean-up levels are met), and (3) when hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

At sites where minimizing exposure is the primary purpose of the IC, it is EPA's policy that if a site cannot support "unlimited use and unrestricted exposure" (EPA, 2000f), ICs are generally required. The "unlimited use and unrestricted exposure" threshold is a site-specific determination similar to that of a five-year review. Essentially, if contamination could result in an unacceptable exposure, ICs would be

required. This is often the case at lead cleanups because residual contamination is frequently managed onsite. Note that the term "residential" is often used interchangeably with the "unlimited use and unrestricted exposure" threshold but these are not synonymous terms. For example, a lead cleanup where the top layer of soil has been removed and replaced can result in a residential use at a site that includes restrictions (e.g., restrictions on digging, requirements for elevated gardens, and an information/outreach program, etc.).

The second common purpose of an IC is to protect the integrity of a remedy. In the lead clean-up context this may mean using institutional controls to prevent penetration of a cap or damage to monitoring equipment. An important consideration in this context is what type of IC will provide the required remedy protection. For example, the primary concern for protecting a remedy in a lead clean-up scenario is typically uncontrolled excavation. For this reason it is important to select ICs that will be relevant to excavators. Examples of potentially effective ICs are local digging or drilling permits and "One-Call" or "Miss Utility" systems. Examples of potentially ineffective ICs are deed notices, because excavators seldom check land records prior to digging.

To better understand the correct IC approach, it is important to understand what tools are available. In general, there are four categories of ICs commonly used in cleanups: governmental controls, proprietary controls, enforcement and permit tools with IC components, and informational devices. The definitions provided below were taken in large part from the current EPA guidance (EPA, 2000f).

Governmental controls are usually implemented and enforced by a state or local government. Some of the more common examples include things like zoning restrictions, building/excavation permits, groundwater drilling and use permits, ordinances, or other provisions that restrict land or resource use at a site. These types of mechanisms are popular in remedies because the administrative processes are in place and are typically well understood within a particular jurisdiction. The greatest concern with this type of control is that it is often implemented, monitored, and enforced by an agency other than EPA or the state.

Proprietary controls are unique in that they have their basis in real property law and that they generally create legal property interests. An example of this type of control is an easement that provides access rights to a property so that an agency may inspect and monitor a cover system. A proprietary control may also be used to restrict certain activities on the property, such as excavating below a certain depth. These are powerful tools in that they can be made to "run-with-the-land" (i.e., effective if ownership changes), but they provide significant challenges because property interests are often transferred. EPA is limited by CERCLA §104(j) with regard to acquiring interests in real property. Prior to acquiring an interest in real property the state must provide an assurance that it will accept transfer of

that interest at completion of the remedial action. This requirement applies at both Fund-lead and enforcement-lead sites. Therefore, if a proprietary control involves the transfer of an interest in real property, EPA must obtain this assurance and find an appropriate entity to hold the interest following the remedial action. At Fund-lead sites this will most likely be the state. At enforcement sites, it may be the state, a PRP, or some other interested and qualified party. In addition, proprietary controls are based on state law, and EPA and many state environmental agencies have limited real estate or common law experience. This can complicate proprietary control enforcement.

Enforcement and permit tools with IC components under CERCLA Sections 104 and 106(a) include unilateral administrative orders (UAOs) and AOCs, which can be issued or negotiated to compel the land owner to limit certain site activities at both federal and private sites. In addition, CERCLA 122(d) authorizes the use of consent decrees at privately-owned sites. Enforcement devices are some of the more common ICs. The strength of these types of tools is that EPA or states can directly enforce them (rather than relying on a local agency for governmental controls or using real estate common law for proprietary controls). The major weakness is that they may be enforceable only against the signatory, recipient, or permitee (i.e., may not run with the land to bind future property owners).

> Unilateral Administrative Order (UAO) – When EPA negotiates with a Potentially Responsible Party (PRP) to do cleanup work at a Superfund site, the agreement may be documented in an administrative order on consent (AOC). If the negotiations fail, EPA has the authority to compel the PRP to do the cleanup by issuing a unilateral administrative order (UAO). Administrative orders are issued under CERCLA sections 104 and 106.

Informational devices are types of devices that only provide information or notification that residual or capped contamination may remain on-site. These types of tools are common at lead cleanups to both provide notification of residual contamination and to provide information that may modify behavior to minimize the potential for unacceptable exposure. Examples include placing a property on a state contaminated properties registry, developing deed notices, and providing periodic lead-education advisories to residents. Due to the nature of informational devices and their non-enforceability, it is important to carefully consider the objective of this category of ICs. Informational devices are most likely to be used as a secondary "layer" to help ensure the overall reliability of other ICs.

There is typically an inverse relationship between the amount of cleanup and the degree of reliance on ICs (i.e., the more cleanup, the less reliance on ICs). EPA tends to focus on a number of considerations when evaluating the long-term viability and amount of redundancy required for ICs at a particular site. EPA guidance strongly advocates the use of ICs in "layers" and/or in "series" (EPA, 2000f). Layering ICs means using multiple ICs concurrently (e.g., a consent decree, deed notice, educational/informational devices and a covenant). Using ICs in series is appropriate when IC

mechanisms are removed or changed as site circumstances change, such as reduction in restrictions during the clean-up life-cycle. As illustrated in the descriptions of the different categories of ICs, there are inherent strengths and weaknesses with each type. The goal is to obtain the best mixture of ICs to manage the risk at a site over the long-term. There are many important factors to consider when determining how many ICs are required at a site. The following is not intended to be a comprehensive list, but rather illustrative of the site-specific nature of these types of decisions. A few common considerations include: (1) the type of enforcement mechanism used (consent decree, order, permit, ordinance); (2) who will enforce the mechanism (i.e., EPA, the state, local agency, third party, etc.); (3) who the intended IC will effect and how; (4) the level of sophistication of the party implementing the cleanup and those remaining on the property; (5) the expected property use (likelihood of redevelopment and/or resale); and (6) the degree of cooperation exhibited by the parties to the cleanup. Since ICs can impact future development at sites, it is important to work cooperatively to determine the appropriate mix of ICs. The objective is not to use as many layers of ICs as possible, but rather to strike a balance that gives the regulators the certainty that the site remedy will be protective over time while maximizing the site's future beneficial use.

At many large lead sites, GIS systems are used to track the cleanup status of properties located on the site. The tracking system facilitates the monitoring of ICs and the maintenance of the remedy. GIS systems can be operated by local governments, state governments or PRPs.

6.8 CLEAN-UP DOCUMENTATION

Upon confirmation that initial yard sampling indicates a given residential yard does not exceed the lead clean-up level for the site, or upon the completion of the cleanup of a residential yard, a letter ("clean" letter) should be sent to the property owner documenting that EPA considers the lead level in the yard to be below the level of human health concern. Prior to issuing a "clean" letter, a property closeout form should be signed by the property owner, which documents the owner is satisfied with the remediation of the property. Examples of property closeout forms are proved in Appendix G. Any areas that are not cleaned up via the owner's request, such as gardens, should be noted in the "clean" letter. If contamination is not cleaned up to depth, this fact, along with protections (i.e., barriers/markers) that are put in place, should be stated in the "clean" letter. The "clean" letter provides official documentation to the property owner for use in future property sales or transactions. Sample "clean" letters are provided in Appendix H.

6.9 ENFORCEMENT

The project manager should strive to characterize all residences within the identified zone of contamination, and achieve cleanup at all residences where lead concentrations exceed the clean-up level. At all residential clean-up sites, a percentage of homeowners typically will refuse to grant access to EPA for sampling and/or for cleanup. In order to meet remedial goals of protecting a community, all residences suspected of being located within a zone of contamination should be sampled. It is important to work with the landowner and be sensitive to a landowner's concerns regarding property access. The project manager should educate the landowner of the dangers that lead contamination may pose. If a landowner still refuses to grant access, the Region should consider issuing an access order for sampling (EPA, 1990c).

An owner of residential property on a Superfund site may be potentially liable under CERCLA § 107(a)(1). However, EPA, as an exercise of enforcement discretion, generally will not take CERCLA enforcement actions against an owner of residential property unless the residential homeowner's activities lead to a release or threat of release of hazardous substances resulting in the taking of a response action at a site. (See Policy Towards Owners of Residential Property at Superfund Sites (July 3, 1991)). Additionally, under CERCLA a residential property owner may qualify for protection from CERCLA liability as a contiguous property owner, bona fide prospective purchaser, or innocent landowner. Under both the statute and EPA's policy, a residential property owner is expected to cooperate with EPA and the person taking the response action. This obligation includes providing access and information as requested, agreeing to comply with land use restrictions relied on in connection with the remedy, and not impeding the effectiveness the effectiveness or integrity of institutional controls. (See CERCLA §§ 101(40)(B)-(H), 107(q)(1)(a), 101(35)(A)-(B)). The project manager should work to inform and educate an owner of EPA's expectations for cooperation in connection with the remedy. If necessary, to meet the commitments of the remedy, EPA should consider taking appropriate steps, such as issuing a UAO, to secure the cooperation of an uncooperative landowner.

If some properties are not addressed under site response actions (e.g., current homeowners with no young children or women of child-bearing age), then consideration should be given to establishing a trust fund (under state authority or local law), to be administered by a local government, for the cleanup of the property at a future date, when the property is transferred (e.g., by sale) to a new owner (see text box). Buyers of contaminated properties could make use of the fund to have the property cleaned up at their discretion.

Example Trust Fund – At the Bunker Hill Superfund Site, a number of property owners refused to have their residential yards cleaned up. Without any obvious need to cleanup the property right away, e.g. an unpaved, contaminated driveway that threatens to recontaminate the neighborhood or a child living at the residence or next door, the PRPs for the site were willing to give the State funds to set aside in an interest bearing account to clean up the properties in the future, when the property changes hands. Property status is then monitored by the local Health District as part of the institutional controls program. The State then manages the funds to ensure maximum interest accrual in an irrevocable trust and disbursement according to the limitations set up in the trust -- for residential property cleanup. Cleanup then occurs under State oversight at the time new owners buy the property thereby ensuring families with children that move into the community are protected.

In the case of rental properties, EPA should order access for cleanup by UAO to all owners of contaminated rental property who refuse access. To ensure the protection of occupants, enforcement of the UAO may be necessary to clean up all rental properties with contamination greater than the clean-up level.

7.0 FIVE-YEAR REVIEW

Five-Year Review – Pursuant to section 121 of CERCLA and the NCP, remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure need to be reviewed every five years to ensure protection of human health and the environment.

CERCLA §121(c) requires an assessment of certain remedial actions every five years on sites where contamination has been left on site (EPA, 2000a). Guidance for conducting five-year reviews has been issued (EPA, 2001h). The purpose of a five-year review is to evaluate the performance of a remedy to determine if the remedy continues to be protective of human health and the environment. Typically, at large lead sites, such as mining and smelting sites, the volume and areal extent of contamination is such that total removal of all contamination above the health-based risk level is economically impractical. Contaminated wastes are generally left on site and covered with soil. The remedy for these types of sites typically includes some type of IC to address residual or encapsulated contamination. A five-year review can determine whether the remedy is stable (i.e., soil covers are undisturbed, and clean areas are not being recontaminated from sources remaining on the site). The review should also assess the ICs that were established for residual source control to determine their effectiveness in protecting human health. As described below, the five-year reviews at large lead sites may involve the collection and evaluation of substantial quantities of data and require significant up-front planning. Much of the following discussion may not apply to small sites.

At many sites, an exposure study has been performed prior to any clean-up activities to determine blood lead concentrations of children in the community. A follow-up exposure study of residents should be conducted during the five-year review to determine if the concentrations have decreased below levels of concern. If the blood lead concentrations have not decreased to acceptable levels, additional environmental studies and individualized, follow-up exposure investigations should be conducted to determine the pathways of exposure that may need to be addressed. Long-term exposure studies can be very useful in understanding exposure trends at a site. They also can be useful to ensure that no pathways of exposure have been missed and to help identify areas of the site that have been recontaminated. In this manner, the project manager can use health data as a means to "double check" the effectiveness of the remedy and to corroborate environmental data. However, blood lead data from limited sampling should not be used as the only metric for gauging the success of a remedy, even if it can be used to identify specific problems. The project manager should coordinate with ATSDR and the local health district with respect to planning and funding such a program.

The five-year review should include resampling at a percentage of each type of property that was remediated during the clean-up actions. A baseline level of resampling should be designed to achieve a

pre-specified level of statistical significance and power. This sampling should assess the potential for recontamination that may be occurring, and may help identify any pathways that may have been missed during remediation. Any sampling that indicates widespread or clusters of soil levels above clean backfill concentrations should be monitored over time to determine if an upward trend exists that may jeopardize the remedy.

Additionally, some level of house dust sampling should occur to determine if levels are rising or falling. House dust, being a primary exposure pathway, should be used as one indicator of remedy effectiveness and also used to detect the presence of recontamination. Lead concentrations in house dust levels often correlate to interior LBP, which is not usually addressed by Superfund (Appendix B). Therefore, interior paint sampling should also be conducted as a component of the risk assessment to aid in determining the source of the lead loading to dust.

At large lead sites, remedy protectiveness issues will often relate to the implementation and management of ICs and recontamination of areas previously cleaned. The five-year review should evaluate the effectiveness of the site ICs and recommend corrections to address any deficiencies that are identified. In order for a five-year review to be effective at sites where ICs are a component in ensuring the effectiveness of the remedy, there should be: (1) clear documentation of the specific type of ICs that were to be implemented, and (2) accurate and complete tracking of subsequent activities and changes in property use following completion of the Superfund remedy.

The following are possible deficiencies for several types of commonly-used ICs and other control measures taken to ensure the protectiveness of the remedy:

- HEPA vacuum loan program not being broadly used.
- Information on interior home cleaning not being widely distributed.
- Lack of access control along rights-of-way, and in unremediated areas.
- Inadequate decontamination of vehicles leaving areas of existing contamination.
- Erosion of unremediated areas onto remediated properties.
- Lack of or inadequate disposal area for snow (that contains contaminated soil).
- Lack of drainage infrastructure and maintenance by local entities.
- Uncontrolled utility excavation in areas with contamination at depth.
- Inadequate road maintenance in areas where contamination exists at depth.
- Inadequate disposal capacity to handle IC-generated wastes.
- Discontinuation of, or diminishing, health education program.
- Decrease of blood lead monitoring.
- Complicated/unfounded ICs and/or change in local government acceptance of ICs.

8.0 FEDERAL FACILITIES

The purpose of this section includes the following: (1) to provide direction to EPA federal facility project managers who oversee response actions involving lead contamination of soils from LBP in residential areas of federal facilities; (2) to build and elaborate on the joint March 1999 EPA and DOD Principles Memorandum (DOD/EPA, 1999a) and the December 1999 Lead-Based Paint Interim Field Guide (DOD/EPA, 1999b); (3) to address situations where the DOD service component will conduct the response actions and the regulatory agencies will provide oversight; and (4) to address the unique considerations that arise when the federal government transfers LBP-contaminated property that is subject to CERCLA §120(h) to non-federal parties (e.g., states, local governments, local reuse authorities [LRAs], and private entities, etc.).

While existing policy, guidance, and directives on lead contamination are applicable at federal facilities, property transfer issues present unique requirements that necessitate this section. This section applies to properties that will be transferred for residential use which are contaminated with lead due to LBP or to properties/parcels whose use would expose sensitive populations (e.g., infants, toddlers, small children, nursing mothers) to unacceptable exposure to lead after the properties are transferred to non-Federal entities.

Beginning in 1995, EPA and DOD began to address policy differences on the clean-up levels for lead in soils from LBP. In 1998, Sherri Goodman, then Deputy Under Secretary of Defense (Environmental Security) and Tim Fields, Assistant Administrator for OSWER, reached agreement on the management of LBP at residential and non-residential areas at BRAC properties. In March 1999, this agreement was formalized as the 'Principles Memorandum' (DOD/EPA, 1999a). The Principles Memorandum stated that for residential areas located on BRAC sites, Title X procedures provide an efficient, effective, and legally adequate framework for addressing LBP in residential areas, and that as a matter of policy, CERCLA/RCRA would apply in limited circumstances. EPA and DOD agreed that generally for residential areas that were being transferred, Title X regulations would apply and that CERCLA/RCRA would apply in limited circumstances. Residential real property is defined by Title X as real property on which there is situated one or more residential dwellings used or occupied, in whole or in part, as the home or residence of one or more persons. It is important to note that Title X defines residential property differently than the Handbook.

For federal property transfers subject to CERCLA where there is a concern about lead contamination to soils from LBP, EPA Regions, where they are involved, will need to make a determination whether the property meets the requirements of CERCLA §120(h)(3). This section of CERCLA outlines deed requirements for transferring property and requires covenants indicating that all

remedial actions have been taken at the site. Federal property contaminated with lead from LBP should be evaluated based on its use, or its intended reuse, before the property has been sold or transferred to another private entity. EPA's evaluation of the transfer should be based on an evaluation of lead contamination by either relying on existing and available information gathered through a combination of file searches and a review of existing data and/or a site risk assessment, which may require the collection and analysis of additional soil samples.

The soil sampling design should be specific to the site. The actual or suspected presence of lead contamination in soil does not necessarily require sampling. Factors to be considered before designing a sampling plan include, but are not limited to, the nature of the facility's operations, its operating records, the age of the buildings/structures under consideration, the maintenance schedule for the buildings/structure, visual inspection, and future use. Based on these factors, it may be reasonable to conclude that the potential risks posed by lead may be acceptable and no further evaluation is needed. It may also be important to consider the ultimate disposition of the property once it leaves federal control. For example, the structures may be scheduled to be demolished, so that the abatement of the hazard may be addressed in the demolition process and may negate the need to conduct clean-up activities.

The EPA project manager and, as appropriate, an EPA risk assessor should work with their federal, state, and local government counterparts to develop a sampling design, where required, that would be scientifically appropriate, minimize the cost of sampling, and provide the information required for risk management decisions. As appropriate, the local redevelopment or reuse authority should be consulted as well. Information from the sampling effort could result in different outcomes: a "no further action decision", a conclusion that more extensive sampling is necessary, or, in some cases, a response action. All of these potential outcomes should be discussed with the lead federal agency, and others as appropriate, prior to the initiation of sampling.

If there is insufficient knowledge to make a conclusion about the risk at the site or if the initial sample results indicate an unacceptable risk from lead, data may be collected by a focused sampling of an environmental media to develop an improved understanding of the risk that may be posed by the lead exposure. It may be appropriate to determine that after visual inspection and/or focused sampling, and after consultation with an EPA risk assessor, the lead from the area may not pose a significant risk that requires further evaluation. Risk evaluations should be based upon a number of factors including the reasonably anticipated future land use, exposure potential, ICs proposed or in place, and bioavailability. The Handbook user is encouraged to obtain detailed information on ICs for federal facilities in the document "Institutional Controls and Transfer of Real Property under CERCLA Section 120(h)3(A), (B), or (C)" (EPA, 2000g).

If the property has been used or will be reused as residential real property after transfer, the EPA project manager should verify that the lead federal agency has followed the Title X regulations and policies regarding sampling and risk assessment. As a guide to assist site managers in understanding Title X regulations and policies, EPA and DOD jointly issued a Field Guide (DOD/EPA, 1999b) that is used by EPA and DOD field personnel when assessing hazards due to LBP. The field guide contains information on performing a Title X paint inspection and risk assessment and outlines the requirements for abating soil contaminated by LBP

The Title X program, through the implementation of the new Title IV of TSCA, establishes certification programs and work practice standards to regulate LBP hazard evaluation and abatement in target housing and child-occupied facilities. There are two types of evaluations covered by Title X. The first evaluation is a paint inspection that includes a surface-by-surface inspection to determine the presence of LBP. All painted surfaces with distinct painting histories are sampled. Usually the paint inspection is done by a combination of portable XRF devices and paint chip sampling.

The second evaluation is a risk assessment to determine if LBP hazards exist. A risk assessment includes taking samples of all deteriorating paint, dust, and soil. The final report recommends methods to deal with all LBP hazards that were found, which could include interim controls or abatement. A comprehensive evaluation consists of a combination of a paint inspection and risk assessment. Paint inspections and risk assessment conducted in accordance with Title X must be performed by certified personnel. All results, whether positive or negative, must be disclosed at the time of sale or rental.

The final TSCA 403 regulation (EPA/HUD, 2001), defines a soil-lead hazard as bare soil on residential real property, or on property of a child-occupied facility, that contains concentrations of lead equal to or exceeding 400 ppm in the play area or an average of 1,200 ppm in the rest of the yard. EPA and DOD have agreed that as a matter of policy, for bare soil with lead concentration between 400 ppm and 1,200 ppm, the Service, in consultation with the EPA, has the option of abatement or interim controls. Based on the final HUD 1012/1013 regulations (24 CFR Part 35) (HUD, 2001), federal agencies can transfer the control and abatement requirements to the purchaser, but by law the federal agency is responsible for performing the LBP inspection and risk assessment and must assure that through contractual mechanisms, the purchaser has performed the abatement of the soil in accordance with Title X.

In cases where the EPA project manager makes a determination that actions taken to address LBP hazards are sufficient (following the requirements outlined in the Field Guide), EPA should agree with the federal agency on the transfer documents and the covenant that all remedial action necessary to protect human health and the environment with respect to any such substances remaining on the property has been taken before the date of such transfer . In the case of BRAC sites, the EPA project manager can agree on the Findings of Suitability to Transfer (FOST) or Findings of Suitability to Lease (FOSL) language, and/or the operating properly and successfully (OPS) determination as required by CERCLA. When an EPA project manager has unresolved questions as to whether actions at residential areas meet the requirements of CERCLA, she/he should raise these issues to the federal agency and provide an opportunity for response. In the case of BRAC sites, it is proper to highlight these concerns in EPA's comments on the FOST/FOSL. Efforts should be made to determine that the purchaser is fully aware that EPA has questions about the condition of the property.

Finding of Suitability to Transfer (FOST) – A process that has been established to identify and prepare property for transfer by deed. Such transfers are usually undertaken at a property where environmental response is not needed or has been taken. However, under certain conditions, new authority now permits earlier transfer. The FOST process also looks at the compatibility of an anticipated reuse with completed restoration activities and identifies restrictions necessary to protect human health and the environment.

Finding of Suitability to Lease (FOSL) – A process that has been established for leasing of property that cannot be transferred by deed because environmental restoration activities are still ongoing. The FOSL process also looks at the compatibility of a proposed reuse with ongoing restoration activities and identifies restrictions necessary to protect human health and the environment and prevent interference with the cleanup.

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APPENDIX A

TITLE X AND EPA'S TOXIC SUBSTANCES CONTROL ACT (TSCA) TITLE IV LEAD PROGRAM

TITLE X AND EPA'S TOXIC SUBSTANCES CONTROL ACT (TSCA) TITLE IV LEAD PROGRAM

Background

The Housing and Community Development Act of 1992 (PL102-550) contained Title X the "Residential Lead-Based Paint Hazard Reduction Act of 1992" (HUD, 1992). Even though this was a U.S. Department of Housing and Urban Development (HUD) authorization bill, it established a series of requirements for EPA. Title X includes a new Title IV of the Toxics Substances Control Act (TSCA). The sections that address EPA alone have section numbers in the four hundred (400) series, such as Section 403, Health Based Standards, whereas the HUD portions have numbers in the one thousand (1000) series, such as Section 1015, Task Force. There is one section, Section 1018, that Congress required both HUD and EPA to jointly issue a rule on disclosure.

Overview

Title X addresses LBP and LBP hazards and requires EPA and HUD to issue regulations to address those items. Title X's emphasis is on actual hazards such as deteriorating paint, lead in dust, or lead in soil versus potential hazards such as intact paint. Generally, Title X does not mandate inspections, risk assessments, abatements of LBP, or LBP hazards. The exceptions are HUD program related actions (Section 1012) or when a federal agency disposes of a property that will be used for residential purposes (Section 1013). However, if you choose to do an inspection, risk assessment, or abatement, Title X establishes certification requirements and work practice standards that must be followed. Title X requires disclosure at the time of sale or rental (Section 1018) and the provision of a brochure *Protect Your Family from Lead in Your Home* (EPA, 1999a), before rehabilitation (Section 406b). EPA may authorize state programs to operate in lieu of the federal program for the 400 series regulations but not Section 1018. See Appendix A for a full discussion of Title X.

Scope of Title X

Title X contains specific classes of structures that it regulates. The first category is "target housing", which is defined as "...any housing constructed prior to 1978 except housing for the elderly or persons with disabilities (unless any child who is less than 6 years of age resides or is expected to reside in such housing for the elderly or persons with disabilities) or any 0-bedroom dwelling."

The second category is "child occupied facilities", which are defined as "... a building or a portion of a building, constructed prior to 1978, visited regularly by the same child, 6 years of age or under, on at least two different days within any week (Sunday through Saturday period), provided that each day's visit lasts at least 3 hours and the combined weekly visit lasts at least 6 hours, and the combined annual visits last at least 60 hours. Child-occupied facilities may include, but are not limited to, day-care centers, preschools and kindergarten classrooms" (EPA, 2001a).

As of December 2001 target housing and child occupied facilities are the only classes of structures for which EPA has issued final regulations.

CERCLA 121(e)(1) exempts any response action conducted entirely on-site from having to obtain a federal, state, or local permit, where the action is carried out under §121. In general, on-site actions need to comply only with the substantive aspects of ARARs and not with the corresponding administrative requirements. Therefore, the administrative requirements laid out under TSCA 402 and 403 are not considered ARARs for actions conducted entirely on-site.

More Information

Section 405 requires EPA to establish a Hot Line and Clearing House for lead. This has been done and the National Lead Information Center's toll free number is 1-(800)-424-LEAD. Additionally the EPA web site at www.epa.gov/lead has all the rules, fact sheets, and guidance documents that the EPA Office of Pollution Prevention and Toxics has developed.

Description of the Sections of Title X

Title X Final Rules in Effect for ONLY Target Housing:

Section 1012. This section establishes the requirements for those who get assistance or mortgage insurance from HUD. The requirements are HUD program specific, but only pertain to those who are involved with a particular HUD program.

Section 1013. This section establishes the requirements for federal agencies that dispose of target housing that will be used for residential purposes.

Section 1018. Section 1018 requires that sellers and landlords disclose known LBP and LBP hazards and provide available reports to buyers and renters. Sellers and landlords must also provide a copy of *Protect Your Family from Lead in Your Home* (EPA, 1999a).

This is a joint rule between EPA and HUD. Section 1018 does not include "child occupied facilities"; EPA developed the concept of "child occupied facilities" under TSCA Title IV, the term is only in effect for TSCA four hundred (400) series rules.

TSCA Final Rules in Effect for ONLY Target Housing and Child Occupied Facilities:

Section 402/404 State Certification Programs establishes a nationally consistent federal Program for the certification of individuals and firms engaged in training, paint inspections, risk assessments, and certification of abatement workers, supervisors and training providers. There are two aspects of the program. States and tribes are encouraged to establish a program that as a whole, is at least as protective as EPA's federal program. The state programs can be more protective. When a state program is approved, it becomes the federal program in that state.

If the state or tribe does not establish an acceptable certification program, EPA operates the national program in that state. Much of the work is done in the EPA Regional Office. As of December 2001, 39 states, the District of Columbia, and 2 tribes have EPA authorized programs. Two states with large populations, which do not have authorized programs, are New York and Florida.

Section 403 establishes hazard standards for lead in paint, dust, and soil. Lead-based paint is a hazard if (1) it is deteriorated; (2) it is present on a friction surface that is subject to abrasion and the dust-lead levels on the nearest horizontal surface are equal to or greater than the applicable dust hazard standard; or (3) it is present on any chewable surface on which there is evidence of teeth marks. (Lead-based paint is statutorily defined as paint containing 1.0 milligram or more lead per square centimeter or 0.5% or more lead by weight.) Dust is a hazard if it contains 40 micrograms or more lead per square foot on floors or 250 micrograms or more lead per square foot on window sills. Soil is a hazard if it contains 400 parts per million or more in play areas or 1,200 parts per million or more in the rest of the yard.

This regulation also established the following clearance levels for interior dust: 40 micrograms lead per square foot for floors, 250 micrograms lead per square foot for window sills, and 400 micrograms lead per square foot for window troughs.

EPA's Section 403 rule was intended to prioritize risks as opposed to being inclusive of situations in which risks of concern exist. Per the rule preamble, *"The hazard standard in this TSCA rule was intended as a ''worst first'' level that will aid in setting priorities to address the greatest lead risks promptly at residential and child-occupied facilities affected by lead-based paint"* (EPA, 2001a). While identification of lead hazards (as defined under TSCA) is a necessary part of the facility reuse process, a minimal approach that would insure only that the letter of the hazard standards are met may not protect against some important risks.

Section 405 establishes standards of environmental sampling laboratories. The National Lead Laboratory Accreditation Program (NLLAP) is administered by the American Industrial Hygiene Association and the American Association for Laboratory Accreditation. All laboratory samples must be analyzed by an NLLAP accredited laboratory.

Section 406b requires that the pamphlet *Protect Your Family from Lead in Your Home* (EPA, 1999a) be distributed no more than 60 days before a renovation in the home.

TSCA Rules Being Developed

Section 402. Renovation and remodeling requirements for target housing and child occupied facilities are being drafted as a proposed rule. Requirements for bridges and structures constructed prior to 1978 are being drafted for re-proposal. Both of these could include training, certification, and work practice standards.

Lead-based Paint Debris. This rule was not required by Title X, but the need was clearly there to treat portions of the debris from lead-based activities differently than the RCRA requirements. There are two categories of waste discussed. First is the paint chips and dust, sludges and filtercakes, wash water and contaminated and decontaminated protective clothing equipment that would continue to be subject to all the requirements of RCRA. Second is the "lead-based paint architectural component debris", which would be exempt from the Toxicity Characteristics rule including Toxicity Characteristic Leaching Procedure (TCLP) testing for lead only. This would allow disposal of these components at construction-demolition (CD) landfills.

Although the Pb Debris Rule is still being developed, in the interim, **EPA has issued a Memorandum that "Regulatory Status of Waste Generated by Contractors and Residents from Lead-Based Paint Activities Conducted in Households" - signed July 31, 2000.** This memo clarifies the regulatory status of waste generated as a result of LBP activities (including abatement, renovation activities, and remodeling) in homes and other residences. This memo explains why LBP generated by contractors in households is "household waste" and thus excluded from the RCRA Subtitle C hazardous waste regulations. The household exclusion applies only to waste generated by either residents or contractors conducting LBP activities in residents. As a result, LBP waste from residences can be discarded in a municipal solid waste landfill or a municipal solid waste combustor.

APPENDIX B

1998 OSWER Directive 9200.4-27P (‘Clarification’)

9200.4-27
EPA/540/F-98/030
PB98-963244

OSWER Directive # 9200.4-27P

MEMORANDUM

SUBJECT: Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities

FROM: Timothy Fields, Jr.
Acting Assistant Administrator

TO: Regional Administrators I-X

PURPOSE

This directive clarifies the existing 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, OSWER Directive 9355.4-12. Specifically, this directive clarifies OSWER's policy on (1) using EPA's Science Advisory Board (SAB) reviewed Integrated Exposure Uptake Biokinetic Model (IEUBK) and blood lead studies, (2) determining the geographic area to use in evaluating human exposure to lead contamination ("exposure units"), (3) addressing multimedia lead contamination and (4) determining appropriate response actions at lead sites. The purpose for clarifying the existing 1994 directive is to promote national consistency in decision-making at CERCLA and RCRA lead sites across the country.

BACKGROUND

OSWER Directive 9355.4-12, issued on July 14, 1994 established OSWER's current approach to addressing lead in soil at CERCLA and RCRA sites. The existing directive established a streamlined approach for determining protective levels for lead in soil at CERCLA sites and RCRA facilities as follows:

- It recommends a 400 ppm screening level for lead in soil at residential properties;
- It describes how to develop site-specific preliminary remediation goals (PRGs) at CERCLA sites and media cleanup standards at RCRA Corrective Action facilities for residential land use; and,
- It describes a strategy for management of lead contamination at CERCLA sites and RCRA Corrective Action facilities that have multiple sources of lead.

The existing interim directive provides direction regarding risk assessment and risk management approaches for addressing soil lead contaminated sites. The OSWER directive states that, " ... implementation of this guidance is expected to provide more consistent decisions across the country ..." However, since that directive was released, OSWER determined that clarification of the guidance is needed. Key areas being clarified by issuance of this directive include: (1) using the IEUBK model and blood lead studies, (2) determining exposure units to be considered in evaluating risk and developing risk management strategies, (3) addressing multimedia lead contamination and (4) determining appropriate response actions at residential lead sites. The existing directive provides the following guidance on these areas:

1. The OSWER directive recommends using the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (Pub. # 9285.7-15-1, PB93-963510) for setting site-specific residential preliminary risk-based remediation goals (PRGs) at CERCLA sites and media cleanup standards (MCSs) at RCRA corrective actions Facilities. The directive states that the IEUBK model is the best tool currently available for predicting the potential blood lead levels of children exposed to lead in the environment. OSWER's directive also recommends the evaluation of blood lead data, where available, and states that well-conducted blood lead studies provide useful information to site managers. The directive however recommends that "... blood lead data not be used alone to assess risk from lead exposure or to develop soil lead cleanup levels."

2. The directive describes OSWER's risk reduction goal as "...generally, OSWER will attempt to limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding a 10 : g/dl blood lead level." The directive also states that "... EPA recommends that a soil lead concentration be determined so that a typical child or group of children exposed to lead at this level would have an estimated risk of no more than 5% of exceeding a blood lead of 10 : g/dl." OSWER generally defines an exposure unit as a geographic area where exposures occur to the receptor of concern during the time of interest and believes that for a child or group of similarly exposed children, this is typically the individual residence and other areas where routine exposures are occurring.

3. The directive recommends that risk managers assess the contribution of multiple environmental sources of lead to overall lead exposure (e.g., consideration of the importance of soil lead levels relative to lead from drinking water, paint, and household dust) which promotes development of risk reduction strategies that address all sources that contribute significantly to exposure.

4. The OSWER directive states that the IEUBK model is not the only factor to be considered in establishing lead cleanup goals. Rather, the IEUBK model is the primary risk assessment tool available for evaluating lead risk and the results of the model are used to guide selection of appropriate risk management strategies for each site.

Since the OSWER directive was issued in 1994, there has been a trend toward a more consistent approach to managing risk at residential lead sites, however, OSWER was interested in identifying areas requiring additional clarification to facilitate more effective implementation of the directive. As a first step in the process, meetings were held with various EPA Regions, States and local governments to discuss how the directive has been implemented nationally at lead sites since 1994. By participating in these meetings and by reviewing the decisions that are being made across the country, OSWER believed that clarification of certain aspects of the 1994 directive would be useful.

All of the documents and guidance referenced in this directive are available through the National Technical Information Service (NTIS) at 703-605-6000 or could be downloaded electronically from: http//epa.gov/superfund/oerr/ini_prod/lead/prods.htm.

OBJECTIVE

At lead contaminated residential sites, OSWER seeks assurance that the health of the most susceptible population (children and women of child bearing age) is protected and promotes a program that proactively assesses and addresses risk. OSWER believes that predictive tools should be used to evaluate the risk of lead exposure, and that cleanup actions should be designed to address both current and potential future risk.

While health studies, surveys, and monitoring can be valuable in identifying current exposures and promoting improved public health, they are not definitive tools in evaluating potential risk from exposure to environmental contaminants. In the case of lead exposure, blood lead monitoring programs can be of critical importance in identifying individuals experiencing potential negative health outcomes and

directing education and intervention resources to address those risks. However, CERCLA §121(b) requires EPA to select cleanup approaches that are protective of human health and the environment and that utilize permanent solutions to the maximum extent practicable. To comply with the requirements set forth in CERCLA §121(b), OSWER will generally require selection of cleanup programs that are proactive in mitigating risk and that do not simply rely on biological monitoring programs to determine if an exposure has already occurred.

To meet these objectives, OSWER will seek actions that limit exposure to soil lead levels such that a typical child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding a 10 : g/dl blood lead level. If lead is predicted to pose a risk to the susceptible population, OSWER recommends that actions be taken to significantly minimize or eliminate this exposure to lead.

The principles laid out in the **four attached fact sheets** (Appendix) support OSWER's goals by encouraging appropriate assessment and response actions at CERCLA and RCRA lead sites across the country.

This clarification directive emphasizes the following key messages regarding the four areas and encourages the users of this directive, be they EPA Regions, States, or other stakeholders, to adopt these principles in assessing and managing CERCLA and RCRA lead sites across the country. The critical elements of the attached papers are as follows:

*I. Using Blood Lead Studies and IEUBK Model at Lead Site*s:

OSWER emphasizes the use of the IEUBK Model for estimating risks for childhood lead exposure from a number of sources, such as soils, dust, air, water, and other sources to predict blood lead levels in children 6 months to 84 (7 years) months old. The 1994 directive also recommended evaluation of available blood lead data and stated that data from a well-conducted blood lead study of children could provide useful information to site managers. In summary, OSWER's clarification policy on the appropriate use of the IEUBK and blood lead studies is that:

- OSWER recommends that the IEUBK model be used as the primary tool to generate risk-based soil cleanup levels at lead sites for current or future residential land use. If Regions propose an alternative method for generating cleanup levels, they are required to submit their approach to the national Lead Sites Consultation Group (LSCG)[1] for review and comment;

- Response actions can be taken using IEUBK predictions alone; blood lead studies are not required; and

- Blood lead studies and surveys are useful tools at lead sites and can be used to identify key site-specific exposure pathways and to direct health professionals to individuals needing immediate assistance in minimizing lead exposure; however, OSWER recommends that blood lead studies not be used for establishing long-term remedial or non-time-critical removal cleanup levels at lead sites.

II. Determining Exposure and Remediation Units at Lead Sites

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[1]The Lead Sites Consultation Group (LSCG) is comprised of senior management representatives from the Waste Management Divisions in all 10 EPA regions along with senior representatives from the Office of Emergency and Remedial Response in EPA headquarters. The LSCG is supported by EPA's Technical Review Workgroup (TRW) for lead and the national Lead Sites Workgroup (LSW). The TRW consists of key scientific experts in lead risk assessment from various EPA Regions, labs and headquarters. The LSW is comprised of senior Regional Project Managers from various Regions and key representatives from headquarters who are experienced in addressing lead threats at Superfund sites.

OSWER recommends that cleanup levels at lead sites be designed to reduce risk to a typical or individual child receiving exposures at the residence to meet Agency guidelines *(i.e*., no greaterthan a 5% chance of exceeding a 10 ：g/dl blood lead level for a full-time child resident). Therefore, it is recommended that risk assessments conducted at lead-contaminated residential sites use the individual residence as the primary exposure unit of concern. This does not mean that a risk assessment should be conducted for every yard, rather that the soil lead contamination data from yards and other residential media (for example, interior dust and drinking water) should be input into the IEUBK model to provide a preliminary remediation goal (PRG) for the residential setting. When applicable, potential exposure to accessible site-related lead sources outside the residential setting should also be evaluated to understand how these other potential exposures contribute to the overall risk to children, and to suggest appropriate cleanup measures for those areas.

III. Addressing Multimedia Contamination at Lead Sites

EPA generally has limited legal authority to use Superfund to address exposure from **interior lead-based paint**. As a policy matter, OSWER recommends that such exposures not be addressed through actual abatement activities. However, EPA Regions should promote addressing interior paint risks through actions by others (*e.g.*, potentially responsible parties (PRPs), other government programs, etc.) as a component of an overall site management strategy. Because of other competing demands on the Superfund Trust Fund, OSWER recommends that EPA Regions avoid using the Superfund Trust Fund for removing **exterior lead-based paint** and soil contaminated from lead-based paint. Superfund dollars *may* however be used in limited circumstances to remediate exterior lead-based paint in order to protect the overall site remedy (*i.e.*, to avoid re-contamination of soils that have been remediated) but generally only after determining that other funding sources are unavailable. As with interior lead-based paint abatement, EPA Regions should promote remediation of exterior lead-based paint by others, such as PRPs, local governments or individual homeowners.

IV. Determining Appropriate Response Actions at Lead Sites

In selecting site management strategies, it is OSWER's preference to seek early risk reduction with a combination of engineering controls (actions which permanently remove or treat contaminants, or create reliable barriers to mitigate the risk of exposure) and non-engineering response actions. All potential lead sources should be identified in site assessment activities. Non-engineering response actions, such as education and health intervention programs, should be considered an integral part of early risk reduction efforts because of their potential to provide immediate health benefits. In addition, engineering controls should be implemented early at sites presenting the greatest risk to children and other susceptible subpopulations.

As a given project progresses, OSWER's goal should be to reduce the reliance on education and intervention programs to mitigate risk. The goal should be cleanup strategies that move away from reliance on long-term changes in community behavior to be protective since behavioral changes may be difficult to maintain over time. The actual remedy selected at each CERCLA site must be determined by application of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (55 FR 8666- 8865, March 8, 1990) remedy selection criteria to site-specific circumstances. This approach also recognizes the NCP preference for permanent remedies and emphasizes selection of engineering over non-engineering remedies for long-term response actions.

This directive clarifies OSWER's policy on four key issue areas addressed in the 1994 OSWER soil lead directive in order to promote a nationally consistent decision-making process for assessing and managing risks associated with lead contaminated sites across the country. The policy presented in these specific issue areas supersedes all existing OSWER policy and directives on these subjects. No other aspects of the existing 1994 directive are affected.

IMPLEMENTATION

The principles laid out in this directive (which includes the four attached factsheets) are meant to apply to all residential lead sites currently being evaluated through the CERCLA Remedial Investigation/Feasibility Study process and all future CERCLA Sites and RCRA Corrective Action Facilities contaminated with lead. The Regions will be required to submit their rationale for deviating from the policies laid out in this directive to the Lead Sites Consultation Group. This directive does not apply to previous remedy selection decisions.

Attachments

cc: Waste Management Policy Managers (Regions I-X)
Stephen Luftig, OERR
Elizabeth Cotsworth, OSW
James Woolford, FFRRO
Barry Breen, OSRE
Larry Reed, OERR
Tom Sheckells, OERR
Murray Newton, OERR
Betsy Shaw, OERR
John Cunningham, OERR
Paul Nadeau, OERR
Bruce Means, OERR
Earl Salo, OGC

NOTICE: This document provides guidance to EPA staff. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus it cannot impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future, as appropriate.

Factsheet: Using the IEUBK Model and Blood Lead Studies at Residential Lead Sites

Question: What is OSWER's policy on using the IEUBK model and blood lead studies in conducting risk assessments and setting cleanup standards at residential lead contamination sites?

Answer: OSWER's policy on using the IEUBK model and blood lead studies in conducting risk assessment and setting cleanup standards is as follows:

A. Use of the IEUBK Model:

1. The IEUBK model is a good predictor of potential long-term blood lead levels for children in residential settings. OSWER recommends that the IEUBK model be used as the primary tool to generate risk-based soil cleanup levels at lead sites for current or future residential land use. If Regions propose an alternative method for generating cleanup levels, they are required to submit their approach to the National Lead Sites Consultation Group (LSCG) for review and comment.

2. Blood lead distributions predicted by the IEUBK model illustrate a plausible range of variability in children's physiology, behavior, and household conditions.

3. Response actions can be taken, and remedial goals developed, using IEUBK predictions alone.

B. Use of Blood Lead Studies/Data:

1. Blood lead studies, surveys, and monitoring are useful tools at lead sites and can be used to help identify key site-specific exposure pathways and direct health professionals to individuals needing immediate assistance in minimizing lead exposure.

2. The utility of blood lead testing results and studies depends on how representative the information is of the population being evaluated, the design of the data collection, and the quality of the laboratory analysis. To this end, OSWER recommends that EPA Regions consult with ATSDR or CDC to assess or design studies according to their intended use.

3. Many blood lead screening, monitoring, or testing programs differ from blood lead studies in that they do not attempt to identify risk factors for childhood exposure to lead sources. Although these programs may be extremely beneficial in identifying children with elevated blood lead levels and identifying candidates for referral to medical professionals for evaluation, they may not provide an accurate representation of community-wide exposure.

4. Well-designed blood lead studies may be used to identify site specific factors and pathways to be considered in applying the IEUBK model at residential lead sites. However, OSWER recommends that blood lead studies not be used to determine future long-term risk where exposure conditions are expected to change over time; rather, they should be considered a snapshot of ongoing exposure under a specific set of circumstances (including community awareness and education) at a specific time. Long-term studies may be helpful in understanding exposure trends within a community and evaluating the effectiveness of cleanup strategies over time.

C. IEUBK and Blood Lead Studies/Data:

1. Blood lead data and IEUBK model predictions are expected to show a general concordance for most sites. However, some deviations between measured and predicted levels are expected. On some occasions, declines in blood lead levels have been observed in association with lead exposure-reduction and health education. However, long-term cleanup goals should be protective

in the absence of changes in community behavior as there is little evidence of the sustained effectiveness of these education/intervention programs over long periods of time.

2. Where actual blood lead data varies significantly from IEUBK Model predictions, the model parameters should not automatically be changed. In such a case, the issue should be raised to the Lead Technical Review Workgroup (TRW) to further identify the source of those differences. Site work need not be put on hold while the issue is being reviewed by the TRW; the site manager should review other elements of the lead directive and the "Removal Actions at Lead Sites" guidance to determine appropriate interim actions to be taken at the site.

The Regions will be required to submit their rationale for deviating from the policies laid out in this factsheet to the Lead Sites Consultation Group.

Factsheet: Determining Exposure and Remediation Units at Residential Lead Sites

Question: How does OSWER define an exposure unit, and subsequently apply this definition in conducting risk assessment and risk management activities at residential lead sites?

Answer: OSWER recognizes that defining and characterizing exposure unit(s) for a site is critically important in undertaking risk assessment activities and in designing protective cleanup strategies. An **exposure unit** is defined as a geographic area where exposures occur to the receptor of concern during the time of interest and that for a child, or group of similarly exposed children, this is typically the individual residence and other areas where chronic or ongoing exposures are occurring.

Various approaches to characterizing and managing risks by exposure units have been examined by OSWER. OSWER recognizes that lead ingestion can also cause adverse health effects in adults and fetuses but believes that by adequately limiting lead exposures to young children at residential sites, these other receptors will generally be likewise protected from adverse health impacts.

EPA's goal is to protect human health and the environment under current and future exposure scenarios. At lead sites, OSWER wants to assure that children's health is protected and promotes a program that proactively assesses risks rather than relying on biological monitoring to determine if an exposure has already occurred. OSWER emphasizes actions be taken at lead sites that will minimize or eliminate exposure of children to environmental lead contamination.

To achieve the above stated goal, OSWER recommends characterizing **exposure units as exposure potential at the individual residence as the primary unit of concern for evaluating potential risk at lead contaminated residential sites**. This recognizes that there are children whose domain and activities occur principally within the confines of a particular residential property. For determining exposure potential (and ultimately developing protective cleanup levels) at the individual home, OSWER recommends the scenario to be evaluated (through use of the IEUBK Model) would be a young child in full-time residence. This approach helps achieve OSWER's recommended health protection goal that an individual child or group of similarly exposed children would have <5% chance of exceeding a blood lead concentration of 10 : g/dl. In designing community wide cleanup strategies, it is essential that non-residential areas (*e.g.*, parks, day care facilities, playgrounds, etc.), where lead exposure may occur, also be characterized with respect to their contribution to soil-lead exposure, and appropriate cleanup actions implemented.

OSWER recommends that risk management decisions for response to residential lead contamination sites focus on reducing risk at residences, but also recommends that response strategies be developed for other site locations (exposure units) where children receive exposure. Flexibility in determining appropriate response actions that provide protection at the individual residence should be considered in context of the NCP remedy selection criteria. The lead exposure issues are complex and OSWER recommends that EPA Regions try to communicate clearly the risk characterization and risk management decisions to the site residents. Affected communities must clearly understand the context of risk management decisions, how these decisions affect the health of their children, and how cleanup actions will influence the future growth and development of the community.

The Regions will be required to submit their rationale for deviating from the policies laid out in this factsheet to the Lead Sites Consultation Group.

Factsheet: Addressing Multimedia Contamination at Residential Lead Sites

Question: What is OSWER's policy on addressing multimedia contamination at residential lead sites?

Answer: OSWER recognizes that several sources of lead-contamination, including soil, ground water, airborne particulates, lead plumbing, interior dust, and interior and exterior lead-based paint may be present at Superfund sites where children are at risk or have documented lead exposure. These lead sources may contribute to elevated blood lead levels and may need to be evaluated in determining risks and cleanup actions at residential lead sites. However, there are limitations on the Agency's statutory authority under CERCLA to abate some of these sources, such as indoor lead-based paint and lead plumbing because CERCLA responses may be taken only to releases or threatened releases into the environment (CERCLA §104 (a)(3) and (4)).

When EPA's resources, or authority to respond or to expend monies under Superfund is limited, OSWER recommends that EPA Regions identify and coordinate to the greatest extent possible with other authorities and funding sources (*e.g.*, other federal agencies and state or local programs). EPA Regions should coordinate with these other authorities to design a comprehensive, cost-effective response strategy that addresses as many sources of lead as practicable. These strategies should include actions to respond to lead-based paint, interior dust, and lead plumbing, as well as ground water sources and lead-contaminated soil.

Although OSWER will encourage that EPA Regions fully cooperate in the development of a comprehensive site management strategy, OSWER realizes that complete active cleanup of these other sources may be difficult to complete due to limited funding available to other authorities. Since complete cleanups of these sources is not guaranteed, and at most sites may be unlikely, OSWER recommends that the soil cleanup levels not be compromised. In other words, the soil cleanup levels should be calculated with the IEUBK model using existing pre-response action site specific data. This is due to the fact that soil cleanup levels at residential lead sites are generally established to protect individuals, from excess exposures to soils, and house dust attributable to those soils, and are not attributable to exposure to other sources such as interior lead paint which should be managed on a residence specific basis. Remediation of non-soil lead sources to mitigate overall lead exposure at individual residences should therefore not be used to modify site-wide soil lead cleanup levels.

The recommendations provided below represent OSWER's policy on addressing lead-contaminated media and/or sources for which EPA has limited or no authority to remediate.

Interior Paint: EPA has limited legal authority to use Superfund to address exposure from interior lead-based paint. As a policy matter, OSWER recommends that such exposures not be addressed through actual abatement activities. However, EPA Regions should promote addressing interior paint risks through actions by others, such as HUD, local governments, or individual home owners as a component of an overall site management strategy. Any activities to clean up interior lead-based paint by PRPs or other parties should not result in an increase of the risk-based soil cleanup levels.

Exterior Paint: Because of other competing demands on the Superfund Trust Fund, OSWER recommends that EPA Regions avoid using the Superfund Trust Fund for removing exterior lead-based paint and soil contaminated from lead-based paint. Superfund dollars *may* be used to respond to exterior lead-based paint for protecting the overall site remedy (*i.e.*, to prevent re-contamination of soils that have been remediated) but only after determining that other funding sources are unavailable. Where other sources of funding are not available, EPA may utilize the CERCLA monies to remediate exterior lead-based paint on homes/buildings, around which soil contaminated by other sources has been cleaned up to prevent recontamination of the soil. The Superfund should not be used to remediate exterior lead-based paint where no soil cleanup has occurred. As with interior lead-based paint abatement, EPA Regions

should promote remediation of exterior lead-based paint by others, such as PRPs, local governments or individual homeowners. Cleanup activities of exterior paint conducted by PRPs or other parties should not result in an increase of the risk-based soil cleanup levels.

Interior Dust: Lead contaminated interior dust can be derived from several sources, including interior paint, home owner hobbies, exterior soil, and other exterior sources. In many cases, it may be difficult to differentiate the source(s) for the lead contamination in the dust. In general, EPA Regions should refrain from using the Superfund Trust Fund to remediate interior dust. Because of the multi-source aspects of interior dust contamination, potential for recontamination, and the need for a continuing effort to manage interior dust exposure, OSWER recommends the use of an aggressive health education program to address interior dust exposure. Such programs, administered through the local health department (or other local agency), should be implemented in conjunction with actions to control the dust source. At a minimum, the program should include blood lead monitoring, and personal hygiene and good housekeeping education for the residents. OSWER believes that EPA Regions can also support the program by providing HEPA vacuums to the health agency for use in thoroughly cleaning home interiors.

Lead Plumbing: Generally CERCLA does not provide for legal authority to respond to risks posed by lead plumbing within residential dwellings. It should be noted that the water purveyor is responsible for providing clean water to the residences. As with interior dust, OSWER recommends that EPA Regions coordinate with local agencies to establish a health education program to inform residents of the hazards associated with lead plumbing and how to protect themselves by regularly flushing, or preferably, replacing lead pipes. Soil cleanup levels should not be adjusted to account for possible remediation of lead plumbing.

Factsheet: Determining Appropriate Response Actions at Residential Lead Sites

Question: What is OSWER's position on the appropriate use of engineering and non-engineering response actions in developing risk management strategies for lead sites?

Answer: One goal emphasized in the recent third round of Superfund Reforms is for EPA to take a consistent approach in selecting and implementing both long- and short-term response actions at lead sites in all regions. One obstacle to achieving this consistency has been differing degrees of reliance on non-engineering response actions in reducing risk.

Site management strategies at lead sites typically include a range of response actions. Alternatives range from engineering controls that permanently remove or treat the contaminant source to non-engineering response actions, such as educational programs and land use restrictions. This continuum represents the range of response options available to risk managers. This position paper clarifies the relationship between engineering and non-engineering response actions in developing site management strategies.

In selecting site management strategies, OSWER's policy will be to seek early risk reduction with a combination of engineering controls (actions which permanently remove or treat contaminants, or which create reliable barriers to mitigate the risk of exposure) and non-engineering response actions. All potential lead sources should be identified in site assessment activities. Non-engineering response actions, such as education and health intervention programs, should be considered an integral part of early risk reduction efforts due to their potential to provide immediate health benefits.[2] In addition, engineering controls should be implemented early at sites presenting the greatest risk to children and other susceptible subpopulations. Community concerns should receive a high priority in site decision-making; local support is vital to the success of health intervention and education programs.

As the project progresses, OSWER's goal should be to reduce reliance on education and intervention programs to mitigate risk. The goal should be cleanup strategies that move away from reliance on long-term changes in community behavior to be protective; behavioral changes may be difficult to maintain over time. The actual remedy selected at each site must be determined by application of the NCP remedy selection criteria to site-specific circumstances. However, this approach recognizes the NCP preference for permanent remedies and emphasizes the use of engineering controls for long-term response actions. This approach also recognizes that well-designed health intervention and education programs, when combined with deed restrictions and/or other institutional controls, may be appropriate for reducing future exposure potential and may supplement engineering controls.

In instances where Regions believe that the use of engineering controls is impracticable, and education, health intervention, or institutional controls are proposed as the sole remedy, Regions will be required to consult with the LSCG.

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[2]The actual effectiveness of health intervention and educational programs in reducing risk continues to be a subject of discussion. Anecdotal information suggests that such programs can provide short-term benefits in some populations. Rigorous statistical studies demonstrating the benefits of educational programs in preventing lead exposure are lacking. It is generally recognized that not all segments of the population will be influenced by such programs, and that long-term benefits are less certain. Local support for such programs is critical. The active (and long-term) participation of local and state public health agencies is needed in implementing institutional controls, including health intervention and education programs; without local implementation of such programs their success is uncertain. Additional research on the effectiveness of these programs is critical to consideration of their use in future cleanups.

APPENDIX C

Contacts and Software for Sampling Design

Table C-1
Contacts and Software for Sample Planning Design

Topic		Contact(s)
Sampling plan design/ Systematic Planning	General support	EPA HQ Quality Staff Phone: (202) 564-6830 FAX: (202) 565-2441 E-mail: quality@epa.gov
	Dynamic Field Activities	Internet: http://www.epa.gov/superfund/programs/dfa/index.htm
Software	DEFT: Data Quality Objectives Decision Error Feasibility Trials	E-mail: quality@epa.gov Internet: http://www.ornl.gov/doe_oro/dqo/resdqo.htm
	FIELDS: Fully Integrated Environmental Decision Support	Internet: http://www.epa.gov/region5fields/static/pages/index.html
	Geo-EAS: Geostatistical Environmental Assessment Software	E-mail: englund.evan@epa.gov Internet: http://www.ai-geostats.org/
	SADA: Spatial Analysis Decision Assistance	E-mail: sada@tiem.utk.edu Internet: http://www.tiem.utk.edu/~sada/
	VSP: Visual Sample Plan	E-mail: nell.cliff@pnl.gov Internet: http://dqo.pnl.gov/vsp/

APPENDIX D

Examples of Property Access Agreement Forms

CONSENT FOR ACCESS TO PROPERTY FOR SAMPLING

Name: _____ Daytime Phone Number: _____

Address(es) of Property(ies): _____

_____

I consent to officers, employees, and authorized representatives of the United States Environmental Protection Agency (EPA) entering and having access to my property for the purpose of taking [DESCRIBE NUMBER OF SAMPLING LOCATIONS AND DEPTHS] which are necessary to implement the cleanup of lead contamination in the soil.

This written permission is given by me voluntarily with knowledge of my right to refuse and without threats or promises of any kind. I understand that EPA or authorized representatives of EPA will contact me at least one week in advance before the soil samples are collected. This agreement is only for the purpose of soil sampling and no other work.

_____
Date

☐ I grant access to my property

☐ I do not grant access to my property

_____
Signature

_____
Signature

☐ I would also like EPA to have a lead expert contact me to schedule a free inspection to identify potential lead hazards in my home and provide safety tips.

United States Environmental Protection Agency Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

CONSENT FOR ENTRY AND ACCESS TO PROPERTY FOR SAMPLING

Description of property (including address) for which consent to access is granted:

> Example: XXXX Street, Texarkana, Arkansas, more particularly described as a lot measuring approximately 3,000 square feet, including a two-room wood structure of approximately 300 square feet

Name of Signatory: _____

Address: _____
_____
_____ Phone: (_____)_____

Relationship to property (e.g., owner, lessee, agent or employee of owner, etc.):

I HEREBY CONSENT to officers, employees and parties authorized by the U.S. Environmental Protection Agency (EPA), entering and having continued access to the property described above at reasonable times for the following purposes (List the activities to be undertaken on the property):
Example:

- Sample collection including: (1) the gathering of soil from the outside area of the property; (2) drawing water from the tap; and (3) vacuuming the inside area of any inhabitable structure in order to collect dust.

- Taking photographs to record the sampling process.

I realize that these actions are undertaken pursuant to EPA's response and enforcement responsibilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. Sections 9601-9675. This written permission is given by me voluntarily with the knowledge of my right to refuse and without threats or promises of any kind.

This agreement expires on: _____
(Date)

I HEREBY WARRANT that I have authority to make this access agreement.

_____ _____
Date Signature

_____
Print name

CONSENT FOR ACCESS TO PROPERTY FOR SAMPLING AND TO TAKE RESPONSE ACTION

Name: _____ Daytime Phone Number: _____

Address(es) of Property(ies): _____

_____

I consent to officers, employees, and authorized representatives of the United States Environmental Protection Agency (EPA) entering and having access to my property for the purpose of sampling and taking a response action including: (1) preparing for and excavation of soil from my property; (2) backfilling the excavated area(s) with clean soil and/or backfill; and (3) restoring any grass or other vegetation or structures to their pre-excavation state. These activities are necessary to implement the cleanup of lead contamination in the soil.

This written permission is given by me voluntarily with knowledge of my right to refuse and without threats or promises of any kind. I understand that EPA or authorized representatives of EPA will contact me approximately two weeks in advance before the removal of soil begins, to discuss the steps involved in the excavation and removal program and all measures EPA will take to restore my yard. I also understand that if there is any damage to structures such as sidewalks that is caused by the work conducted by EPA or authorized representatives of EPA, then EPA or authorized representatives of EPA shall repair such damage.

_____
Date

☐ I grant
access to my property

☐ I do not grant
access to my property

_____
Signature

_____
Signature

XXXX TRIBE OF OKLAHOMA

PROPERTY ACCESS CONSENT AGREEMENT
FOR SAMPLING AND TO TAKE RESPONSE ACTION

The Property which is the subject of this agreement is described as follows:

NE 1/4 SE 1/4, Section 6, Township 28 North, Range 24 East, Xxxx County, Oklahoma otherwise described as Beaver Springs Park and Tribal Office which includes the Pow Wow grounds (hereinafter the Property).

THIS ____ DAY OF _____, 1999, by authority of the Xxxx Tribal Business Committee, permission is hereby granted to officers, employees and parties authorized by the United States Environmental Protection Agency (EPA) entering and having continued access to the Property until 4:30 pm (CST) on _____, to conduct the following work (hereinafter the work):

(1) To perform necessary response actions (e.g., excavation of contaminated soil, backfilling with clean soil or gravel, and sodding or seeding) to address lead and other metals from mining waste contamination on the above-described lands in accordance with the EPA Record of Decision issued August 27, 1997;

(2) To take necessary samples of environmental media to identify lead and other metals that may be a threat to public health or welfare or the environment.

Nothing contained in this permit shall operate to delay or prevent a termination of Federal trust responsibilities with respect to the Property by the issuance of a fee patent or otherwise during the term of the work; however, such termination shall not serve to terminate the work. The Xxxx Tribal Business Committee shall notify EPA of any change in status or ownership of the Property.

The Xxxx Tribal Business Committee realizes that the work will be undertaken pursuant to EPA's Superfund authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. Sections 9601-9675.

This written permission is given by the Xxxx Tribal Business Committee voluntarily with the knowledge of its right to refuse and without threats or promises of any kind.

The Xxxx Tribal Business Committee is the property owner or a responsible representative of the property owner and I, Xx Xxxx, as Chairman of that Committee, warrant that I have authority to make this access agreement.

_____ _____

Xx Xxxx
Xxxx Tribal Chairman
Xxxx Tribe of Oklahoma

Date

_____ _____

U.S. Environmental Protection Agency

Date

CONSENT FOR ACCESS TO PROPERTY TO TAKE RESPONSE ACTION

Name: _____ Daytime Phone Number: _____

Address(es) of Property(ies): _____

_____

I consent to officers, employees, and authorized representatives of the United States Environmental Protection Agency (EPA) entering and having access to my property for the purpose of taking a response action including: (1) preparing for and excavation of soil from my property; (2) backfilling the excavated area(s) with clean soil and/or backfill; and (3) restoring any grass or other vegetation or structures to their pre-excavation state. These activities are necessary to implement the cleanup of lead contamination in the soil.

This written permission is given by me voluntarily with knowledge of my right to refuse and without threats or promises of any kind. I understand that EPA or authorized representatives of EPA will contact me approximately two weeks in advance before the removal of soil begins, to discuss the steps involved in the excavation and removal program and all measures EPA will take to restore my yard. I also understand that if there is any damage to structures such as sidewalks that is caused by the work conducted by EPA or authorized representatives of EPA, then EPA or authorized representatives of EPA shall repair such damage.

_____
Date

☐ I grant access to my property

☐ I do not grant access to my property

_____
Signature

_____
Signature

APPENDIX E

Example of Dust Abatement Access Form

CONSENT FOR ACCESS TO PROPERTY

Name: _____ Daytime Phone Number: _____

Address(es) of Property(ies): _____

_____

I hereby consent to grant officers, employees, contractors, sub-contractors and authorized representatives of the United States Environmental Protection Agency (EPA) access to the interior of my home and/or property for the purpose of interior dust abatement. The home dust abatement program being offered at this time consists of vacuuming floors and walls with a special vacuuming system. This system is portable and compact and easy to use. A team of bonded representatives will be providing the service at no charge to the homeowner.

Videotaping of the interior of the residence will be necessary to provide backup documentation in the event of any claims. It will be necessary that someone remain at the residence for one or two days while it is being vacuumed. This lead abatement program is offered only to homeowners who have or will grant access to their property for the remediation of in their yards. These activities are necessary to interrupt the movement of lead through soil dust, house dust, and paint dust.

If you want the process completed in your home and prefer to do it yourself, please note in the appropriate space and arrangements will be made to schedule the loan of a HEPA-VAC unit to you.

This written permission is given voluntarily with the knowledge of its right to refuse and without threats or promises of any kind. I understand that , if any damage to my property results from these activities or any work conducted by the USEPA or its authorized representatives, then the USEPA or its authorized representatives shall repair or replace such damage.

_____

Date

‘ I grant access to my property for Representatives of the EPA to video and vacuum.
‘ I wish to make arrangements to vacuum myself.
‘ I do not grant access to my property.

_____

Signature

Please return as soon as possible for scheduling of work. If you should have any questions please contact [LOCAL CONTACT NAME] at [PHONE NUMBER].

APPENDIX F

Example of Property Inspection Checklist

TAR CREEK PROJECT
PROPERTY HOME INSPECTION CHECKLIST

Address _____ Date _____

Property Group Number _____

Home Interior Access (check one, see comments):
☐ Approved by Property Owner ☐ Denied by Property Owner

Property (Yard) Access (check one, see comments):
☐ Approved by Property Owner ☐ Denied by Property Owner

	OK	NA	PROBLEM/CONDITION
YARD AREA			
1. Lawn Area			
A. Location of Flower/Plant Boxes			
B. Soil (grade) next to house			
C. Shrubbery			
D. Trees			
E. Low areas near house (that could cause ponding of water)			
F. Other: _____			
2. Utility			
A. Water Meter			
B. Gas Meter			
C. Sewer Lines			
D. Other: _____			
3. Driveway			
A. Concrete cracked, damaged			
B. Blacktop cracked, damaged			
C. Uneven Settling			
D. Other: _____			

	OK	NA	PROBLEM/CONDITION
YARD AREA (cont.)			
4. Streetwalk & Walkways			
A. Concrete cracked, eroded			
B. Tripping hazards			
C. Tree roots cracking, lifting slab			
D. Sections missing			
E. Other _____			
5. Garage			
A. Settlement cracks in walls			
B. Concrete floor slab cracked, damaged			
C. Door jambs damaged, rotted			
D. Door hard to open, close			
E. Other: _____			
6. Swimming Pool (Above Ground)			
A. Leakage			
B. Visible damage			
C. Other: _____			
7. Swimming Pool (Below Ground)			
A. Leakage			
B. Visible damage			
C. Other _____			
8. Storm Cellar			
A. Damaged			
B. Indication of Flooding			
C. Other: _____			

	OK	NA	PROBLEM/CONDITION
YARD AREA (cont.)			
9. Electrical Service			
A. Damaged circuit breaker panel box			
B. Wiring hanging outside			
C. Damaged electric meter			
D. Other:_____			
EXTERIOR AREA			
10. 9 Brick 9 Siding			
A. Brick bulging, spalling, cracking			
B. Mortar loose, needs repointing			
C. Lintel needs repair			
D. Stucco bulging, cracking			
E. Siding dented, damaged			
F. Finish wearing off siding			
G. Siding loose, not level, missing			
H. Siding rotted, termites			
I. Composite shingles worn, broken, missing			
J. Windows damaged			
K. Other:_____			
11. Roofing			
A. Age of covering			
B. Shingles worn, damaged, patched			
C. Brick chimney broken, leaning			
D. Joint open between chimney & exterior wall			
E. Need flashing at chimney, vents, walls			

	OK	NA	PROBLEM/CONDITION
EXTERIOR AREA (cont.)			
F. Parapet wall leaning			
G. Roof sagging			
H. Metal flashing damaged, missing			
I. Other: _____			
12. Gutters & Leaders 9 Yes 9 No			
A. Copper discolored, greenish, damaged			
B. Galvanized rusted, patched			
C. Fascia board rotted, damaged, patched			
D. Drain onto foundation wall			
E. Need to divert water from wall			
F. Soffit venting 9 Yes 9 No			
G. Concrete slab cracked, deteriorated			
H. Concrete slab/splash block need			
I. Other: _____			
13. Entrance Steps			
A. Concrete cracked			
B. Brick cracked, mortar loose			
C. Structurally sound			
D. Handrail			
E. Other: _____			
14. Exterior Doors			
A. Damaged			
B. Opens/closes freely			
C. Weatherstripping			
D. Trim rotted, missing			

	OK	NA	PROBLEM/CONDITION
EXTERIOR AREA (cont.)			
E. Jambs rotted, damaged			
F. Frame separation from walls			
G. Other:_____			
INTERIOR AREA			
15. Windows			
A. Trim/sills rotted			
B. Broken glass			
C. Open freely			
E. Frame separation from walls			
F. Other: _____			
16. Kitchen			
A. Cracked walls, ceiling			
B. Loose nails, tape on drywall			
C. Soft, springy floors			
D. Wood, tiles on floor damaged			
E. Faucet leaks			
F. Doors don't close			
G. Cabinets don't close			
H. Moisture in cabinets			
I. Walls have moisture damage			
J. Other: _____			
17. Interior Rooms			
A. Cracked walls, ceiling			
B. Loose nails, tape on drywall			
C. Soft, springy floor			
D. Carpeting water damaged			
E. Water stains near windows			

	OK	NA	PROBLEM/CONDITION
INTERIOR AREA (cont.)			
F. Mold/mildew on walls			
G. Other:_____			
18. Toilet Facility			
A. Cracked tile, plaster on walls			
B. Cracked plaster on ceilings			
C. Loose tiles on walls, floors			
D. Loose nails, tape on drywall			
E. Toilet cracked			
F. Water leaks at closet flange			
G. Grout missing around tub			
H. Shower pan damaged, missing			
I. Shower door damaged, missing			
J. Need new shower door			
K. Water stains on ceiling below bathroom			
L. Hot water heater tank corroded			
M. Water stains on floor around hot water heater			
N. Moisture present around hot water heater			
O. Other:_____			
19. Interior Doors			
A. Open freely			
B. Frame separation from walls			
C. Other:_____			
20. Attic			
A. Only if visual indicator			
B. Other:_____			

	OK	NA	PROBLEM/CONDITION
INTERIOR AREA (cont.)			
21. Foundation			
A. Minor cracks			
B. Settlement cracks at corners, walls			
C. Wall bulging inward			
D. Seepage into basement/cellar			
E. Mortar deteriorating			
F. Other: _____			
22. Basement or Cellar			
A. Seepage, water stains on floor/wall			
B. Sump pump installed			
C. Water pipe leaks			
D. Sewer pipe leaks			
E. Other: _____			
FOUNDATION AREA			
23. Foundation (Slab on Grade)			
A. Settlement cracks			
B. Joint separation			
C. Spalding			
D. Other: _____			
24. Foundation (Elevated Slab w/Crawl Space)			
A. Concrete support integrity			
B. Evidence of moisture or visible moisture in crawl space			
C. Evidence of water accumulation (e.g., water stains)			

	OK	NA	PROBLEM/CONDITION
FOUNDATION AREA (cont.)			
D. Sagging joist/support girders			
E. Fungus growth evident			
F. Sump pump evident			
G. Vents present			
H. Vapor barriers			
I. Pier settlement			
J. Uneven subgrade			
K. Insect damage			
L. Sill plate damaged			
M. Subfloor damaged, loose			
N. Need subfloor			
O. Other:_____			
25. Plumbing (Raised Floors Only)			
A. Pipe insulation crumbling, missing			
B. Need to insulate pipes			
C. Water pipes leaking			
D. Sewer pipes leaking			
E. Water pipe condition			
F. Other: _____			
26. Plumbing			
A. Water pipe conditions			
B. Sewage pipe conditions			
C. Pipes leaking			
D. Pipe insulation			
E. Corrosion on drain lines			
F. Other: _____			

	OK	NA	PROBLEM/CONDITION
FOUNDATION AREA (cont.)			
27. Other Area			
A. _____			
B. _____			
C. _____			
D. _____			

COMMENTS: _____

_____

_____

Topo Survey Requested 9 Yes 9 No

_____ _____

Inspector Signature Date

APPENDIX G

Examples of Property Closeout Forms

USEPA REMEDIATION AGREEMENT FORM

Name: Sam's Restaurant

Address: 5000 Main St.
Madison, IL 62060

Phone: 000-123-4567

This form documents the completion of remedial activity performed on my property. My signature will designate that I am satisfied with the restoration of my property, and that no items are in question, now, or at any time in the future, except those items listed below, if any.

Comments: 100% satisfied.

Restoration items in question:
1. NONE
2.
3.
4.
5.
6.
7.

Chloe Irish	Chloe Irish	01/24/98
Resident Signature	Printed Name	Date
Brad W. Bradley	Brad W. Bradley	04/13/98
USEPA Representative Signature	Printed Name	Date

RESIDENTIAL REMEDIATION INSPECTION/AGREEMENT FORM

Name Sara O'Mara

Address 777 East Ave, Whoville, IN 45123

Phone 000-987-6543

This form documents the completion of remedial activities performed on my property. My signature will designate that I am satisfied with the restoration of my property, and that no items are in question, now, or at any time in the future, except those items listed below, if any.

Comments

Restoration Items in Question:

1. Roll netting on sod to be trimmed off.
2. Stone left side, more stone to be added, taper from building.
3. At double doors back left corner, add rock up to lip to allow vehicle to get in.
4. Also add rock at back of building in middle in front of concrete ledge.
5. Also add rock in open parking area & grade the tops off of the high spots.
6. Check outside of fence on 7th Street, clean up dirt clods rolling under sod & fence.
7.

Property Inspection Date 12/04/98

Lawn Care Instructions Reviewed/Delivered 12/04/98

Sara O'Mara	Sara O'Mara	12/09/98
Resident Signature	Printed Name	Date

Brad W. Bradley	Brad W. Bradley	02/12/99
USEPA Representative Signature	Printed Name	Date

APPENDIX H

Examples of Clean Letters

EPA LOGO AND ADDRESS

Date

Name
Address
City, State Zip

Dear :

The U.S. Environmental Protection Agency (EPA) has completed the cleanup of the lead contamination in your yard located at [ADDRESS, CITY, STATE], in connection with the [SITE NAME] site in [CITY, STATE] (the Site). By way of this letter, U.S. EPA is certifying that your yard has been cleaned up to less than [CLEAN-UP LEVEL] parts per million lead, the level which U.S. EPA considers protective of children's health at the Site.

Thank you for your cooperation in this clean-up effort. It has been our pleasure to work with you. If you have any questions concerning this letter or need further information, please contact me at [PROJECT MANAGER'S PHONE NUMBER].

Sincerely,

[PROJECT MANAGER NAME]
Remedial Project Manager

EPA LOGO AND ADDRESS

Date

Name
Address
City, State Zip

Dear :

The United States Environmental Protection Agency (U.S. EPA) has sampled your yard located at [ADDRESS, CITY, STATE] for lead. The results of this sampling, which are enclosed with this letter, indicate that your yard contains less than [CLEAN-UP LEVEL] per million lead, the level which U.S. EPA considers protective of children's health at the [SITE NAME, CITY, STATE]. Thus, U.S. EPA will not need to perform soil clean-up activities in your yard.

If you have any questions concerning this letter or the enclosure, please contact me at [PROJECT MANAGER'S PHONE NUMBER].

Sincerely,

PROJECT MANAGER NAME
Remedial Project Manager

Enclosure

ENCLOSURE

Analytical results for [ADDRESS]
in parts per million (ppm) of lead:

Depth Zone (inches)	Yards		OR Quadrant			
	Front	Back	1	2	3	4
0 to 1	ppm	ppm	ppm	ppm	ppm	ppm
1 to 6	ppm	ppm	ppm	ppm	ppm	ppm
6 to 12	ppm	ppm	ppm	ppm	ppm	ppm
18 to 24	ppm	ppm	ppm	ppm	ppm	ppm
Deeper Zones (if applicable)	ppm	ppm	ppm	ppm	ppm	ppm
Drip Zone Composite	ppm	ppm	ppm	ppm	ppm	ppm

Mr. John Smith
123 N. Main
Joplin, Missouri 64108

Dear Mr. Smith,

This letter serves as written notification that a lead-contaminated soil clean-up action was performed under authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and reauthorization Act of 1986 on property you have an interest in at the Jasper County, National Priorities Listed Superfund site. Our records show that your property located at **123 N. Main** was included in this action. The clean-up action conducted by the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (COE) addressed residences with soil lead levels over 800 ppm, day care facilities, and residences with children under six years of age with blood lead levels over 15 g/dL.

Briefly, the primary objective of the clean-up action on your property was to remove highly lead-contaminated near-surface yard soils that were located at your residence. In some cases trees, shrubs, flowers, and other vegetation were left in place. As a result a small amount of lead-contaminated soils may be left near the surface on your property. This small amount of contamination should not cause a health threat under normal circumstances. In the future if additional landscaping, or planting requiring excavation below six inches are done, care should be exercised to minimize recontamination.

The excavation criteria for the project was as follows:

A) From the surface to 12 inches, excavation continued until 500 ppm or less lead levels concentrations were achieved;

B) If the residual lead concentrations at a depth of one foot exceeded 1,500 ppm a "marker barrier" was placed at that depth. The marker barrier used was the temporary orange plastic construction-type fence. This material is permeable, and will allow water and plant roots to pass through it. Only a small number of properties required the installation of the barrier. The primary purpose of this marker barrier is to inhibit and alert individuals excavating in these areas in future years.

In general, all areas of the yard that exceeded 500 mg/kg lead at the surface were removed. Soil brought in to backfill the excavation contained less than 240 mg/kg lead.

IF YOU HAVE PLANS TO DO ANY EXCAVATION WORK AT YOUR PROPERTY AND YOU ENCOUNTER THE ORANGE BARRIER PLEASE CONTACT YOUR LOCAL HEALTH DEPARTMENT, THE MISSOURI DEPARTMENT OF NATURAL RESOURCES, OR THE EPA FOR GUIDANCE.

Please save this document for your permanent records. In the event you sell or transfer the property to someone you can show the next owner that a lead cleanup was performed. If you require more specific information concerning the excavation on your property, please feel free to contact me at (xxx) xxx-xxxx.

Sincerely,

(Project Manager)